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Better Communication and Learning in the Classroom. Training teachers' awareness of voice use and room acoustics. An intervention study

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Abstract
The classroom is a common workplace integrating teaching staff and students. Both research and media report on the hampering effects of poor sound environments. Previous research show that it is not enough to treat the room acoustics. Optimized acoustics should be combined with other evidence-based preventive measures for to support teachers' vocal health, well-being; students' performance and study-environment. An intervention program for teachers was designed targeting classroom communication in different acoustic environments. Teachers (n=25) participated. The teachers worked at different schools and at different levels. The overarching aim with this present paper was to investigate the effects of this intervention in teachers' classroom communication and explore the effects on internal (vocal health and well-being) and external (acoustical characteristics in the classroom) factors influencing teachers' communication and interaction with their students. Assessments were done pre/post intervention, at 5-weeks and 3-months follow-up. Self-assessments of vocal health, stress, burnout and self-efficacy were made. The classrooms' acoustics were measured. The results showed significant improvement of teachers' vocal health and self-efficacy; while their perception of stress and burnout significantly decreased. Correlations to the sound environment were found in that that in classrooms with higher ventilation noise teachers reported higher degree of burnout and more voice symptoms. We may conclude that the intervention, albeit its shortness, proved to be effective and can ideally be delivered by a speech-language pathologist, active in the school setting.

Keywords: teachers, interaction, classroom sound environment, vocal health, well being

1 Introduction

Classroom communication is key in creating relationships and support learning [1][2]. A core feature for a classroom supportive of communication is a high quality of the interactions between the teacher and the students [3]. Teachers' communication is important, in terms of the impact their communication has on their students, and for their own well-being and work-ability [4]. The effect of teachers' communication on the students' language learning has been shown in previous research, indicating that the teacher's mode of communication, *i.e.* speech rate and voice quality [5] [6] affect 8-year old students' comprehension [7].

Teachers' communication in the classroom is affected by a number of internal (e.g self-efficacy; vocal health; awareness of room acoustics etc.) and external factors (room acoustics; the students' perception of the teacher; back-ground noise; ambient air quality etc.). The room acoustics from the aspect of speakers' comfort has attracted increased research interest [8], [9]. However, as suggested by Pelegrín-García, to treat the room acoustics is not enough, also teachers' behavior needs to be brought into focus [10]. Also, extensive research has led to the conclusion that teachers present with more voice problems compared to other occupational groups e.g [11], [12]. Also, teachers' voice problems have been established as a factor that affects teachers' capacity to work [13].

Teachers' exposure to noise affects the voice in terms of more vocal symptoms and increased SPL [14], and increased SPL also correlates with more cognitive fatigue at the end of the workday[15]. Stress symptoms also have a significant association with vocal symptoms[16].

In her thesis, Karjalainen states [4]: "The act of classroom communication, i. e. how teachers speak and use other aspects of body communication in their interactions with the students, has not been given much attention, at least not in the area of research. In Sweden, classroom communication seems to be somewhat out of sight, since there seem to be no courses offered on communication skills during teacher education or in professional development as in-service training".

Hence, an intervention program was designed to target teachers' classroom communication in different acoustic environments, training teachers' awareness and, use of voice quality, vocal intensity, speech rate and speech intelligibility as well as other aspects of non-verbal communication: use of gaze, mimics, gestures, positions and movements in the classroom. The overarching aim of the study was to investigate internal (vocal health and well-being) and external (acoustical characteristics in the classroom) factors influencing teachers' communication in the classroom. The further aim was to investigate the effects of the intervention on teachers' classroom communication. The present paper is a summary of the articles included in Karjalainen's doctoral dissertation [17], [18] and [19].

2 Methods

2.1 Participants

The research team was contacted from the school authority in a municipality in Southern Sweden, where lightning and acoustics were treated in a large number of schools. The headmasters at seven schools approved their schools participation. Thirty-two teachers working in grades 3-5 (students' age 9-11 yrs). were willing to participate. The teachers were given oral and written information. Four teachers declined to participate after receiving information. Three teachers were not included since they were working in grade 2. Two teachers were working in grade 6, but were included. In the end, 25 teachers (23 F/2M) participated in the in-service training.

Table 1. Distribution of the 25 participating teachers' as per teaching grade, teaching experience, number of certified teachers (teachers that completed their education) and age.

	Teachers teaching in grade 3	Teachers teaching in grade 4	Teachers teaching in grade 5	Teachers teaching in grade 6
N	11	10	2	2
Years of teaching				
0-T	2	2		
6-19	5	5	2	2
>20	4	3		
Certified	10	9	2	2
Age, mean (range)	43.5 (34-63)	44.6 (27-57)	44.0 (41-47)	41.5 (36-47)

2.2 Procedure, the in-service training

The in-service training was performed in group sessions to four groups with 4-8 participants during fall 2016 and spring 2017. The sessions consisted of five modules and took place at two of the schools after class. They lasted 90 minutes and were given for five consecutive weeks. The process of the training and also the measuring points where the teachers were assessed, emerge from Figure 1.

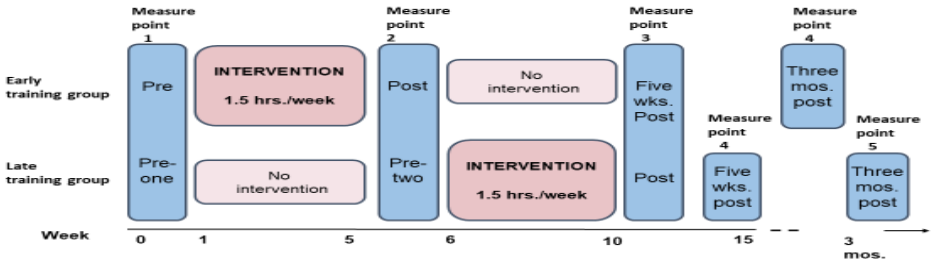

Figure 1. The time-line of the study showing the process of training and testing in two training groups of teachers.

The in-service training aimed to increase teachers' knowledge and practical skills in classroom communication. The content of the training program was evidence-based on knowledge from previous studies and clinical work/teaching, and also on *The Communication Supporting Classrooms Observation Tool (CSCOT)* which contains evidence-based techniques for interactions [20]. The content was presented through a mix of mini-lectures and work-shop practices with frequent feedback on the teachers' actions. Subjects for the sessions were: voice use and voice ergonomics; room acoustics; non-verbal communication and language-supporting strategies.

2.3 Tests and assessments

2.3.1 Room acoustical measures

Acoustical measurements were made for all classrooms. The classrooms were measured for RT (T_{20}), clarity (C_{50}) and ventilation system noise (VSN). All measurements were made in unoccupied classrooms, according to the standards. RT (T_{20}) was measured in accordance with ISO 3382-2 and analyzed in octave bands 125 Hz and 250-4000 Hz. C_{50} was measured according to ISO 3382-1. The equipment used were ElectroVoice 120 + Dodekaeder loudspeakers, a Room Capture system with a Roland UA-55 Quad-Capture sound card, a Crown XLS 1500 amplifier and a BSWA MP281 microphone connected to a Gras amplifier. Two different loudspeaker positions were used, one to the left and one to the right, with the centre of the loudspeaker measured 1.5 meter above the floor and the six recording microphones were positioned in the two last rows of the classrooms with a distance > 5 meters from the loudspeakers. Twelve measurements were made in each classroom. The measurements of VSN were performed in accordance with ISO 10052 (ref), meaning that equivalent sound levels are given in both dBA ($L_{A,\,eq}$) and dBC ($L_{C,\,eq}$) filters and recorded for 30 seconds using a Brüel and Kjaer 2250 sound level meter [4].

2.3.2 Questionnaires

Questionnaires were chosen to be able to make repeated measures of the wide spread of factors regarding teachers' vocal health (Voice Handicap Index-11, VHI-11 [21]), stress (Perceived Stress Questionnaire, PSQ [22]; Well-being [23]; burn-out related to aspects of the workplace [24]. Also self-efficacy was tested since there is a well-known relationship between burnout and self-efficacy in teachers (e.g. Brown, 2012)

Teachers' Sense of Efficacy Scale: Classroom Management Subscale (TSES) was found and it had been translated into Swedish and additionally, had already been used together with questionnaires for stress and burnout [25]. All the questionnaires were presented in Swedish and had previously been validated in either in the original language or in the original language and in Swedish. The questionnaires were filled out using paper and pen. Scorings and calculations were made in accordance with the test manuals.

2.3.3 Focus group interviews

For one of the studies data on the teachers' own view on their classroom communication was collected in focus group interviews. The focus groups were held 6 months post in-service training. The interviews focused on whether the teachers experienced that they had made any changes in their teaching practices related to the in-service training. Five focus groups were held six months post in-service training and they lasted between 17 to 33 minutes and were audio recorded with a digital Zoom Handy Recorder H2 (Zoom Corporation, Tokyo, Japan) [4].

3 Results

The primary objective of this study was to explore the relationship between teachers' well-being and the acoustic characteristics in the classrooms they were working in, either refurbished or non-refurbished. The only significant differences regarding both teachers' well-being and classroom acoustics due to refurbishment were on two acoustical measures, namely RT 250-4000 Hz and C_{50}. RT 250-4000 Hz was significantly shorter in the refurbished classrooms and C_{50} was significantly higher in the refurbished classrooms, meaning the differences were in favor for of the refurbished classrooms. Since RT 250-4000 Hz and C50 were the only measures that differed significantly between refurbished and non-refurbished classrooms, the correlations were made on the pooled data of all classrooms in order to retain more statistical power.

There was a low significant positive correlation between higher degree of burnout and higher ventilation system noise (VSN) dBA. Voice symptoms had a moderate positive correlation with higher VSN dBA. After corrections for multiple testing were made, no previously significant correlations remained significant. Teachers working in lower grades reported more voice symptoms than those working in higher grades.

3.1 Relationship between teachers' well-being and the classroom acoustics

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3.2 Effects of the in-service training on teachers' vocal health, self-efficacy and well-being.

The main results were significant decrease in voice problems at the 3-months follow-up and significant decrease of both stress and degree of burnout at 5-weeks follow-up. Self-efficacy score had increased

significantly at 5-week follow-up. As for voice problems reported with VHI-sum there was a decrease post-intervention and the decrease was significant at 3-month follow-up. Also PSQ index had decreased post-intervention, with a significant decrease at 5-week follow-up. For CBI there was also a significant decrease at 5-week follow-up, and although the result was similar at 3-month follow-up it was not significant. For QPS only small and non-significant changes were seen. Figure 2.

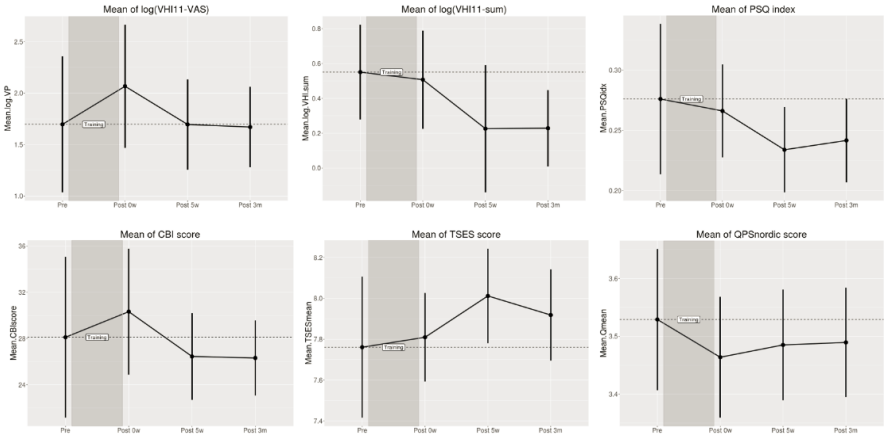

Figure 2. Data from the teachers participating in the study with mean values and regression confidence intervals. The dotted line through the first measure point (Pre-training) indicates the baseline

3.3 Teachers' experience and understanding of classroom communication after in-service training.

"Three overarching themes emerged from the thematic analyses, namely *awareness of voice use, the use of body communication* and *setting the stage for learning.* The teachers talked about *voice use* from different perspectives, ranging from voice use in relation to being heard to vocal health. The teachers gave examples of trying out new kinds of voice use in order to put less strain on the voice. They also mentioned thinking about posture and abdominal breathing while speaking. There was also a more explicit awareness of the importance of the voice as a working tool. The following example describes how a teacher talks about the importance of voice in teaching and that a loss of voice would make it impossible to keep working as a teacher: "*But what you think about more, probably, is that the voice is an incredibly good, important instrument. It's mostly that [which] all teaching is based on – that you can speak. Lose your voice and that's it really. If you get so hoarse that you can't speak, you can't do anything here, that's just the way it is." (Participant 4)*

As for *the use of body communication*, there were examples of moving around more in the classroom while teaching. This is exemplified in one teacher's description of moving around more and fully using the room from different angles: "*I move more in the classroom and stop and talk from different angles, not just from the front. I might stand towards the back of the room. Or in the corner or by the window. Yes, I move about much more." (Participant 7*)

This teacher's description of how she stops and talks shows she is also using positioning in the classroom. Further, teachers reported using more body communication than before and that body communication sometimes can be used instead of words. However, the teachers also mentioned standing still in front of the class and silently waiting to gain the students attention, and that this had gotten the students' attention. Silently awaiting the students, as opposed to raising the voice also constitutes an ease on the voice, and is one of the approaches brought up in the in-service training. Articulation was brought up by some teachers inasmuch as they were more aware after the in-service training of the need to talk more slowly and articulate more deliberately.

Setting the stage for learning relates to the classroom environment. The teachers talked about sound and that they were more aware of the impact of the sound environment after the in-service training and were more focused on noise and sounds in the classroom. One teacher reflected on her awareness of sounds and how to control them and she talked about the impact of high noise levels and how her awareness of the environment had changed. *"Yes, I would say more focus on sound, things that make noises, all those small things. You think more about where they come from. How they start and it doesn't take much to stop them so they don't get to be too much, you stop it in time so you can keep the noise level down. And it's not just we teachers who suffer from the noise, it's the students too of course. It's their working environment as well as ours." (Participant 13)*

The teachers also expressed that they were more active in checking that the students could hear them across the room. It was mentioned that classes vary in this context, which in turn affected what was brought to attention in the classroom. For example in a more noisy class the teacher needs to make the students aware of the sound levels they are generating. The teachers also reported thinking more about the physical, acoustic environment regarding furniture, especially bookshelves" [4].

4 Discussion and Conclusions

Teachers' reported higher degree of burnout and more voice symptoms if working in classrooms with higher noise levels from the ventilation, showing an indication of external factors (acoustical characteristics) affecting internal factors (well-being). In the current sample both teachers' well-being and the acoustical properties of the classrooms were favourable. In another sample, more associations between teachers' well-being and classroom acoustics can be expected. Teachers working in lower grades reported more voice symptoms than those working in higher grades. Voice use is connected to which grade the teacher is working in.

Specific effects of the in-service training program:

Teachers' vocal health and well-being improved and long-term effects were inferred. The teachers increased their knowledge and awareness of voice use, body communication as well as the prerequisites for successful classroom communication and implemented these new practices in their classroom communication.

Finally, these studies show that a rather short intervention aiming at increasing teachers' awareness of voice use and classroom acoustics has good effects. This type of in-service training is recommended for teachers and could preferably be led by a Speech Language Pathologist.

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References

[1] G. Kogut, and R. Silver, "Teacher talk, pedagogical talk and classroom activities," presented at the 3rd Redesigning Pedagogy International Conference, Singapore, Jun. 2009.
[2] J. Hattie, *Visible learning : a synthesis of over 800 meta-analyses relating to achievement*. London : Routledge, 2009, 2009. [Online]. Available: http://ludwig.lub.lu.se/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat01310a&AN=lovisa.001966058&site=eds-live&scope=site

[3] J. E. Dockrell, I. Bakopoulou, J. Law, S. Spencer, and G. Lindsay, "Capturing communication supporting classrooms: The development of a tool and feasibility study," *Child Lang. Teach. Ther.*, vol. 31, no. 3, pp. 271–286, Oct. 2015, doi: 10.1177/0265659015572165.
[4] S. Karjalainen, "Training teacher communication in the classroom. Voice use, body communication and well-being in relation to classroom acoustics.," Lund University, Faculty of Medicine, 2021. Accessed: Sep. 01, 2021. [Online]. Available: https://portal.research.lu.se/portal/en/publications/training-teacher-communication-in-the-classroom-voice-use-body-communication-and-wellbeing-in-relation-to-classroom-acoustics(2b2a4c98-e68e-4c28-976a-91e9659ac95c).html
[5] V. Lyberg-Åhlander, K. J. Brännström, and B. S. Sahlen, "On the interaction of speakers' voice quality, ambient noise and task complexity with children's listening comprehension and cognition," *Front. Psychol.*, vol. 6, 2015, doi: 10.3389/fpsyg.2015.00871.
[6] M. Haake, K. Hansson, A. Gulz, S. Schotz, and B. Sahlen, "The slower the better? Does the speaker's speech rate influence children's performance on a language comprehension test?," *Int J Speech Lang Pathol*, vol. 16, no. 2, pp. 181–190, Apr. 2014, doi: 10.3109/17549507.2013.845690.
[7] V. Lyberg-Ahlander, M. Haake, J. Brannstrom, S. Schotz, and B. Sahlen, "Does the speaker's voice quality influence children's performance on a language comprehension test?," *Int J Speech Lang Pathol*, vol. 17, no. 1, pp. 63–73, Feb. 2015, doi: 10.3109/17549507.2014.898098.
[8] P. Bottalico, S. Graetzer, and E. J. Hunter, "Effects of speech style, room acoustics, and vocal fatigue on vocal effort," *J Acoust Soc Am*, vol. 139, no. 5, p. 2870, May 2016, doi: 10.1121/1.4950812.
[9] D. P. Garcia, J. Brunskog, and B. Rasmussen, "Speaker-Oriented Classroom Acoustics Design Guidelines in the Context of Current Regulations in European Countries," *Acust. United Acta Acust.*, vol. 100, pp. 1073–1089, 2014, doi: 10.3813/AAA.918787.
[10] D. P. Garcia, "The role of classroom acoustics on vocal intensity regulation and speakers' comfort," PhD Thesis, 2011. [Online]. Available: internal-pdf://3000483409/David Pelegrín García thesis.pdf
[11] V. Lyberg-Åhlander, R. Rydell, P. Fredlund, C. Magnusson, and S. Wilén, "Prevalence of Voice Disorders in the General Population, Based on the Stockholm Public Health Cohort," *J. Voice Off. J. Voice Found.*, vol. 33, no. 6, pp. 900–905, Nov. 2019, doi: 10.1016/j.jvoice.2018.07.007.
[12] I. R. Titze, J. Lemke, and D. Montequin, "Populations in the U.S. workforce who rely on voice as a primary tool of trade: a preliminary report," *J. Voice*, vol. 11, no. 3, pp. 254–259, 1997.
[13] H. Vertanen-Greis, E. Loyttyniemi, J. Uitti, and T. Putus, "Work ability of teachers associated with voice disorders, stress, and the indoor environment: A questionnaire study in Finland," *J. Voice*, Oct. 2020, doi: 10.1016/j.jvoice.2020.09.022.
[14] V. L. Ahlander, D. P. Garcia, S. Whitling, R. Rydell, and A. Lofqvist, "Teachers' Voice Use in Teaching Environments: A Field Study Using Ambulatory Phonation Monitor," *J Voice*, vol. 28, no. 6, p. 841.e5-841.15, Jun. 2014, doi: 10.1016/j.jvoice.2014.03.006.
[15] J. Kristiansen, S. P. Lund, R. Persson, H. Shibuya, P. M. Nielsen, and M. Scholz, "A study of classroom acoustics and school teachers' noise exposure, voice load and speaking time during teaching, and the effects on vocal and mental fatigue development," *Int Arch Occup Env. Health*, vol. 87, no. 8, pp. 851–860, Nov. 2014, doi: 10.1007/s00420-014-0927-8.
[16] S. Holmqvist, "The Association Between Possible Stress Markers and Vocal Symptoms," *J. Voice*, vol. 27, no. 6, pp. 787-e10, Nov. 2013.
[17] S. Karjalainen, K. J. Brännström, J. Christensson, B. Sahlén, and V. Lyberg-Åhlander, *A Pilot Study on the Relationship between Primary-School Teachers' Well-Being and the Acoustics of their Classrooms*, vol. 17. 2020. doi: 10.3390/ijerph17062083.
[18] S. Karjalainen, K. J. Brännström, J. Christensson, B. Sahlén, and V. Lyberg-Åhlander, *A Pilot Study on the Relationship between Primary-School Teachers' Well-Being and the Acoustics of their Classrooms*, vol. 17. 2020. doi: 10.3390/ijerph17062083.
[19] S. Karjalainen, V. Lyberg Åhlander, B. Sahlén, and A. Houmann, "Teachers' descriptions of classroom communication after an SLP-led in-service training," 2021.

[20] J. E. Dockrell, I. Bakopoulou, J. Law, S. Spencer, and G. Lindsay, "Developing a communication supporting classroom observation tool," 2012. [Online]. Available: internal-pdf://4019510250/Dockrell 2012 Developing CSC.pdf
[21] C. A. Rosen, A. S. Lee, J. Osborne, T. Zullo, and T. Murry, "Development and Validation of the Voice Handicap Index-10," *The Laryngoscope*, vol. 114, no. 9, pp. 1549–1556, 2004.
[22] M. Rönnlund, P. Vestergren, A. Stenling, L.-G. Nilsson, M. Bergdahl, and J. Bergdahl, "Dimensionality of stress experiences: Factorial structure of the Perceived Stress Questionnaire (PSQ) in a population-based Swedish sample," *Scand. J. Psychol.*, vol. 56, no. 5, pp. 592–598, Oct. 2015, doi: 10.1111/sjop.12214.
[23] A.-L. Elo *et al.*, "Validation of the Nordic Questionnaire for Psychological and Social Factors at Work—QPSNordic," Ashland, OH, US: Hogrefe & Huber Publishers, 2000, pp. 47–57.
[24] M. Arneson H. ,. &. Liljegren, *Svensk utprovning av Copenhagen Burnout Inventory (CBI). [Swedish evaluation of the Copenhagen Burnout Inventory (CBI)]*. 2005.
[25] D. Wedholm and M. Wideklint, "Effekten av Psykologisk Fallkonsultation på Förskollärare – En Grupprandomiserad Studie. [The Effect of Consultee-Centered Case Consultation on Preschool Teachers – A Group Randomized Trial].," Master thesis, Örebro University.