

A NEW PROPOSAL FOR TEACHING PSYCHOACOUSTICS

Nova proposta de ensino da psicoacústica

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ABSTRACT

Purpose: to evaluate the effectiveness of a CD-ROM didactic material on the theme Acoustics and Psycho-acoustics in the learning of students in the Speech Pathology graduation course. **Method:** this study was carried out at Faculdade de Odontologia de Bauru(FOB/USP). Seventeen students from the second grade of the Speech Pathology course participated in this study: 7 from the Speech Pathology course from FOB/USP and 10 from the Speech Pathology course from Centro Universitário do Norte Paulista. Each student received a CD-ROM and was told to keep it for a 15-day period and study it. The evaluation of the students' learning was carried out in two moments in the pre and post-test, through written assessment using a multiple choice questionnaire with questions on the sub-themes Acoustics and Psycho-acoustics. **Results:** statistically significant results were verified between evaluations: in the pre-test, the students' score was on average 29,82% and in the post-test, 91,76%. 100% of the students agreed that the material used provided them with a greater understanding of the theme. **Conclusion:** the CD-ROM significantly contributed to the students' learning.

KEYWORDS: Science; Technology; Acoustics; Education

■ INTRODUCTION

For many centuries, the impel movement of civilizations is the desire to acquire knowledge and the willing to transmitting it. The human being

learnt several ways to transmit knowledge, from the process of information exchange between master and pupil up to nowadays¹, in which the great scientific development of the study centers provided a fast transformation and update of this dynamic². However, due to the large territorial extension of our country and the centralization of divulgation poles, often the information access becomes difficult.

An alternative faced to this difficulty is the Telehealth and/or Tele-education, which configures as an instrument to the democratization of the education access, in which the internet is characterized as a privileged space of sharing information³. The dissemination of the computer and the internet usage provide a new way to put in practice trainings, develop the collaborative learning, the distance education and, mainly, providing an accessible, affordable and available source for the continuous education⁴.

One of the fundamental characteristics of the modern distance education is its total integration with use of technologies of information and communication (TICs). Certainly, the new technologies will not substitute the contact of student and professor or books, but will constitute in tools important to teaching, that should facilitate the access

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to education⁵. Using the country context as a point of view, both the territorial extension as well as heterogeneous distribution of graduation and post-graduation courses, it is evident the necessity of educational materials elaboration that supports in the teaching exercise⁶.

Specifically in audiology, Telehealth has been used in the development of educational actions during the process of intervention and rehabilitation of the hearing impairment patient, aiming to improve the life quality⁷. This practice has shown positive results on the utilization of new technologic resources⁸.

In recent years, in several universities of the country, stayed clear the need to prepare different educational materials that assist the docent practice. In the specific case of Audiology, which adds a number of disciplines focused on the diagnosis and treatment of hearing impairments, students need a broad knowledge about Acoustics and Psychoacoustics for understanding the audiological diagnosis, as also the benefits of hearing aids to their users, emphasizing techniques necessary to indication and adaptation these devices⁹.

Related to the educational materials applied to Audiology, several researches are being developed to analyze its effectiveness in the apprenticeship of undergration and post-graduation student. In Brazil, researchers of all country has approached different topics in development of educational materials in CD-ROM, in this area, e.g.: the workers' hearing health, earmold in the process of selection and adaptation of hearing aids and the selection and indication of the frequency modulation system in the adaptation of the hearing impaired patient. These materials were analyzed and the results presented in the assessment of pre and post-test proved the effectiveness of the educational material to the student learning⁹.

Particularly related to the Speech-Language Pathology and Audiology Telehealth group of the Speech Language and Audiology Department of the Bauru School of Dentistry, University of São Paulo – FOB/USP, it is correct to affirm that this was the pioneer in developing educational materials to guide user of hearing aids. With an experience of over ten years, its performance has been recognized on scientific communities national and internationals directing a new proposal for speech-language and audiology therapy⁷.

Faced to the exposed, the proposal of this article is to elaborate and utilize multimedia resources as learning environment to the deepening of knowledge in Acoustics and Psychoacoustics applied to Audiology. Thus, its objective was to evaluate the effectiveness of an educational material develop in

CD-ROM about the theme Acoustics and Psychoacoustics to the student learning of the Speech-Language and Audiology graduation course and its assessment as an educational material in the process teaching-learning.

■ METHOD

Subjects

In this study participated, seven undergraduate students from the Speech-Language and Audiology course of the Bauru School of Dentistry – University of São Paulo and 10 students from the University Center of Northern São Paulo, in *São José do Rio Preto, São Paulo*.

In the selection of the sample, the inclusion criteria was students of the second year of Speech-Language and Audiology course who demonstrated interest in participate of the research. The second year of graduation was chosen because students have not had contact with the discipline, in order to verify if the program produced in CD-ROM, could provide learning about the specific topic addressed.

The exclusion criteria was the other students or the second year students that do not shown interest in participate of the student.

After the selection, was explained, in detail, the purpose of the project and the participation of each student, pointing out the volunteer aspect.

Procedures

The elaboration and confection of the CD-ROM “The Sound and Psychoacoustic” was part of the project “Foundation of Psychoacoustic Applied to Audiology: contribution of multimedia resources in teaching and learning”, with the financial support of the Support to Studies of Graduation Nucleus, NAEG, University of São Paulo.

Based on all topics referring to Sound and Psychoacoustic subject contained in CD-ROM, was elaborated the questionnaire 1 of multiple choice. This questionnaire was composed by 25 items with four possibilities of choice in each one, referring to each item, in which 15 questions approached the sub-theme “Acoustic” and the other 10 questions approached the sub-theme “Psychoacoustic”.

The students who participated of the program received a gratuitous CD-ROM and remained the same for a period of 15 days, so they could study it. The evaluation of the effectiveness of the educational material was realized in two distinct moments, in pre and post-test. In pre-test the assessment was realized before the use of the CD-ROM, aiming to evaluate the previous knowledge of student. In post-test, the questionnaire was applied after a 15 day period of CD-ROM study.

The execution of pre and post-test aimed to evaluate the modification in the level of students' knowledge concerning the subject studied in the CD-ROM. To this end, the questions of pre and post-test were the same, just being changed the order of presentation.

In another moment, was applied the questionnaire 2 to participants of the study, developed to evaluation of the multimedia source as an educational material. This questionnaire was developed containing eight questions with two possibilities of answer each one (yes/no). Also, had a space reserved to subject comments related to the educational material. The eight questions on questionnaire 2 were divided in the following categories: educational method, easiness of understanding, interactivity, alterations in the program and CD-ROM creation. The item "alterations in software" was subdivided in four themes: layout alterations, links alterations, images alterations and text alterations.

This research was submitted to evaluation of the Ethics and Research Committee of the institution of origin, and was approved under protocol

No. 101/2004. All participants in this study signed a consent form.

The statistical analyses was used aiming to find out the mean, median, the standard deviation, the minimum and maximum values referring to the number of correct answers of each participant in pre and post-test.

To analyze the students' benefit with the manipulation of the CD-ROM, was employed the Wilcoxon nonparametric test ($p \leq 0.05$), comparing the situations pre and post-test of the questionnaire as a whole and in its sub-themes – Acoustics and Psychoacoustics.

■ RESULTS

The results referring to the effectiveness evaluation of the CD-ROM as an educational material are shown in Table 1 in number and percentage of correct answers. Comparing the results in pre and post-test with the application of the Wilcoxon nonparametric test, was verified the results statistically significant $p = 0.0003$.

Table 1 – Number of correct answers in absolute numbers (N) and percentages (%) on questions of pre and post-test of the CD-ROM for subjects in the study and their statistical analysis (mean, median, standard deviation, minimum and maximum)

Students	Questionnaire			
	Pre-test		Post-test	
	N	%	N	%
1	10	40.00	22	88.00
2	12	48.00	21	84.00
3	12	48.00	22	80.00
4	9	36.00	22	88.00
5	9	36.00	23	92.00
6	11	44.00	24	96.00
7	13	52.00	22	88.00
8	7	28.00	24	96.00
9	4	16.00	23	88.00
10	6	24.00	24	96.00
11	6	24.00	23	92.00
12	6	24.00	22	88.00
13	5	20.00	24	96.00
14	2	8.00	24	96.00
15	5	20.00	23	92.00
16	6	24.00	25	100.00
17	4	16.00	25	100.00
Mean	7.47	29.88	23.12	91.76
Median	6.00	24.00	23.00	92.00
Minimum Value	2.00	8.00	21.00	80.00
Maximum Value	13.00	52.00	25.00	100.00
Standard Deviation	3.26	13.04	1.16	5.56

Significant Level $p=0,0003$

As regards to the comparative analysis of data in the category "Acoustic" was verified that all student obtained better performance in situation

post-test (mean= 94.86%) in relation to situation pre-test (mean= 25.46%) $p=0.00025$, as observed in Table 2.

Table 2 – Number of correct answers in absolute numbers (N) and percentages (%) on questions of pre and post-test of the questionnaire referring to the acoustic category for subjects in the study and their statistical analysis (mean, median, standard deviation, minimum and maximum)

Students	Questionnaire			
	Pre-test		Post-test	
	N	%	N	%
1	2	13.32	13	86.65
2	6	39.96	12	79.92
3	5	33.30	12	79.92
4	5	33.30	15	100.00
5	5	33.30	15	100.00
6	8	53.28	14	93.24
7	3	19.98	15	100.00
8	6	39.96	14	93.24
9	2	13.32	14	93.24
10	3	19.98	15	100.00
11	3	19.98	15	100.00
12	3	19.98	14	93.24
13	2	13.32	14	93.24
14	1	6.66	15	100.00
15	3	19.98	15	100.00
16	4	26.64	15	100.00
17	3	19.98	15	100.00
Mean	3.76	25.00	14.23	94.82
Median	3.00	20.00	15.00	100.00
Minimum Value	1.00	7.00	12.00	80.00
Maximum Value	8.00	53.00	15.00	100.00
Standard Deviation	1.82	12.08	1.03	6.88

The comparative analysis to category “Psycho-acoustic” also showed better performance of student in post-test assessment (mean= 87.64%)

in relation to pre-test (mean= 35.29%) $p=0.00027$, as Table 3 shows.

Table 3 – Number of correct answers in absolute numbers (N) and percentages (%) on questions of pre and post-test of the questionnaire referring to the psychoacoustic category for subjects in the study and their statistical analysis (mean, median, standard deviation, minimum and maximum)

Students	Questionnaire			
	Pre-test		Post-test	
	N	%	N	%
1	2	20.00	9	90.00
2	3	30.00	9	90.00
3	3	30.00	8	80.00
4	3	30.00	8	80.00
5	3	30.00	10	100.00
6	1	10.00	9	90.00
7	2	20.00	8	80.00
8	8	80.00	9	90.00
9	4	40.00	9	90.00
10	3	30.00	8	80.00
11	6	60.00	7	70.00
12	4	40.00	9	90.00
13	4	40.00	9	90.00
14	6	60.00	8	80.00
15	5	50.00	9	90.00
16	2	20.00	10	100.00
17	7	70.00	10	100.00
Mean	3.88	38.82	8.76	87.64
Median	3.00	30.00	9.00	90.00
Minimum Value	1.00	10.00	7.00	70.00
Maximum Value	8.00	80.00	10.00	100.00
Standard Deviation	1.93	19.32	0.83	8.31

Comparing the sub-theme “Acoustic” to sub-theme “Psychoacoustic” was verified no statistically significant difference in pre-test performance

($p=1.14$). However, in post-test this difference existed ($p=0.01$), with correct answers mean to sub-theme “Acoustic” higher than “Psychoacoustic”.

Table 4– Comparison of the results of the sub-theme “Acoustic” with the sub-theme “Psychoacoustics” in the pre and post-test

Sub-themes	Results	
	Pre- test	Post-test
Acoustic e Psychoacoustic	$p=1.14$	$p=0.01$

Analyzing the results of questionnaire 2, referring to evaluation of CD-ROM as an educational material in teaching-learning process, 100% of students answered “yes” to questions relative to “Didactic Method”, “Interactivity” and “CD-ROM Creation”. On theme “Easiness of Understanding”, 88.3% of student answered “yes” and 11.7% answered “no”.

In the category “Alterations in Program” was verified that 100% would not make any alterations in layout, links and images. Although, 19.98% would change the presentations of the texts, while 80.92% of the total sample would not make such modifications (Table 4).

Table 5 – Distribution of results, in percentage, obtained in the categories of the questionnaire 2, on evaluation of using multimedia as a method of teaching-learning

Categories	Answers (%)	
	Yes	No
Didactic Method	100.00	0.00
Easiness of Understanding	89.00	11.00
Interactivity	100.00	0.00
Layout Alteration	100.00	0.00
Links Alteration	100.00	0.00
Images Alteration	100.00	0.00
Text Alteration	83.00	17.00
Creation of the CD-ROM	100.00	0.00

■ DISCUSSION

Distance Education is the process teaching/learning in which professors and students are not physically together, but are interconnected by technologies, mainly the telematics, as internet¹⁰.

This significant change suggests new ways to performance and direction in teaching dynamic. Thus, both elaboration of syllabuses, the sharing of knowledge but also the effectiveness evaluation of the new proposal should be performed at different times. In first stage the evaluation of the performance has the purpose of adjustment the participant to the study program and, in the second stage, verifies if the objectives were accomplished. Analyzing evaluations pre and post-test of CD-ROM used in this study, was verified that before knowing the content of the educational material, the participants show a mean percentage of correct answers of 29.88%. After the study, was verified statistically significant differences ($p=0.0003$) and the average percentage of correct answers was 91.76% demonstrating higher knowledge about the theme (Table 1).

According to the progression of the number of correct answers and of the statistically significant difference in answers post-test, the CD-ROM presented efficacy as an educational material, assisting self-learning and the assimilation of the subject by undergraduation student in Speech-Language

and Audiology course. This statement shows that the CD-ROM can be a resource in programs of DE, effective as a complementary material in apprenticeship of several themes.

These results are different from those found out in another studies involving the CD-ROM as an educational material¹⁰, in which were not find differences in pre and post-test, suggesting a probable previous knowledge on the subject, the reduced time for material analysis or the need for reformulation of the syllabus. Although, the same results are similar to projects realized in the area of Audiology^{9, 11} as well as studies realized by other health areas, such as nursing and medicine^{12, 13} that presented the effectiveness of the educational material in CD-ROM by means of the statistically significant difference between results presented in pre and post-test.

Regarding the sub-themes “Acoustic” and “Psychoacoustic”, was observed in Tables 2 and 3 that all students had a better performance in situations post-test comparing to situation pre-test.

During the comparative analysis of post-test between sub-themes “Acoustic” and “Psychoacoustic”, there was a statistically significant difference ($p=0.01$), with better performance for the sub-theme “Acoustic”. In a more detailed analysis of the results presented, it was verified that the sub-theme “Acoustics” was presented in a more interactive,

involving a greater number of self-explanatory figures and a wider variety of categories. These results are consistent with the studies that show that interactivity, motivation and interest can greatly influence the outcome¹⁴.

A study¹⁰ added that one of the objectives of Distance Education is to provide the creation of educational materials that may be presented to a higher number of students potentially spread in a large area. This dynamic has as proposal the sharing of knowledge, mainly to isolated regions of great educational centers. In present research, was studied the evaluation realized in different centers, i.e. one located in the city of Bauru and the other in the city of São José do Rio Preto, separated by 200 km.

Table 4 displayed the analysis of CD-ROM as an educational material in the process of teaching-learning, demonstrating that all participants agreed that the material used provided a better understanding about the approached theme. On results in category "easiness of understanding", 88.3% mentioned that the material used is explicative and with ease comprehension, while 11.7% disagree on this statement. The results presented as the contribution of the CD-ROM "Acoustic and Psychoacoustic" in student learning as a tool for DE, reinforce data discovered in literature⁹ about the facilities provided by this resource in any actuation area, since it allows break barriers geographical, physical and financial.

In category "Interactive" and "link alteration" was observed that 100% of students agreed that the presentation manner of the used material makes that the own student directs your learning, as shown in Table 4. The interactivity is considered one of the benefits of the technological development in Distance Education, in which the student can

conduce and explore, participating of all process of knowledge construction¹⁰.

Regarding to the images used in CD-ROM, the participants were unanimous in your answers, i.e., 100% answered that would not make changes (Table 4). These results agree with researches which demonstrate that the innovation brought by creation and development of educational materials in CD-ROM associated to the insertion of images, text and sound with the improvement in learning process⁹.

However, in relation to the texts, 19.98% (Table 4) mark that would make changes, but do not describe or suggest which would be such changes.

Analyzing the results, was verified that 100% of student presented interest on elaboration process in creations of the material in multimedia, demonstrating that using of technologies of information and communication stimulates the knowledge and learning about the approached theme.

Any comments or suggestions about the CD-ROM "Acoustic and Psychoacoustic" as an educational material in the process of teaching-learning were made by participants.

In all context discussed, education assumed a crucial role in socialization and construction of knowledge, may exceed the instrumental character, aimed at training professionals committed^{15, 16}.

■ CONCLUSION

From the results presented it was concluded that the material produced was adequate because it allowed learning, providing its effectiveness as educational material in the process of teaching and learning.

RESUMO

Objetivo: avaliar a eficácia de um material didático elaborado em CD-ROM a respeito do tema Acústica e Psicoacústica no aprendizado do aluno de graduação do Curso de Fonoaudiologia. **Método:** o estudo foi realizado na Faculdade de Odontologia de Bauru – Universidade de São Paulo (USP). Participaram desse estudo 17 alunos do segundo ano do Curso de Fonoaudiologia, sendo 07 alunos do Curso de Fonoaudiologia da Faculdade de Odontologia de Bauru – USP e 10 alunos do Curso de Fonoaudiologia do Centro Universitário do Norte Paulista. Cada aluno participante do programa recebeu o CD ROM gratuitamente e permaneceu com o mesmo por um período de 15 dias com a finalidade de estudá-lo. A avaliação do aprendizado do aluno foi realizada em dois momentos, no pré e no pós-teste. De forma a cumprir o objetivo, foi utilizada avaliação escrita em forma de questionário de múltipla escolha contendo questões abrangentes referentes aos sub-temas Acústica e Psicoacústica.

Resultados: verificou-se resultados estatisticamente significantes entre as avaliações com $p=0,0003$ (teste não-paramétrico de Wilcoxon), sendo que no pré-teste a pontuação dos alunos foi em média 29,82% e no pós-teste foi 91,76%, 100% dos alunos concordaram que o material utilizado proporcionou maior entendimento a respeito do tema. **Conclusão:** o CD-ROM contribuiu de forma significativa para o aprendizado do aluno.

DESCRIPTORIOS: Ciência; Tecnologia; Acústica; Educação

■ REFERENCES

- Oliveira EFB, Azevedo JLMC, Azevedo OC. Eficácia de um simulador multimídia no ensino de técnicas básicas de videocirurgia para alunos do curso de graduação em medicina. *Rev. Col. Bras. Cir.* 2007;34(4):251-6.
- Christante L, Ramos MP, Bessa R, Sigulem D. O papel do ensino a distância na educação médica continuada: uma análise crítica. *Rev Assoc Med Bras.* 2003; 49(3): 326-9.
- Veloso R, Alves VS. Sistemas de educação a distância: subsídios para a construção do modelo de gestão desta modalidade de ensino no contexto de secretaria de saúde do estado da Bahia. *Revista Baiana de Saúde Pública.* 2009; 33(1):86-94.
- Barbosa ATR, Curilem GM, Azevedo FM. Manuais on-line adaptativos ao usuário para equipamentos eletromédicos. *Revista Brasileira de Engenharia Biomédica.* 2008;24(1):3-15.
- Cunha SLS. Reflexões sobre o EAD no Ensino de Física. *Revista Brasileira de Ensino de Física.* 2006; 28(2):151-3.
- Blasca WQ, Maximino LP, Galdino DG, Campos K, Picolini MM. Novas Tecnologias educacionais no ensino da audiolgia. *Revista Cefac.* [serial on the Internet]. 2010 [cited 2010 Aug 21]; 12 (6):1017-24. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1516-18462010005000021&lng=en. In press 2010. Epub Apr 23, 2010. doi: 10.1590/S1516-18462010005000021
- Campos K, Oliveira JRM, Blasca WQ. Processo de adaptação de aparelho de amplificação sonora individual: elaboração de um DVD para auxiliar a orientação a indivíduos idosos. *Revista da Sociedade Brasileira de Fonoaudiologia.* 2010;15(1):19-25
- Spinardi ACP, Blasca WQ, Wen CL, Maximino LP. Telefonia audiolgia: ciência e tecnologia em saúde. *Pró-Fono Revista de Atualização Científica.* 2009; 21(3):249-54.
- Blasca WQ, Mantovani DA, Campos PD, Bevilacqua MC. Os recursos de multimídia aplicados à audiolgia. In: XX ENCONTRO INTERNACIONAL DE AUDIOLOGIA, 2005, São Paulo. Anais do XX Encontro Internacional de Audiolgia, 2005.
- Netto SP. Midia Educativa: treinamento e educação a distancia. *Revista Brasileira de Aprendizagem Aberta e a Distancia.* 2003 [cited 2003 set]; 2(1):1-3. Available from: www.abed.org.br/revistacientifica/Revista_PDF_Doc/2003
- Martins JS, Pinheiro MMC, Blasi HF. A utilização de um software infantil na terapia fonoaudiológica. *Rev Soc Bras Fonoaudiol.* 2008;13(4):398-404.
- Camacho ACLF. Educação a distância no ensino da legislação, ética e exercício de enfermagem. *Revista Brasileira de Enfermagem.* 2009;62(1):151-5.
- Mota TD, Tonomura ET, Carvalho ACP. Ferramenta de ensino a distância para o Departamento de Radiologia da UFRJ. *Rev Imagem.* 2006;28(3):147-54.

14. Souza AELN. A multimídia como ferramenta de trabalho na Audiologia Educacional: subsídio ao educador de crianças deficientes auditivas. [Tese]. Bauru: Hospital de Animálias Craniofaciais, Universidade de São Paulo; 2003.
15. Grotto EMB, Terrazzan EA. Prática docente: concepções sobre o uso de ambientes educacionais baseados na WEB. Rev Novas Tecnologias na Educação. 2003;1(2):1-9.
16. Oliveira MRNS. Do mito da tecnologia ao paradigma tecnológico: a mediação tecnológica nas práticas didáticas pedagógicas. Rev Bras Educação. 2001;(18):101-7.

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