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# Development of a Sound Simulator for inclusive Learning: The use of a Prototype in Teaching

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***Abstract*—** *The demand for practical experiments in the disciplines of Veterinary Medicine is paramount for training of future veterinary doctors. In practical classes in veterinary clinics, teachers uses electronic animal prototypes to simulate care and train real-life skills, reducing the use of live animals in class. Our simulator makes it possible for people with disabilities to have tactile and sonorous access to animals, either for educational purposes in higher education or contact with animals that are difficult to access. The project aims to improve the Animal Sound Simulator (SAVEDOG) and develop a single control center application for preparing theoretical-practical classes of Veterinary Clinic. Vygotsky's socio-historical theory is used as basis for developing a methodology for developing the higher psychological functions in students with visual impairment.*

***Keywords-Assistive Technology, Educational Robotics, Veterinary Education***

## I. INTRODUCTION

The number of Brazilians with some type of visual impairment, congenital or acquired, is approximately 16 million [7] and the insertion of this population in formal education through assistive technologies is mandatory by law on the Education Guidelines and Bases Law (Law No. 9.394 / 96) and Resolution 02 of the National Council of Education [3].

The Technical Assistance Committee (Administrative Rule 142 of November 16, 2006) defines this area as interdisciplinary because it encompasses strategies, methodologies, resources, practices, products and services to promote the participation of disabled persons with disabilities or reduced mobility, aiming at greater autonomy, independence, quality of life and social inclusion. In general, instrumental mediation processes can also: favor, compensate and enhance abilities or functions compromised by visual, auditory, motor or communication deficiency [2].

The common sense about visual impairment cognitively incapacitating the subject is rejected by Vygotsky [11], by admitting a reorganization of the forces of the organism and personality under the action of higher psychological functions, through the voluntary articulation of knowledge. The visual impairment uses the auditory, olfactory, tactile and kinesthetic senses to develop individual processes of coding and creating mental images. This leads to understanding, interpreting and apprehending according to the plurality of experiences, the efficiency of the instructional material, and the way in which subject-object interaction is stimulated.

Blindness, therefore, is not characterized as an obstacle to development, but it reorganizes it sensorially in relation to the construction and structuring of knowledge. Visual information is acquired by other means, matching the learning capacity with that of the seer. If seers define an object through visualization, the blind articulate the higher psychological functions by relating already appropriate elements to others they wish to understand. Such functions correspond to thought, memory and concentration, with possible ramifications of logical conceptual thinking and imagination, mediated and visual memory (in the blind acquired), voluntary attention and concentration [1].

The common aspects between objects or phenomena are identified and generalized so that they can be mentally represented and participate in the construction of concepts. Thus, through language, the capacity for

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abstraction meets with conceptualization via the elaboration of complex mental activities. Then, the visual impairment articulates information from touch and hearing to mentally represent images of objects or signs. The symbolic contents replace the objects or phenomena, enabling the elaboration of a mental vision of the empirical world. By understanding conceptualization as a voluntary process of abstraction in relation to concrete situations and the objects contained within it, language provides the possibility of expressing the concepts arising from the connections between higher psychological functions [9].

The learning of certain contents by people with visual impairment requires specific mediations and differentiated resources capable of helping to overcome any difficulties that may arise during the subject-object interaction. To that end, the development and application of assistive strategies related to the unaffected senses are expected, creating challenges that stimulate, among other capacities, voluntary attention and logical reasoning [12].

In this sense, this work aims to present the development of a robotic device, through which the subject with some visual impairment can enhance their emerging psychological functions, and improving their process of knowledge construction in classes of the discipline of Veterinary Clinic on the following cognitive abilities: perception, attention, memory and problem solving.

## II. LEARNING MEASURED BY ANINAL SOUND SIMULATOR

In the area of Veterinary Medicine it is common the use of living beings for chemical tests, practice of surgical techniques or proof of theories. While this may qualify for undergraduate training, it raises sensitive issues both in the field of ethics and to the safety of students and animals. In this scenario, the use of an electronic simulator, replacing the living animal, is a good complementary tool in teaching practice. Educational activities with a simulator can facilitate the safe and continuous development of skills needed to detect abnormalities, reducing diagnostic error and avoiding trauma to the patients. Therefore, clinical practice through teaching tool that simulate real behavior can really improve learning, by allowingsystematic repetition and facilitates corrections of failures in the anamnesis [5].

*Fig.1: SAVEDOG with educational audio simulator.*
*Source: The Author*

In the learning context, the use of the SAVEDOG simulator is in accordance with Vygotsky's theory because it constitutes a triad formed by the subject of learning, the object of knowledge and the mediating element (colleague or teacher or cultural artifacts). As in the clinical examination, the students must assess the heart rate and breathing sounds to make a diagnosis consistent with the knowledge acquired in the classroom [6], the process of dealing with the use of material instruments and audio signs promotes the improvement of the higher psychological functions as: reflection, abstraction, invention, creation, imagination, designing and operating symbols of signs and therefor being linked to both the concept of internalized action andthe zone of proximal development - ZPD [13].

The main idea here is to construct a learning space for the visually impaired subject, considering the modes of action on the object of knowledge through the interaction of the electronic animal sound simulator and the teacher. Thisis anexperimental approach, where the qualitative aspects of the phenomena of adquiring knowledge preponderate over the quantitative, contributing to increase both the capacity for observation and phenomenological description, in theconceptual construction on the subject.

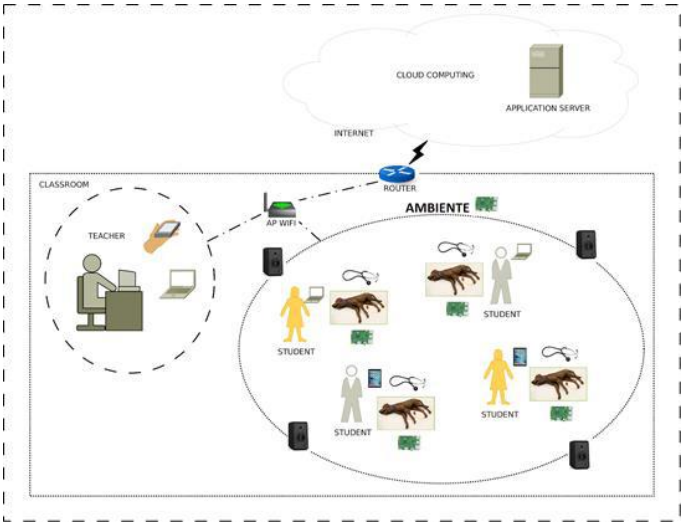


*Fig. 2: Conceptual map of the learning environment.*
*Source: The Author*

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In this sense, the main task on teaching can be considered as waysto producing meanings, as a process that underlies the conection between the world and the subject, learning concepts related to symptoms of clinical diseases that affect the respiratory and cardiovascular systems of domestic animals. Thus, we hope to collaborate in an environment in which learning can be conceived as a process of appropriation of cultural elements that result in the reproduction of historically formed human properties, capacities and modes of behavior [14].

In the class, teachers use an electronic device capable of emitting various sounds related to the state of health of a dog, but limited to a single sound emitted by several audio outputs at a time. The configuration of the sound to be emitted is determined by the teacher through a cable connected to the puppet, allowing toprogramsome situations in a supervised scenario.

Thus, the developed electronic system performs the independent configuration of audios in each animal simulator, in which each device contemplates an animal or environment and its quantity is determined by the number of IP (network address) available in the local network of the institution, being able to obtain 100 devices without difficulties.

According to Cedro [4], to produce meaning and considering the dynamic interactions between the subjects, it will be necessary to have the following characteristics:

• Performing by the subject, as protagonist;
• Involve in a problem situation;
• Enable searching for a solution;
• Allow the development of knowledge through analysis and synthesis;
• Allow the creation of a mode of action;

In this way, will follow the following procedures:

• Inform the objectives of the experiment and how it will be carried out;
• Establish a narrative that can contribute to the motivation and the active participation of the students in the proposed activity;
• Map student´s main concepts and ideas on the subject to be worked on;
• Submit a script written in Braille, so that students can work on the skills related to this language, reading the proposed questions and responding verbally, as the experiment will be recorded in audio and video;
• Perform the anamnesis procedures proposed in the script, verbally registering the description of the phenomena addressed and how the proposed problem was solved;

The technique for data collection will be participative observation, where the researcher establishes a dialogue with the subject, seeking to intermediate the relation with the object of knowledge. The activity will be recorded in video and audio for later analysis of the subject's speeches, where they will be searched for elements able to indicate the presence of the higher psychological functions as [4]:

• Be performed by the subject as Protagnist;
• Criticism: such as the possibility of the subject to question, contradict and debate;
• The discovery: as the possibility of the subject to experiment, model, symbolize generalize;
• Social practice: emphasized by social relevance and applicability of knowledge to the community;

## III. TECNHOLOGY DEVELOPED

The project goal is developing a universal platform for remote audio playback, in which, each device can play at least 04 different audios in their outputs. The control panel is able to individually control each device individually, with the possibility of updating sounds. The core was developed in Windows platform using the Visual Studio development tool in C # language. The tool makes it possible to select the audios in each of the outputs in the different devices found in the network.

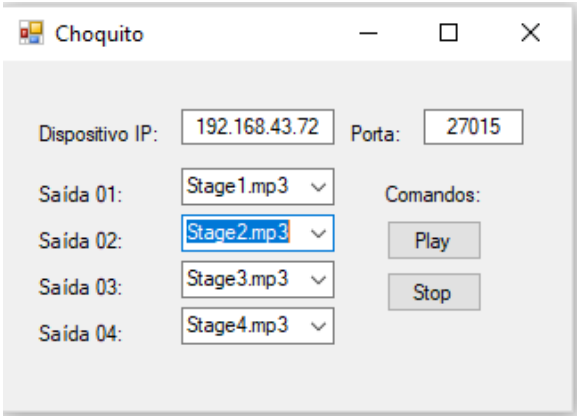


*Fig. 3: Sending audio to a respective device in the network called choquito (Educational Frog). Source: The Author*

In order to select the chosen device, its respective IP address is required in the local network, to which the program will send the sounds to be executed in the outputs predetermined by the user. The hardware was designed using the Arduino Uno board (fig. 4), an audio module and a wifi module, both independent. During development a prototype functional protoboard was created.

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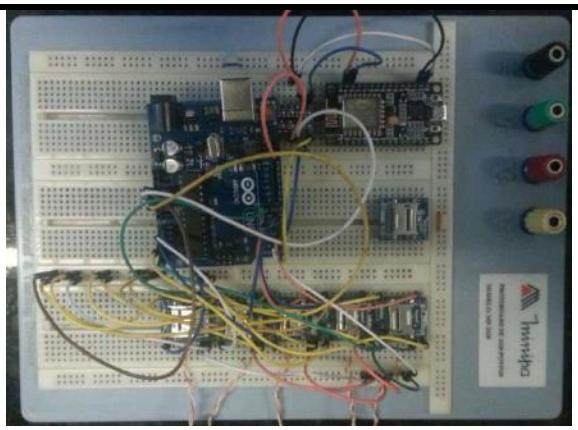

*Fig. 4: Preliminary functionality test. Source: The Author*

After this firt prototype, the circuit was modeled on blueprint for board circuit factoring, followed by mounting all electronic components on the board (fig. 6)

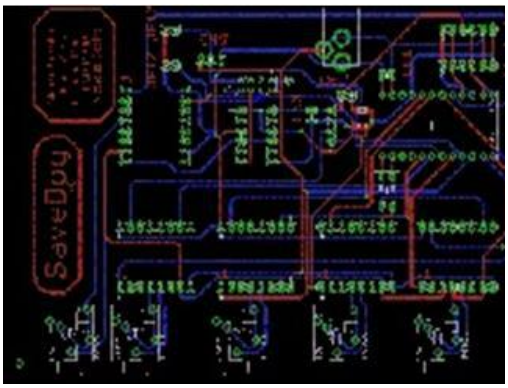

*Fig. 5: Circuit modeling. Source: The Author*

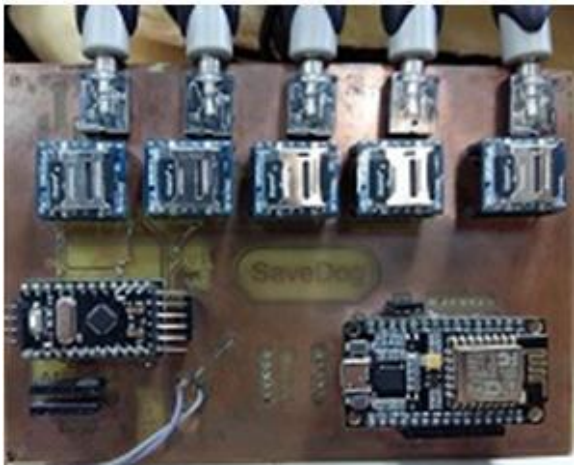

*Fig. 6: Test of the developed circuit. Source: The Author*

The platform used was RaspBerry Pi3 (fig. 7), Plug and Play audio modules with the Linux operating system Ubuntu MATE IoT embedded.

*Fig.7: Design of the second version of the audio system: The Author*

In this sense, we installed the operating system and 04 USB audio modules. In the operating system was developed the module of data reception by network (cable or wireless), with several other devices connected, but properly identified by a unique IP number. Designed in Python language, the system obtains instructions from a central in the local network receiving, through network message, the addressed IP, the audio name and the numbering of the respective port to be reproduced. From this information it is checked whether the message is for a defined IP and, if so, executes the command in Linux Shell for the requested audio playback.

## IV. RESULTS AND DISCUSSION

From the perspective of cognitive development based on the socio-historical relationship of the subject with the object of knowledge, this project was in line with Passerino's approach [8], regarding technology's action in the dimensions of knowledge, reasoning and culture. The purpose is to intermediate the relevant information in the field of Veterinary Clinic,stimulating visually impaired students to understand scientific phenomena, and preparing them for testing hypotheses in order to re-elaborate beliefs, towards of developing negotiation attitudes in a technologically interaction practices. The Vygotsky's theory of learning has guided the elaboration ofall didactic-pedagogical strategies, where SAVEDOG has successfully performed the main role as a tool for implementing these strategies.

The opportunity to perform simulations in real evaluation conditions, from audios previously extracted from animals with diagnosed diseases, effectively improve the learning of visually impaired students. The results achieved by SAVEDOG educational toolfulfills the requirements of reliability and complexity for the desired pedagogical model, since that electronic animal prototype offers a level of complexity appropriate to the student's degree of experience, as well as to value the principles of ethics and well-being of students and animals.

This teaching environment can also contribute to the immediate comparison between veterinary diagnostic experiments, enhancing the construction of scientific

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knowledge by students. In addition to enabling by programming, the reconstruction of new scenarios for the application of several other simulations of veterinary environments without the need of physical displacement of students and teachers.

Among the results achieved are:

- Development of a methodology for use of assistive technology in the construction of veterinary diagnostic knowledge for students with visual impairment;
- Improvement use realistic simulators, like SAVEDOG, as a learning tool in the discipline of Veterinary Clinic;
- Reduction of the cost of acquiring and maintaining equipment for animal sound simulation;
- Possibility of creating a multidisciplinary room for the simulation of difficult access environments.

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