TOWARDS WEB-BASED VISUAL TRAINING

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ABSTRACT.

To an extent, vision is a function that can be learned. Broadly speaking, this learning -named visual perceptive development, takes place spontaneously. Nevertheless, it is not the case of a significant number of children who, due to their visual or perceptual impairment, have difficulties either receiving or processing visual stimuli from their environment. In this case, Visual Stimulation programs should be applied to these people so that their visual functions can be developed.

The advances developed in last two decades on information and communication technologies, ICT, are not reflected in the existing software tools for-the field. As a contribution to solve this problem, we have designed and developed an Interactive Educational System supported on a web platform with the main aim to provide professionals the required mechanisms to perform the basic Visual Stimulation tasks. At the same time, it takes advantage of the several opportunities offered by the Internet. In this paper, we analyze the limitations of previous existing tools and present EVIN (Visual Stimulation on the Internet). The main objective of the EVIN project is the development of a web platform which exploits the potential of ICT along with the experience gained by low vision professionals.

List of keywords: Visual Training, Visual tasks, On-line Platforms, Game-based Learning.

1. INTRODUCTION.

Visual development is a process that begins even before birth, and as expressed by Ferrell (2010) is a continuum in which visual skills do not occur independently or in isolation, but is constructed through experience and practice. This learning is called *visual perceptive development*.

A child with normal vision will usually develop their visual perception in a spontaneous way. However, a significant number of children will not do that automatically. This is not only the case of students with low vision, but of many normal vision children who have perceptive difficulties because of several reasons. To a degree, *vision is a function that can be learned* and *its quality can be improved with training* (Barraga, 1980). Therefore, those children should be encouraged through a systematic program aimed to develop their visual functions. Otherwise, they will be working on worse conditions than they would due to their visual or perceptual impairment.

Therefore, *visual stimulation/training* has as main objective *to optimize the use of vision*. Instruction in *visual efficiency* - the process of using vision effectively (D'Andrea and Farrenkopf, 2000), can have a deep impact on a visually impaired student's overall functioning and quality of life, not only in the school environment, but at home, community, and workplace settings as well (Erin & Topor, 2010).

The evidence that extending visual experiences increases the neuronal growth in the visual cortex (Shonkoff and Phillips, 2000) strongly suggests that the best way forward is to provide opportunities for visual development when possible, supplying experiences that require visual behaviors gradually more complex (Ferrell, 2010). Visual development showed by children without functional alterations can serve as a basis for intervention with children who have low vision (Lueck and Heinze, 2004), with the understanding that children with visual impairment may have differences in the developmental sequence (Ferrell, 1998).

Access to visual inputs immediately after birth plays a vital role in the creation and preservation of neural structures. This neural architecture will allow the proper development of visual functions - visual acuity, contrast sensitivity, color vision, etc. (Lewis and Maurer, 2009). There exists a sensitive period during the children evolution in which the vision is developed and the brain shows remarkable plasticity. However, visual skills can be acquired outside of this time as Mamer showed (Mamer, 1999).

In the mid-nineties, several studies are conducted on the effectiveness of the computer as a medium for visual training. As a result, the first computer games for this purpose arise: Lilli & Gogo (Jaritz et al., 1994) and a set of games developed in the Resource Tomteboda Centre of Sweden: *The truck, Worm max, Look Here*, etc. (Hammarlund, 1994). These programs only cover, with few exercises, some basic visual functions (fixing, tracking, monitoring, mapping and exploration, etc.).

At the turn of the century, two interesting applications are released: EVO (Computer-assisted visual training) and SENSwitcher. EVO (Rodriguez et al., 2001) is–the first in providing feedback about the degree of success or failure of students in performing a given task. Nevertheless, this feedback is not available in real time and it is just stored locally on the computer where training is carried out. SENSwitcher is a tool for basic visual training that can be downloaded or networked. SENSwitcher is not designed specifically for visually impaired children, although it can be used to work the most basic levels with visually impaired infants without other deficiencies or with multiple disability children with visual impairment.

Today, authoring tools make easier for professionals to create such exercises. After analyzing these applications and other similar resources, we have found a number of important limitations, the most notable is the total or partial absence of feedback mechanisms that facilitate the assessment and monitoring of students and/or the lack of ability to adapt to different types and degrees of visual impairment.

Furthermore, the advances in the area of ICT are not reflected in the existing software in the field. Actually, we have just found some recent research on applying new technologies to treat specific areas but not to stimulate visual perceptive development in general. Some examples are the game platform for treatment of amblyopia -uncorrectable decrease in vision in one or both eyes with no apparent structural abnormality seen to explain it, described in (To et al., 2011) or the work detailed in (Poggel et al., 2010) to improve the visual field size as well as the subjective visual performance.

As a contribution to solve the identified problems, we have designed and developed the web platform EVIN (Visual Stimulation on the Internet). It is an environment that not only makes visual training possible, but the production of other tasks related to any teaching-learning process such as individual and general assessment of students, the collection of statistical information and management of resources and users. In addition, the information gathered by the platform will be the basis for the development of an adaptive system-that suggests users the most appropriate activities for each case.

The rest of this paper is structured as follows. The second section presents the EVIN project, its aims, its main features and the currently available activities to perform visual training. The third section draws the main conclusions and will comment some possible future work related to this project.

2. THE EVIN PROJECT.

The main objective of the EVIN project is the development of a web platform which exploits the potential of ICT along with the experience gained by low vision professionals and emerging advances in the Visual Stimulation field in order to stimulate the visual perceptive development in those people who have difficulties either receiving or processing visual stimuli from their environment. This stimulation is performed through *games* by exercising the user in different visual tasks. Each *game* can be adapted to the different characteristics of students by setting a number of stimulus features or *parameters* that introduce different *levels of difficulty* in the visual task in which they will exercise. Some examples of such parameters are: size of stimuli, number and presentation time thereof, possibility of rotation, speed of presentation, etc.

While running, the system requires the participation of educators and other responsible professionals for guiding students in their learning process. In addition, the application also provides mechanisms to monitor individual and overall results achieved by students during the conduct of the games. It is also possible to manage the information about users and resources through the system interface.

The two following subsections will present the main features of this project and the currently available activities to perform visual training.

2.1 Main features.

The EVIN platform has a number of features that are innovative compared to most of the existing applications to date in the field:

Flexibility of visual training exercises/games. Each game allows the tutor to adapt the stimulus characteristics (stimulus size, complexity, number of stimuli, etc.) to the specific needs of each student.

Student and resources assessment. The results obtained by a student in a particular exercise/game are displayed in real time, so providing immediate feedback. At the same time, these results together with the profile of each student are stored in a database which enables monitoring of individual and global progress made by students as well as the evaluation of the effectiveness of different games. Likewise, it facilitates the statistical analysis of the recorded data in order to draw conclusions that will open the way for the development of a methodology that provides guidance for professionals in the field.

Independence and reuse of resources. It is possible to move games to other platforms or websites and the aggregation of new activities regardless of their specific implementation.

Support for resources and users management. The system allows users to plan (add, modify or delete) activities deemed appropriate by professionals. Besides, it is possible to manage information about users (students, teachers, administrators, etc.).

Incorporation of ICT in the educational process regarding visual learning. EVIN is the first web platform known to date for this purpose. It provides a number of advantages such as the ease of diffusion or independence of the operating system utilized by the user, who can access it without further requirements on their computer that a browser.

It promotes the inclusion of people with visual and/or cognitive impairment in the Information Society. While performing visual perceptive learning, students are trained in the use of computers and efficient access to information.

Quality software. The application is being developed using techniques and tools of software engineering. This allows a maintainable product and its transport to other systems/architectures, in contrast to most existing visual stimulation applications to date.

2.2 Games.

Currently, the platform includes five games: *Exploration, Facial expressions, Spatial perception*, *Puzzle* and *Prominent features.* They have been used routinely within Visual Stimulation programs, both with traditional materials and through computer games, exercising visual functions of very different complexity.

The exercise named *Exploration* is a discrimination and match task. In it, the learner has to look for all stimuli equal to that previously established as the sample. It serves to train students in basic visual functions (fixation, visual sweeps, discrimination, etc.). In this game there are 105 possible configurations varying the number and type of stimuli, and the type of visual sweep (order in which the student must match stimuli).

The activity called *Facial expressions* is a matching task in which a smiley shows one of the four basic emotions -joy, sadness, anger/annoyance and surprise. The game consists of selecting all photos in which the person has the same expression as the smiley. This activity exercises the following tasks: visual attention, fixation; visual sweeps, recognition, discrimination and matching of facial gestures. The difficulty level is determined by the number of stimuli and emotions that will be used.

In the *Spatial perception* exercise, the student must place a set of three-dimensional drawings in the same location and position as in the model shown in the upper left corner. The whole composition is made on a board with squares in a perspective way where figures can be placed, moved and rotated.

This activity exercises the following tasks: visual attention, recognition, discrimination, visual memory, shape constancy, perspective and spatial relations.

As in the previous case, the game Puzzle exercises more elaborate visual functions in which cognitive components are primarily involved: spatial perception, relationship part/whole, visual memory, etc. The puzzles of the platform can be 2x2, 3x3 or 4x4, also having the option to rotate the pieces and to show or not a template as a guide for the conduct of the exercise.

The *Prominent features* game *i*s a matching task in which a set of critical features or lines extracted from an image are shown in the upper left corner. The game is to select the correct picture from the group of images that appear on the screen. The lines may be located in the same position as in the picture or they can be configured so that they are reversed or rotated symmetrically in order to make the exercise more difficult. In addition, the number of stimuli and the number of lines to be seen in the model can be selected by the trainer. This activity exercises the following tasks: visual attention, fixation; visual sweeps, visual closure, recognition, discrimination and matching of critical features. Note that the generation of the critical features was performed using a tool specifically developed for this purpose. Thus, no programming skills are required to add new images to the game.

Finally, it should be noted that there exists a drop-down menu inside of each game which contains some useful options such as exiting the game, consulting the help or changing to a new screen. Furthermore, games have sound and visual reinforcement which can be taken off before starting an individual game, thus giving it greater flexibility.

3. CONCLUSIONS AND FUTURE WORK.

This paper has emphasized that, to an extent, the *vision is a function that can be learned* whose quality can be improved with *training/visual stimulation programs* which should begin at the earliest possible age. These programs are suitable for all students who have *difficulties either receiving or processing visual stimuli from their environment*. If visual stimulation exercises are not done in time, individuals will be working on worse conditions than the visual impairment itself.

Moreover, we have focused attention on the desirability of incorporating ICT in the field of Visual Stimulation. We have briefly reviewed some of the currently used programs. After analyzing this software, two important limitations have been found: the lack of feedback mechanisms to assess and monitor the progress of students during their learning process and, in general, the little ability to adapt to different types and degrees of visual impairment.

Afterwards, we have introduced the web platform EVIN as a tool to serve visual stimulation professionals. It offers resources for conducting visual training tailored to individual characteristics of each student, individual and general assessment mechanisms and support to management of information about games and users included in the system. Due to diffusion characteristics of the web, it enables the collection of a large amount of information from a centralized process and allows students to work in various locations: at school, in special schools, at home, etc.

Currently, we are planning the evaluation of EVIN with specialists in low vision and children with vision deficiencies in real-world scenarios.

To summarize, the initiative of this project could provide a tool of great potential in the field of visual stimulation. However, the current platform requires both improving certain features and extending it with more exercises in order to achieve its goals.

We are currently working on the following improvements:

Increasing the number of games. The number of games should range between 16 and 20, so that they can practice a sufficient number of visual tasks while the job of selecting the most appropriate game for each case should not be complex.

Application of adaptation techniques from the Artificial intelligence research area to allow EVIN to adapt to the user for specific problems both to decide the best sequence of games to play and to adjust the stimulus characteristics of each one. These decisions sometimes may be complex, so it will be helpful for practitioners to have this feature within the application.

Adaptation of the display to mobile devices. We are working on the games so that they can run on a majority of mobile devices.

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