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# Using Affective Avatars and Rich Multimedia Content for Education of Children with Autism

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### **ABSTRACT**

Autism is a communication disorder that mandates early and continuous educational interventions on various levels like the everyday social, communication and reasoning skills. Computer-aided education has recently been considered as a likely intervention method for such cases, and therefore different systems have been proposed and developed worldwide. In more recent years, affective computing applications for the aforementioned interventions have also been proposed to shed light on this problem. In this paper, we examine the technological and educational needs of affective interventions for autistic persons. Enabling affective technologies are visited and a number of possible exploitation scenarios are illustrated. Emphasis is placed in covering the continuous and long term needs of autistic persons by unobtrusive and ubiquitous technologies with the engagement of an affective speaking avatar. A personalised prototype system facilitating these scenarios is described. In addition the feedback from educators for autistic persons is provided for the system in terms of its usefulness, efficiency and the envisaged reaction of the autistic persons, collected by means of an anonymous questionnaire. Results illustrate the clear potential of this effort in facilitating a very promising autism intervention.

# **Categories and Subject Descriptors**

D.2.4 [Software/Program Verification]: Validation, proofs. [Programming Reliability, Correctness D.2.6 **Environments**]: Integrated environments, Interactive environments H.1.2 [User/Machine Systems]: Human factors, H.3.4 [Systems and Software]: Performance evaluation (efficiency and effectiveness)

### **General Terms**

Measurement, Design, Experimentation, Human Factors.

# **Keywords**

Computer-aided learning, affective computing, autism, emotions, human-computer interaction, avatars.

### 1. INTRODUCTION

Autism is a lifelong pervasive developmental disorder affecting social, communication and reasoning skills [1]. Formally, it is considered that autism consists of "triad of impairments":

- i. A social impairment: it is very hard for a person with autism to relate to and empathize with other people;
- a communication impairment: understanding and using verbal and non-verbal signals is very hard for persons with autism, displaying behaviour considered socially or emotionally inappropriate and
- iii. a tendency towards rigidity and inflexibility in thinking, language and behaviour.

People with autism have a limited range of imaginative activities and face difficulties in making sense of the social world [2]. In addition, they have problems in understanding and using both verbal and non-verbal communication channels. Finally, autism is characterized with rigidness in thinking, language and behaviour. It is agreed that the common individualities of autism are abnormal reaction to input stimuli, lack of human engagement and inability to generalize between environments [3]. Education is considered as the most proper solution for the problem of autism. Early stage education might help autistic persons in coping with the "theory of mind deficit – difficulty in understanding mental states of others and ascribing them to themselves or others" [4]. Computers have been considered as a promising educational tool aiding for autistic persons. One of the first experiments took place in the early 1960's, where Colby had some initial success in using computers to instil an interest in speech-related sounds and language in mute children with autism [5.]. Nevertheless, the significance of computers in the educational process for people with autism was realised only recently and there significant progress hasn't been made thus far. Nowadays, with the advancement of Information and Communication Technologies (ICT), computer-aided learning (CAL) is considered as a key method for handling autism interventions, particularly for young children.

Acting not only as machines (objects) but also as humans (subjects), computers represent a considerable and valuable part of the educational techniques [6]. According to the literature, autistic persons, children in particular, enjoy interacting with computers since they are experienced as "safe" [7]. This stems from the theory that computers are not having the expectations and judgments that make social interaction problematic for autistic persons. Recent literature reveals that computer systems represent a controlled environment with minimum or no distractions that is crucial in the education process for autistic children [8]. It has been reported that in interactions with computers, children with autism can feel certain level of control over the environment, which cannot happen when interacting with human beings [9]. Moreover, this feeling of control is independent of the type of software interface and is said to be generic to all interactions with computers. According to the current literature, persons with autism enjoy interacting with computers. This "safe" environment acts as a catalyst in the educational process. Bernard-Optiz et al. [10] studied training procedures with software used for social behavior education. The study carried out in two different groups of children: a group of children with autism and a group of children without autism. Children had to find a solution to different scenarios involving characters in problematic social conflicts. While the performances of both groups improved, the progression of the group without autism was steadier.

Most of the software platforms use entertaining content in educational settings in order to present knowledge in an attractive way. This synergy is often called "edutainment" [11]. This paper presents an evaluation of the edutainment platform for autistic children - Affective Computer-Aided Learning Platform for Children with Autism (ACALPA) [12]. The platform supports edutainment method using an affective avatar, synthesized speech and multimedia content (videos, images and sounds). The main goal of the platform is to facilitate the teacher-child learning scheme where the users will be both the teachers and the children with autism. Therefore, the evaluation process is primarily focused on the impact of the platform as seen by the educators. The goal is to evaluate the implementation of recent advances in research, theory and technology (affective avatars, speech etc.). Thirteen educators of autistic people participated in the study. The evaluation included a questionnaire oriented towards the feedback they received from the autistic people within a one-month period of usage as an educational tool.

# 2. RELATED WORK

Recent research and literature reveals that virtual reality systems and collaborative virtual environments utilizing emotionally expressive avatars can be facilitated as an assistive technology, educational or a therapeutic technology for people with autism [13]. Findings in psychology and neurology suggest that emotions are also an important factor in decision-making, problem solving, cognition and intelligence in general. [14]. Picard states that the emotional state of others affects not only our own emotional state, but directly the decisions we make [15]. Another area where emotions are used is that of learning. It has been argued that the ability to show emotions through body language ensures the quality of tutor-learner and learner-learner interaction [16].

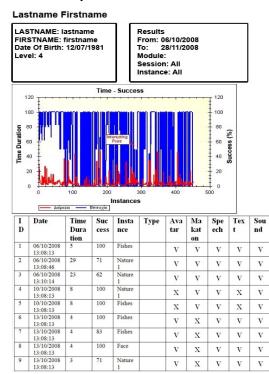
Avatars express their mental and emotional state especially via facial expressions. Recent research reveals that due to the high distinction and clear recognition of the emotions expressed by avatars people with autism seem to understand and to use them appropriately [14].

Furthermore, most of the educational platforms that have been developed in order to satisfy the educators and the persons with autism focus on their unique learning styles. Current literature indicates that there is a high level of use of special education software [17]. However, teachers working with young autistic children report significant shortcomings in the majority of software platforms used in their classrooms. Difficulties that have come to light include insufficient error control, inappropriate audio feedback on error, and other user problems [18].

Although software design remains poorly documented, several experimental studies have shown the usefulness of computers for autism [18]. Psychopathologists express growing interest in using computers for special education of autistic people [19]. Besides that, parents were among the first to develop computer-based approaches for this purpose [20].

# 3. ACALPA

ACALPA is a platform that is intended to enhance or mediate the teacher-child educational process [12]. It is based on various interaction procedures according to the disability level of the autistic person in question. Several modules comprise the platform. Each of them represents a specific learning domain. Namely, there are modules where the child is asked to identify the correct image between two or more images, to put images in the correct sequence (according to time), identify emotions by visual expressions etc. Furthermore, the more complex modules are in the form of semi-virtual environments. They provide the child with the ability to interact in a safe and controlled way.



# Fig. 1 Printable report representing percent of success and time of completion of each instance.

The theme of each module varies from objects in the normal surroundings, everyday use objects, colours, words etc. The instructions are given either by an affective avatar, synthesized speech in autistic person's native language (in the specific example - Greek), written in the screen, by the corresponding makaton symbol or a combination of these. Additionally, the avatar can express emotions depending on the situations, e.g. happiness when the correct image is selected, sadness if not. The instructions and the difficulty level can be personalised for each user. User input/feedback is facilitated by means of a mouse interaction, a touch screen or large buttons attached to the computer.

Equally important function of the platform is the recording of the interaction/education process in a database. Consequently, the educators are enabled with track record of the users' progress and modify the difficulty levels accordingly. Additionally, an educator may register specific educational or personality data for each autistic person. The printable format of all the records (Fig. 1) enables easy monitoring and analysis of the learning process. In this way, a longitudinal record may be achieved indicating "a learning curve" for each autistic person separately, thereby enhancing and normalising the educational procedures toward each person's needs.

#### 4. EVALUATION OF THE SYSTEM

ACALPA was implemented in a specialised school for people with autism. The school numbers approximately 50 persons with autism, ranging from 8 to 30 years of age, but mostly children. The persons are educated by thirteen highly specialised educators. The system was used for a period of one month as part of the daily educational process. Furthermore, at least one educator was accompanying a child in the interaction with the system. Meanwhile, children's progress was tracked through the reports of the system.

**Table 1. Contents of the Questionnaire** 

Category	Type of questions
Content	Related to autistic persons daily life, non-discriminating, integration of the content, ability to add more.
Educational Approach Of Theory	According to the theories for educating autistic persons, ability to support techniques and methods used in this kind of education (TEACCH), autonomic education or working as a team.
Educational Approach In Practice	Supporting of creativity, attract the attention of autistic persons, supporting of skill and difficulty levels, educational material well organized
Technological Performance	Protection of sensitive data, printable forms and reports
Interaction	Can educator provide a new approach of the educational procedure, avatar and synthesized speech interaction, emotional face of the avatar, multimedia material.
Feedback	Feedback provide by the system to the user under question, positive and negative feedback

Software Design

Clear and simple design, complexity, use of colours and fonts, navigation through forms.

At the end of the usage period, the teachers were given a questionnaire that inspects the main aspects of the platform and the edutainment process using the platform. The questionnaire consists of the categories shown in Table 1.

Evaluation of the results on our survey indicates that the avatar advances the educational process (Error! Reference source not found.2). Educators suggest that most of the times persons with autism are able to recognize the avatar's mental and emotional

state provided by facial expressions (Fig. 33). Moreover the synthesized speech is provided by lips synchronisation of the avatar. Consequently, an avatar speaking in the native language of the autistic persons is making more sense than an avatar without speech. Educators believe that an avatar with native voice is more effective than an avatar without voice (Fig. 2).

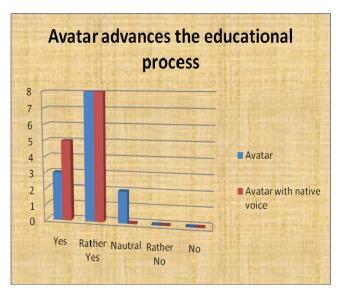


Fig. 2 Evaluation of the avatar's usefulness in the educational process.  $\phantom{\Big|}$ 

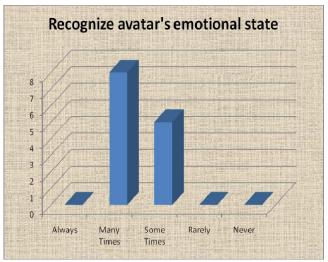


Fig. 3 Persons with autism most of the times are able to recognize the avatar's emotional state  ${\bf r}$ 

An interesting point which characterized children with autism is that they are unable to choose which event is more or less important [21]. As a consequence they are often saturated because of too many stimuli and thus they adopt an extremely repetitive, unusual, self-injurious, or aggressive behaviour. During development of the system, educators ask for the software not to be complex. For instance, if a child should distinguish a dog from a cat, the multimedia material should depict only the dog and the cat, without extra background information. For this reason the multimedia material is as simple as possible by providing clearly the main objects. In this way, ACALPA helps children with autism to focus their attention on a specific task. However, educators have the ability to experiment by providing more complex themes. Evaluation of the results indicates that although most of the times the multimedia material attracts autistic persons only in some of them the autistic persons are not complicated (Fig. 4).

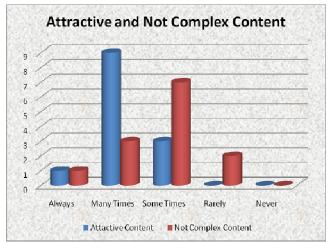


Fig. 4 The content presented by the system appears to be attractive and not complex for autistic people.

Moreover, one of the goals of our investigation was to examine if the system is able to support techniques and methods that are used in autistic persons' education. For example, the TEACCH intervention program (Treatment and Education of Autistic and related Communication handicapped CHildren) involves a structured teaching approach and the use of visual materials. TEACCH is providing services for autistic people by making use of various associated techniques depending upon the individual person's needs [22]. TEACCH principles involve changing the behaviour and skill level of the person as well as developing an environment that matches the person's needs. TEACCH is a structured technique especially targeting to the person's visual processing strengths by organizing the environment and providing a visual conduct to supply information about activities. Visual structure is provided at a variety of levels such as organizing areas of the environment, providing a daily schedule using pictures or written words, as well as visual instructions and visual organization signalling the beginning and end of tasks. This technique is based upon the observation that children with autism learn and connect information differently than other children. Accepting this method's principles while developing the system, the educators were asked for a feedback about the system's ability to support methods used in education of autistic persons. Most of the educators agreed that the structure and the content of the system are formed in the right way so as to make it capable of supporting the TEACCH method (Fig. 5).

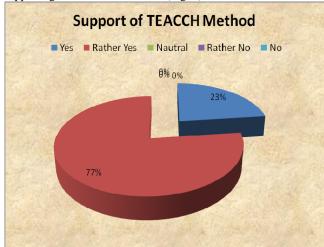
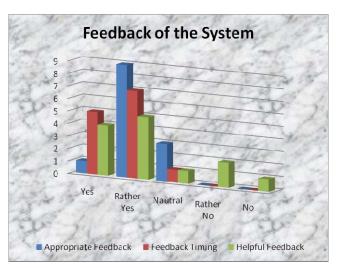


Fig. 5 Most of the educators agree that the system is capable of supporting the TEACCH method.

During the initial stage of the system development, interviews with educators of autistic persons revealed that the feedback provided to the autistic persons during educational process plays an essential role. Based on this, the system approach on a successful answer is integrated by means of the avatar's happy emotion, a voice telling "Bravo" or "Well done" and sound of applause. On the contrary, the avatar, with a sad face, encourages the user to try again. Apart from the type of the feedback, the timing had also played essential role in keeping the persons attention. Moreover, in both occasions, the avatar uses the autistic person's name; an ability that stems from the personalized system's architecture. On our survey, most of the educators showed a positive impact on the feedback that is provided by our system. Most of them agreed that the feedback is suited in the appropriate form, although it should be more helpful in case of a wrong answer. As a result, the feedback approach we followed appears to suit the needs of the user with autism (Fig. 6).



#### Fig. 6 The feedback of the avatar provided in the right way

As described in the introduction of this paper, mush recent educational research focuses on teaching and learning by means of the usage of personal computers.

Results suggested that autistic persons are more interested in using a personal computer (independently of the software) rather than playing with other kind of games or toys (Fig. 7).

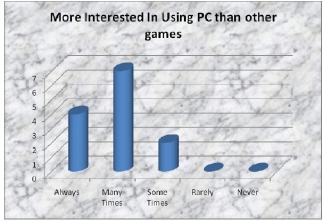


Fig. 7 Persons with autism are more interested in interacting with a personal computer rather than playing with other types of games or toys.

In our try to evaluate our software (ACALPA) as for the variety, the quality and the impact to the user's mental state, related groups of questions were included to the questionnaire. Educators believe that the variety and the quality of the content that is represented by the software are able to support the educational approach we followed. Moreover, the evaluation of the results on our survey indicates that in most of the cases the system encourages the autistic person (Fig. 8). A more interesting finding is the persuasion of the educators that the system is able not only to provide but also to motivate social activities among the autistic persons and collaboration in term of groups. In addition, the level of creativity is increasing in most of the cases

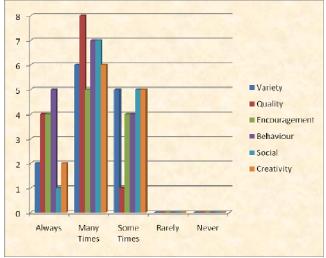


Fig. 8 Educators believe that the system suits the educational needs

## 5. CONCLUSION

This study demonstrates that an interactive learning environment might facilitate the educational procedure for people with autism.

Thirteen educators of autistic persons used our platform (ACALPA) for a month. The answers from the questionnaire provided by them reveal that using of avatars in such system is promising for people with autism. Moreover, avatar's emotional expressions, provided in a safe environment, makes autistic persons understand the emotional state more easily. Furthermore, educators believe that when the avatar is accompanied by a synthesized speech in the autistic's native language the educational processes are facilitated in a more proper way.

In addition, the multimedia content plays essential role in the procedure. Based on the results, content must not only be attractive but also simple in order not to complicate the persons with autism. Moreover, it should contain content from variety activities of the daily life. In this way, autistic persons don't lose their interest during the game.

Another point is that supporting of techniques and methods that are used in autistic persons' education, such as TEACCH, gives the ability to the educators to integrate a large amount of information in a more organized way.

Finally, the appropriate feedback of the software during the interaction with the autistic person is very important. Our system provides the appropriate feedback, in the appropriate time by a helpful form. The feedback is provided by means of the avatar, the synthesized speech, text, makaton symbol, sound or combination of them.

Further work includes usage or designing of different type of applications in order to capture autistic person's movements as a factor of their behaviour [23]. Automated capture technologies and the associated access interfaces for exploring past experiences are particularly promising for monitoring the effectiveness educational systems for behavioural and learning disabilities in children [24].

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