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Procedia Computer Science 14 (2012) 20 – 27

Procedia
Computer ScienceProceedings of the 4th International Conference on Software Development for
Enhancing Accessibility and Fighting Info-exclusion (DSAI 2012)

A Web-Based Application to Address Individual Interests of Children with Autism Spectrum Disorders

Margarida Lucas da Silva^a, Daniel Gonçalves^b, Tiago Guerreiro^b, Hugo Silva^{a*}^a*Instituto Superior Técnico, Avenida Rovisco Pais, 49, 1050-001 Lisboa, Portugal*^b*INESC-ID, Rua Alves Redol, 9, 1000-029 Lisboa, Portugal*

Abstract

Autism spectrum disorders (ASDs) are a triad of disturbances affecting the areas of communication, social interaction and behavior. In educational contexts, these limitations can be deeply disabling unless appropriate intervention methodologies are promoted. Children with ASDs usually have very strict interests, which may cause a lack of interest in standard ICT tools overtime. Our paper presents a new way to overcome these issues, by enabling children to have the opportunity to enjoy a rich multimedia platform. This approach allows tutors and peers to prepare a unique setup for the child's needs, giving the possibility to fully customize the layout and contents. Special attention was given to the promotion of communicative and social competences of children with ASDs, enabling them to interact with one another through messages, share opinions, and experiences. Preliminary results show that children feel motivated using the tool, and number of interactions between peers increase. In this paper we will describe the platform and how it can be customized, and finally, introduce the evaluation methodology to be used.

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Keywords: autism spectrum disorders, web application, customization, user-tuned content

1. Introduction

Children with autism spectrum disorder (ASDs), exhibit a range of specificities in terms of their cognitive and communicative skills that need to be appropriately addressed. Each case is unique, and the ability to define user-tuned content is fundamental to the widespread of adequate work strategies with the children, based on

E-mail address: margarida.lucas.silva@ist.utl.pt (Margarida Lucas da Silva), daniel.goncalves@vimmi.inesc.pt (Daniel Gonçalves), tjvg@vimmi.inesc.pt (Tiago Guerreiro), hugo.silva@lx.it.pt (Hugo Silva).

their individual interest. ICT based strategies have enabled a huge leap in the field. However, only standardized content and application models are available, which might not be the best approach, as each children or group of children has individual needs. Nowadays, web-based applications play a major role in content display both for online and offline use, becoming more accessible with time, and giving the possibility to develop tools that easily meet users needs. The intrinsic features of web technologies, makes them a straightforward and complete solution for easy and fast customization to new requirements in terms of needs within the target user group. Also, the constant development of new ways to be more interactive and efficient makes web technologies, a good solution to tackle problems that were typically linked to more traditional monolithic applications.

In our work, we are going to analyze a multimedia platform developed using web standards that focuses on children individual interests. Existing tools targeted at children with special needs try to be more accessible and provide educational content. However, children often lose motivation to use it, since they don't find it appealing enough, don't relate to any content inside, or even find content that might stress them in some way. Our tool gives the possibility to tune the presented contents to the children's interests, and to evaluate how these can be used to motivate them to use an application that can produce positive outcomes in an educational context. The rest of the paper is organized as follows: Section 2 provides an overview of ASDs; Section 3 describes the background of our work; Section 4 introduces the proposed approach; Section 5 shows the evaluation methodology; and finally Section 6 outlines the main conclusions.

2. Autism Spectrum Disorders

Autism spectrum disorders are a group of developmental disabilities, comprising Classic Autism, Asperger syndrome and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) [1]. Their symptoms range from moderate to severe, varying among patients. In 1979, Lorna Wing carried out an epidemiological study and realized that there were a transverse triad of impairments: a) impairments in social interaction; b) impairments in language and communication skills; and c) social imagination, which is an inability of imagining things they didn't experience yet. These impairments are the currently basis used to diagnose ASDs [2]. Furthermore, a behavior pattern suggests restrictive, repetitive and stereotyped interests and motor mannerisms (e.g. hand or finger flapping).

There are also other characteristics often highlighted in autistic patients but which are not always present, such as an exceptional memory, superior skills in attention, and perception and unusual sensory perceptions. All patients show several differences between their disabilities, creating an unique personality that requires looking at each child as a different case. Because they have restricted interests and can become very fixated on them, these restrictions might be used in their benefit. Boyd developed a study [3] where he compared the effects of circumscribed interests to less preferred tangible stimuli on the social behaviors, and the results showed an increase in social interactions in tests with circumscribed interests. These results were important since they state how children become more interested and motivated when contents are fitted to them.

3. Background

Putnam and Chong [4] conducted a survey to understand what kind of tools these users are using, and their experience with them. Most of the responders gave all kind of examples of some contents that should be available for the children, so that they could be motivated to use the tool in a daily basis, and also 19% of the responders said that these tools should be fun to use to prevent the tool abandonment. In Putnam and Chong findings, they also find that design considerations have a big importance in the tool that children use.

De Leo and Leroy [5] developed a smartphone application to form messages. These messages could have text or images, and all images could be customizable, giving the possibility to the children to choose their own images. Ismail and Omar [6] created an application that gave the possibility to decide what kind of content was

of interest to include (from a restricted list), and visually where to place it. Morris and Kirschbaum [7] created an algorithm to find images in the Internet that were of the interest to the children, to be used in any kind of application. Rahman and Naha [8] created an application running in a network, in which a tutor can show pictures of objects to send messages, and the pictures of that object in the children's computer may differ according to their preferences.

These examples show the ecosystem and difficulty in tuning the application to each child; as a growing concern in the software development, now some involve the user in the design process [9], or give customization possibilities. This way the user can set the look and feel of the tool so they can understand or feel more comfortable in using the tools. Despite the recent effort, current tools are still not able to meet the needs of tutors and children, in terms of adjusting the application content and visual aspect to the preferences of the children. In Table 1 we can see all options available in these studies: multimedia content (images, audio, video), custom content, custom layout (menu icons, wallpaper), tool configuration (change tool sections, or available functionalities) and user-centred design (user is involved in the design process of the tool). As we can see, none of these approaches supports all these functionalities, showing some limitations. In our tool, we will give all the options described in the table, making it 100% customizable.

Table 1. Survey of the tool options for the user

	Multimedia content	Custom content	Custom layout	Tool Configuration	User-Centred Design
[5]	Yes	Yes	No	No	No
[6]	Yes	No	No	Yes	No
[7]	Yes	Yes	No	Yes	No
[8]	Yes	Yes	No	No	No

4. Proposed Approach

In this section we are going to describe in detail the system used to run the tests, which we have called *Troc@s*. This application was developed to make fully customizable tools available to the children, which are simple enough for tutors to customize the layout and content in a user-tuned fashion. Focus was given to the development of communicative competence in autistic children; all the activities are targeted at communication skills training. They are based in multimedia content: images, videos, audio and stories. Also these are activities familiar to the children, facilitating the platform inclusion in their lives.

4.1. Application

Interpersonal communication and interaction skills of children with ASD may be very limited, which creates the motivation to develop a tool to support their needs for integration in social life. This is important not only for educational purposes, but also for leisure, so that individuals can share their tastes with others, comment on existing content, and communicate with their peers. Furthermore, tutors have the need to setup contents adapted to the reality of each group, to stimulate them and promote greater autonomy in normal activities such as accessing photos, music, among others.

In this context, this tool is directed to the specifics of this topic. It has the twofold objective of encouraging socialization and facilitating interaction among children with ASD, while allowing tutors to easily customize the contents and look-and-feel of the tool. The application can be fully customized with icons, background

images and the contents that allow each child to be more effective while using it. Children can even use their own drawings or favorite images to better associate each feature of the software with the underlying function. Tutors have full control over the software and they can intervene virtually at all levels. They can act at the content level, where contents are structured and organized under the application folder tree, just as any other document is organized in regular computer work, as we can see in figure 1. But they can also act all the way up to the presentation level, where they are able to manage the screen and navigation structure by simply editing the HTML files, that also can be easily assigned individually to each user. The application reads all folders and files names, and uses them for the titles. In this way the application is not bound to a main language, it uses everything that is specified by the tutor in the folder and files names. The menu icons are defined by the subfolders that exist in the base folder and in the profile folder; if for example the images folder didn't exist, then it wouldn't be available in the menu. Also, the default profile is available as default for every child, and if we add a profile to a child, specifying their name (e.g. johndoe profile), the tool gives priority to the individual profile, and only then, to default profile.

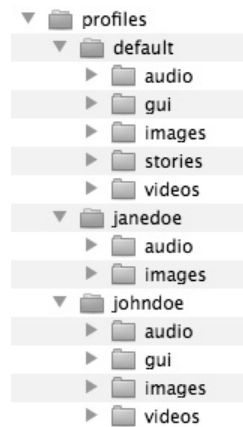


Fig. 1. Example of a profile content folder tree..

This means that if we define a different background image for a given content page in the johndoe profile, the janedoe profile won't be able to see it, this profile will load the videos folder from the default profile, since he doesn't have a videos folder in his profile, with his individual content. This also applies to files: johndoe profile will load videos from his individual profile first, and then from the default profile. Individual profiles never share content; the only way to share it is to assign the individual profile to the user.

All the activities are targeted at communication skills training. They are based in multimedia content that children can autonomously browse through and learn from. In addition there is also a message board, and content preference sharing options, these being the main contribution of the tool to the field, when compared to existing work. In the message board, children can post messages to their colleagues. The sender child has a buddy list with names and photos of all counterparts, from which the receiver colleague can be chosen. The message can then be written either through text, picture exchange, or a combination of both methods.



Fig. 2. Message board of the application.



Fig. 3. Activity with content preference-sharing pane.

When the receiver colleague opens the message board, he will immediately be able to see all of the messages sent to him by others. Figure 2 shows the message board screen. For content preference sharing, associated to each multimedia element (image, sound or video), there is a positive and a negative preference option. These allow the child to express and share with its counterparts at any time his/her preference regarding the individual element. This information is associated with the content and shown every time it is accessed, allowing all children to see the opinion of their colleagues. Figure 3 shows one of the activities with the content preference-sharing pane on the right of the screen.

4.2. Framework

The framework was designed with both the end-users and the tutors in mind, targeting the seamless delivery of rich multimedia content, while providing high customization levels, easy content management and

maintenance by non-technologically proficient individuals. We found the answers to these requirements in web technologies. Web browsers are currently the best platforms for rich multimedia content delivery, and web standards provide some of the best tools for GUI layout and formatting. Also it is easy to install, since most computers runs a browser, not requiring many computational resources or any hardware compability. However, they have limited capabilities to interact and control operating system functions.

To enable the browser to perform OS level operations, we implemented a Python Websocket server, which takes advantage of the advanced connectivity capabilities introduced by HTML5. Through this infrastructure (Figure 4), the presentation layer implemented at the browser level, can manipulate the file system, read all files from the platform, and automatically generate thumbnails, among other operations. Data persistency is assured through the Couch BD database engine, also managed by the Python Websocket server. For each user, we can assign a user profile, or use a default. In each user profile we can use independently customized files, such as the HTML structure files, the CSS, the background images, the menu icons, and even the content shown: the images, videos and audio listing. We can see an example of this file structure in Figure 1.

All likes assigned to the content, and the exchanged messages are saved in the database as JSON strings, associated to each user. This tool also saves logs with the user navigation, files loaded, messages sent/received, likes, and amount of time spent in the tool.

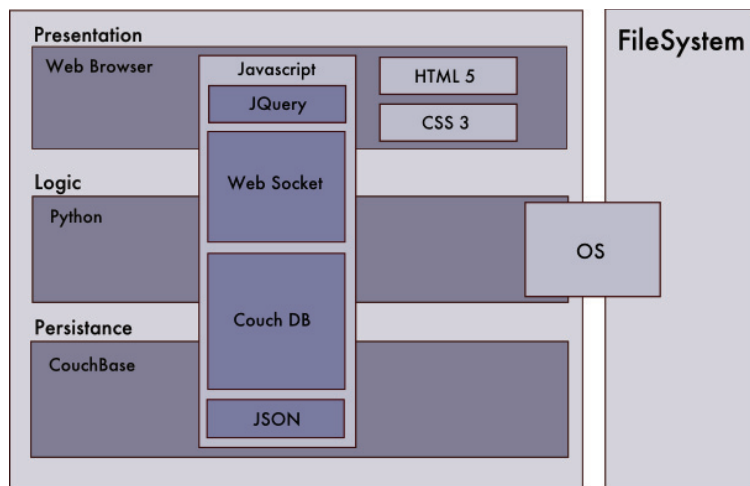


Fig. 4. Framework of the platform.

5. Evaluation Methodology

In a previous study where a prototype version of the platform was used with 3 children, preliminary results based on behavior observation, shown that the children felt compelled toward the use of the tool, and that the number of interactions between peers increased [10]. For the new set of tests following the work presented in this paper, we will have to overcome some challenges and limitations: a) a dependency to a tutor; b) the need to respect a daily routine; c) the difficulty in dealing with spontaneous or unexpected moments; and d) different levels of severity that can be translated in a variety of unique behaviors, making difficult a general approach that can meet all users' needs. These situations make the evaluation results less accurate. To overcome this, each child will be analyzed individually, as a case study so that each result can be measured accordingly.

For the evaluation we are going to focus on the platform customization to the children preferences. We want to understand if this full adaptation to the user by using the platform is beneficial, and for that we will assess: 1) if it is sufficiently expressive; 2) if the tutors can easily use the platform and address the children needs; and 3) if the platform with full customization can actually provide improved outcomes with the children. These are the three main issues we are going to answer in these evaluations. First we will conduct a survey with the tutors; we want to assess their needs and see if the functionalities in the platform address those needs. In case the platform doesn't cover all problems pointed out, changes will be made before the usability tests with the children. Next, we will present the tool to the tutors, explaining all the functionalities, and perform a test with well-defined tasks in order to evaluate the teacher proficiency in using the platform. In these tasks we will gather: (1) The amount of time needed; (2) The amount of errors made through the task. Then we will perform a new survey to assess tutors satisfaction, and gather information about difficulties and suggestions to apply to our approach.

After this period, 4 children with ages between 12 and 15 will start using the application, without any customization, only with the default content for a period of 2 weeks. Then we will have another period of 2 weeks evaluation with another 4 children, with the platform fully adapted to each child. During these 4 weeks, we will try understand if the child is exploring the full potential of the tool, and for that we designed metrics that will assess through the data logs:

- The amount of time spent in the platform.
- See the navigation areas they use the most, and spend more time with. This will tell us what the children prefers to use, or has more interest.
- The amount of likes that the children did in the content.
- The amount of messages exchanged by the children, using text, images, or both.

Finally, we are going to conduct an interview with the tutors, so we can gather their opinions and observations about the children's behavior through the tests. We are interested in knowing if they saw any noticeable changes or actions in their students under the tests.

6. Conclusions

Adapting ICT to users with ASD has become a major concern, and some approaches have been developed in order to address the user-tuned content customization. In this paper we show an application that can be fully adapted to the children's needs, by using a solution that uses web technologies to be easy to use and customize. The application is managed through the regular file system explorer, which users are already familiar with, allowing them to easily create folders with the desired content and assign them to the user they want. This simple system allows the rapid customization of any content such as images, videos or audio, but also the look and feel of platform, by changing wallpapers, menu icons, or even, in case the tutors are trained to do so, to change all the layout of the pages, by simply editing HTML and CSS files. With this, we will be able to assess if adapting the application to the restrictive preferences of children with ASD motivates them and contributes to the development of communicative and social skills, by giving a mean for children to interact comfortably with other children, or simply access to their preferred content more easily.

Acknowledgements

This work has been partially funded by Fundação Portugal Telecom, ASUS Portugal, and by the Fundação para a Ciência e Tecnologia (FCT) under the grant SFRH/BD/65248/2009. The authors would also like to acknowledge the special education teacher Carla Simões (Agrupamento Vertical de Escolas do Vale da Amoreira) and Prof. Fernanda Botelho (ESE-IPS) for their support in the results of the preliminary tests, and in

the preparation of the new evaluation methodology tests to assess the impact of the customization of the tool with the children.

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