

Visual Schedule: A Mobile Application for Autistic Children - Preliminary Study

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Abstract: Children with autism often experience considerable challenges and one of them is the difficulty in understanding, structuring and predicting their daily life activities and routines. Several methodologies have been studied and implemented to help autistic children with these routine activities and tasks, and one of those methods is the use of visual schedules. For this, mobile apps and related technology have been considered as an excellent tool in supporting autistic children's development. But despite the technological resources and the variety of mobile apps available today, the authors could not find such needed resources available for the Portuguese speaking autistic children population, especially in relation to visual schedules/routines, which are considered very important for the child's development. Therefore, based on the literature and in some apps available in other countries for autistic children, the authors propose a set of mock-ups of a visual schedule application for smartphone. The visual mock-ups represent the idea of the app that we intend to implement in a near future to be used by Portuguese autistic children aged between 4 to 10 years old to support them in their daily routine and the performance of related tasks.

1 INTRODUCTION

Autism spectrum disorder (ASD) is a developmental disorder of the brain characterized by deficits in three major areas of behaviour: social, communicative, and repetitive behaviours and restricted interests and activities. The social problems include less eye contact, less attention and difficulty in learning and using the social skills needed to function in society (Sorensen, 2009). As a result, it impacts how a child perceives and socializes with others, causing difficulties in communication and interaction with other people (Lubetsky et al, 2011). Also, because of the disorder of social interaction, many autistic children do not have the concept of time management. Therefore, it is very difficult for them to understand what they need to do as daily tasks (Niwa et al, 2014).

Several approaches have been made to assist education of autistic children as well as several methods have been implemented in different countries to help children in their daily lives, with their routines and tasks. One of the methods considered by several authors as an effective intervention technique for helping children with ASD is the use of visual schedules. By providing a

structure, visual schedules support children to be more independent (Hayes et al, 2010). And although many special support education tools still use traditional methods such as picture cards and whiteboards (Niwa et al, 2014), technologies have also been considered as an excellent tool in supporting education and inclusion for children with disabilities, including those with autism (Laabidi et al, 2014; Rani et al, 2014).

But despite the various studies and methods implemented in other countries, we have noticed that in Portugal, there is a gap in educational methods based on mobile technology for children with autism. Therefore, this study aims to develop a set of mock-ups for a new visual schedule application for Portuguese autistic children. Our goal is that through this method, children will be able in a simpler, more engaging and independently way, to accomplish their daily routines.

Since there is not much work available in this area in our country, we need to start designing and developing interactive methods and interfaces to face this gap. This work is such a first step in this area.

This paper is organized as follows: section 2 presents the related work and section 3 describes the

methods used to design the mock-ups of an interactive visual schedule for autistic children. Section 4 describes our use-case and proposed mock-ups, section 5 discusses the obtained results while section 6 concludes the paper and provides future research steps.

2 RELATED WORK

2.1 Visual Schedules

Most adults naturally make plans for their daily behaviours and routines but autistic children have several difficulties to make such plans for themselves. Children with autism often experience considerable challenges in understanding, structuring, and predicting their daily life activities. Also, they need a constant confirmation of their behaviours (Niwa et al, 2014).

There are many conventional therapies that work for autistic children, and according with Azahari et al., (Azahari et al, 2016) one of the most effective educational approach is the visual method. More precisely visual schedules have been shown to be an effective intervention technique for helping individuals with ASD (Hirano et al, 2010). Through symbols such as pictures, words, and other visual elements, visual schedules describe activities, and what task will be happening, in what order, and where (Hayes et al, 2010) (Figure 1).



Figure 1: Paper-based visual schedules. Individual student schedules include representations for each activity of the day (Hayes et al, 2010).

Even though, visual support has always been typically made of paper in supporting autistic children's learning and development (Hayes et al, 2010), it has also been reported, by many parents and caregivers, that this is a good methodology when used with the support of new technology that involves visual communications (Rani et al, 2014). Even more,

and according with several authors, mobile devices could play a significant role in enhancing the quality of life for children with ASD and their families (Vlachou and Drigas, 2017)

2.2 Visual Schedule Mobile Applications for Autistic Children

Studies have shown that autistic children are enthusiast with technology, in particular with mobile technology. This is especially because the touch screen interface makes it appealing and simple to use and learn everyday. It also helps the interaction between children and other people (Vlachou and Drigas, 2017). Besides, mobile devices are able to assist them to be more concentrated and motivated to learn and apply what they have learnt (Azahari et al, 2016). And beyond their strong interest in mobile technology, autistic children are enthusiastic to use a certain type of applications (Niwa et al, 2014).

During our research, we found various mobile applications for children with autism and Asperger's syndrome, but taking into account our study's objective, the applications mentioned below are only those related to visual schedules for autism.

Niwa et al. (Niwa et al, 2014) developed "Smiley", a schedule application to help autistic children to do something by themselves without instructions from teachers or parents. Many special education schools in Japan have already adopted "Smiley" as a primer of a schedule application.

Hayes et al. (Hayes et al, 2010) created "vSked", a prototype visual support which assists teachers in managing their classrooms by providing interfaces for creating, facilitating, and viewing progress of classroom activities based on an interactive visual schedule. It can be also used at home.

Song et al. (Song and Yusof, 2010) talks about "PECS", which allows the child to move the images around to form sentences by touching the mobile device screen. It gives the ability to easily customize the images based on the needs, interests and preferences of each child (Figure 2).



Figure 2: The smartphone app "PECS" (Song and Yusof, 2010).

Another mobile assistive application is “MOSOCO”, proposed by Escobedo et al. (Escobedo et al, 2012). This app uses augmented reality and visual supports to help children with autism to practice social skills in real-life situations. This study was tested in a public school in Southern California and the results demonstrated that “MOSOCO” facilitates the practice and learning of social skills.

In addition to the applications mentioned above, on Apple App Store (iOS system), we found a few paid apps related with our study such as: “Children with Autism: A visual schedule”, “Visual Schedule Planner” (Figure 3), “Birdhouse for Autism”, “Choiceworks”, “First Then Visual Schedule”, and “PictogramAgenda”. Besides not being free, these applications are not available in the Portuguese language and most of them are only developed for iPad.



Figure 3: Image from the “Visual Schedule Planner” app.

In its turn, on Google Play Store (Android system) there are several apps free for downloading. But despite this variety of apps, the authors could not find many resources available in Portuguese, to be used by Portuguese speaking autistic children, especially relating to visual schedules/routines.

On Google Play Store we looked for free apps that matched the following English and Portuguese search terms: “schedule routine for autism”, “visual routine for autism”, “visual schedule autism”, “visual timer autism” and “rotina autismo”. Therefore, we found eight free apps available for downloading. And even though, three of them are available in Portuguese language, none of them were developed in Portugal. The apps “Minha Rotina Lite” and “Autismo Projeto Integrar” (Figure 4) were made in Brasil, and “Lista visual - Visual Schedule” was made in Canada.

The first app is only available for tablet and it is not the full version (the full version is paid). The version available has limited tasks and, in addition, some terms used are not the same as those used in

Portuguese language, from Portugal. In the second app, the images and the sequence are predefined and customization is not possible while the third app does not contain a distinction of users (a different profile for the child and their parents/teachers) and so it can become confusing due to all available options and functionalities each time the child accesses the app.



Figure 4: Some images of “Autismo Projeto Integrar” app (Krause, 2016).

3 METHODS

Taking into consideration our research in terms of the availability of visual schedule apps for autistic children, we may conclude that, in Portugal, there is a clear gap for this type of mobile apps. Children are increasingly using computers for a variety of activities, however, designing for children can be extremely challenging, particularly for children with special needs (Hayes et al, 2010). So we decided to analyse the existing visual schedule mobile apps developed in other countries, and understand what are the successful functionalities and which must be avoided, when developing such an app. Beyond the apps, we also analysed the existing literature on the subject to help us define our app’s main requirements and avoid common mistakes right from the beginning. The combination of all recommendations and a set of User Interface Design (UI) principles for designing and developing a mobile-based learning application are summarized in Table 1 and explained in Section 4.

4 REQUIREMENTS & USE-CASE

Based on the literature review and in some apps available in other languages rather than Portuguese from Portugal, our idea focuses on the development of visual mock-ups of a visual schedule application

for smartphone. The visual mock-ups represent the idea of the app that we intend to implement in a near future. Our goal is to have a very simple design to be easily understandable and used by children and prepared to be customized by parents/teachers. And although it is intended to be used independently by the child, at the beginning, it may be necessary the help of an adult to use the tools and complete the tasks.

4.1 Requirements

According with Hussain et al. (Hussain et al, 2016), numerous apps for autistic children are difficult to use, particularly in terms of user-interface design. Instead of what happens in many available applications for children, Niwa et al. (Niwa et al, 2014) suggested that applications must have simple functions and operations, focused on basic manipulations which will allow autistic children to understand what to do next, easily. The same authors also refer that such apps must also have an attractive design.

Another important characteristic that many apps do not have is related with customization of images. Parents or teachers should be able to customize the app with personal photos of real situations and

activities, based on the needs, interests and preferences of each child (De Leo and Leroy, 2008; Song, 2012; Voon et al, 2015). All this can facilitate the learning process. Some apps lack on a good structure which may cause anxiety (Fletcher-Watson et al, 2016). Others have only one login mode which may be confusing and the child could easily reset the settings (Voon et al, 2015).

The design and development of a learning mobile application for educating children implies essential elements to guarantee that the user will easily and effectively use the application. Since in this phase we could not engage the final user (the children with ASD), our design process of visual mock-ups was mainly based on the literature review, the analysis of existing apps and also on a set of User Interface Design (UI) principles for designing and developing a mobile-based learning application proposed by Hussain et al. (Hussain et al, 2016) and Hashim et al. (Hashim et al, 2010). Thus, with the proposed design we intend to have a combination of the benefits found in some tested apps and in the results demonstrated in the studies of our review. At the same time, we tried to avoid already encountered problems. Moreover, we intend to suggest some design decisions to provide an app which better fits the target group's needs. The list of found recommendations is available in Table 1.

Table 1: The combination of all recommendations and design principles to design a visual schedule app for autistic children.

Design Principle	Suitable Design
Structure	<ul style="list-style-type: none"> ▪ Simple structure and sequence (Fletcher-Watson et al, 2016; Niwa et al, 2014) ▪ Two login modes - the child login and the parent/teacher login which makes the layout simpler and more perceptible for the child (Voon et al, 2015) ▪ The admin section should be protected with a password (Hussain et al, 2016)
Navigation	<ul style="list-style-type: none"> ▪ Simple navigation, easy to understand and use (Hussain et al, 2016; Niwa et al, 2014) ▪ Should always be consistent (Hashim et al, 2010) ▪ Similar actions and similar buttons located in similar positions (Hashim et al, 2010)
Interface	<ul style="list-style-type: none"> ▪ Simple and attractive (Hussain et al, 2016; Niwa et al, 2014) ▪ Should be user friendly (Hashim et al, 2010)
Content	<ul style="list-style-type: none"> ▪ Information must be small and consistent and unnecessary information should be avoided (Hashim et al, 2010)
Images	<ul style="list-style-type: none"> ▪ The customization of images should be available and must be at the parental login mode (De Leo and Leroy, 2008; Hussain et al, 2016; Song, 2012; Voon et al, 2015) ▪ Images must be identical to real life (personal and real photographs of the child) because it facilitates the recognition and allows children to learn more efficiently and effectively (De Leo and Leroy, 2008; Hussain et al, 2016; Song, 2012; Voon et al, 2015) ▪ Through their own login, children must have access to all images corresponding to the activities previous organised by their parents/teachers (De Leo and Leroy, 2008; Song, 2012; Voon et al, 2015)
Text, video and audio	<ul style="list-style-type: none"> ▪ Options to add text, audio and video to each task and for all the steps should be available (Song, 2012; Voon et al, 2015) ▪ The audio should correspond to the images and must be user-friendly (Hussain et al, 2016)
Colours	<ul style="list-style-type: none"> ▪ Dark colours such as black should be avoided (Hussain et al, 2016)

4.2 Use-case

The proposed app's name is "My Routine" and it is designed to be used by Portuguese autistic children aged between 4 to 10 years old to support them in their daily routine and for the performance of related different tasks. Activities such as "use the bathroom", "get dressed" or "eat breakfast" can be supported by the app because it contains each step for the accomplishment of the task. Through pictures, words and sounds it is shown the sequence of steps within each activity. It is also designed to be used by parents, teachers and special educators, once they are responsible to organize all the activities (names and descriptions) taking into account the child's routine, upload real photos of the child, record audio and even upload videos in the app related with each child's task.

Therefore, the following images are in English for the sake of understanding of a wider audience, but the idea is to have the app developed and implemented in Portuguese.

4.2.1 Child's Profile

As suggested by a few authors (De Leo and Leroy, 2008; Hussain et al, 2016; Song, 2012; Voon et al, 2015), an application must be customizable with images, texts and audio. Thus, in the design process we thought that the application could be more appealing if it started with the child's photo and name. Figure 5 (left), represents the child's profile and what s/he sees as soon as s/he runs the application (his/her name and photo). This corresponds to the child's login mode but we considered the idea of having two login modes very relevant, being one for the child and the other for the parent or teacher (Voon et al, 2015). This helps the layout to be simple and more perceptible for the child.

In the child layout, it is possible to switch to the parent/teacher profile through the button in the lower right corner. The parent/teacher profile is protected with a password to avoid any confusion in the child's understanding and perception.

By choosing to continue in the child profile and after clicking on the photo, Figure 5 (right) represents the following menu. This menu consists of several buttons with the days of the week. Taking into account the ideas proposed by Niwa et al. (Niwa et al, 2014), and also the potential group users of our application, we decided the best would be to have a very simple structure and navigation. Beyond the days of the week (from Monday to Sunday), the

authors thought that it might be important have two more options, "Holidays" and "Special days". These options allow parents to personalize specific activities taking into account different occasions of the year. The month of the year is also presented, in this case "January" accompanied by a customizable background image. For a better identification and because this is a visual schedule, each day is combined with a symbol with the corresponding day of the month, and the current day is highlighted. For the school days we choose a school board, and for the other days we chose different symbols that may represent different activities. The next step is the choice of the day of the week. The colours used are the type of shade used in other apps for children, not too light and not too dark (Hussain et al, 2016).



Figure 5: The beginning of the app "My Routine" with the child's profile image (left), followed by the first menu to choose the day of the week (right).

When choosing the day of the week the various morning activities/tasks are visualized (Figure 6 - left): use the bathroom, brush teeth, get dressed, eat breakfast, make the bed, shoes and jacket, backpack and lunch, go to school. These activities/tasks were chosen based on real activities performed by Portuguese children during their school days. Our layout was inspired by the combination of schedule apps such as "Visual Schedule Planner" and "Minha Rotina Lite" as, for each day of the week, they have several organised images representing the planned activities. Moreover, these two apps are completely audio-visual customizable.

Therefore, the space we have for images identified with "Real photo" must be customized with personal photographs of the child (De Leo and Leroy, 2008; Hussain et al, 2016; Song, 2012; Voon et al, 2015).

As previously mentioned, the customization with personal and real photographs of the child facilitates the recognition and allows children to learn more efficiently and effectively (De Leo and Leroy, 2008; Hussain et al, 2016; Song, 2012; Voon et al, 2015).

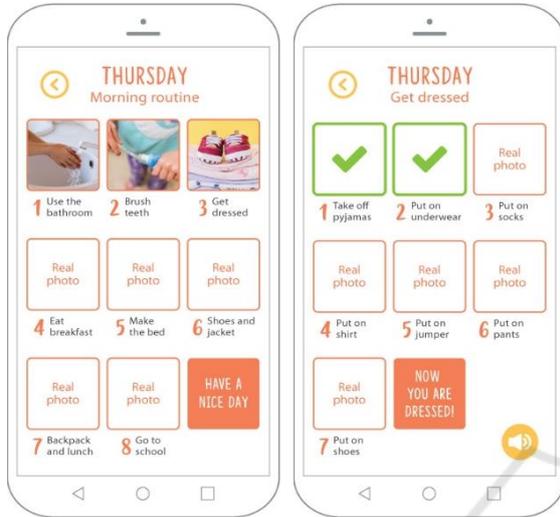


Figure 6: All the tasks that are planned to be performed by the child (left) and details of the task “Get dressed” (right).

The app “Autismo Projeto Integrar” helped us in the organization of the tasks and how to organise each task steps. When a task is chosen, all the steps related with that task are displayed (Figure 6 - right). The space designed for images are accompanied with a small text to support each step, if necessary (Song, 2012; Voon et al, 2015). In this case, the chosen task is “Get dressed” and all the steps that the child will have to perform are displayed. After the child completes each step s/he will have to click on the corresponding image in order to confirm that a particular step is completed and the green check mark symbol will appear. Each step can also have audio combined, preferably personalized with a voice of someone the child knows well (Hussain et al, 2016). The sound button (present in the lower right corner) gives the child the opportunity to listen the several steps previously recorded. As soon as the task “Get dressed” is completed the menu with all the activities reappears and this specific task appears with a green check mark symbol (similar to Figure 6 - left).

As recommended by several authors, we tried to design a simple structure, sequence and navigation (Fletcher-Watson et al, 2016; Hussain et al, 2016; Niwa et al, 2014). And as referred by Hashim el al. (Hashim et al, 2010), we also tried to maintain the consistence needed for autistic children. Also, we placed similar actions in similar positions because it

will help the child to understand the content, the sequence and it will be easier to use.

4.2.2 Parental Profile

In addition to the child's profile, there is also the adult profile. Thus, parents, teachers and special educators must login into the app in order to structure, organise and customize the child’s tasks (Figure 7). The authors agree with Hussain et al. (Hussain et al, 2016), that this area should be protected with a password in order to avoid the child to feel confused or even to reset the settings (Voon et al, 2015).

Right after signing in, tasks can be introduced. On “Add task” menu (Figure 7 - right) a task name and description should be inserted; a real photo of the child performing the task must be uploaded; recorded audio and video can be uploaded (if desirable). Parents/teachers should also choose the days on which the task must be performed. Multiple days may be chosen as various activities can be repeated on different days.

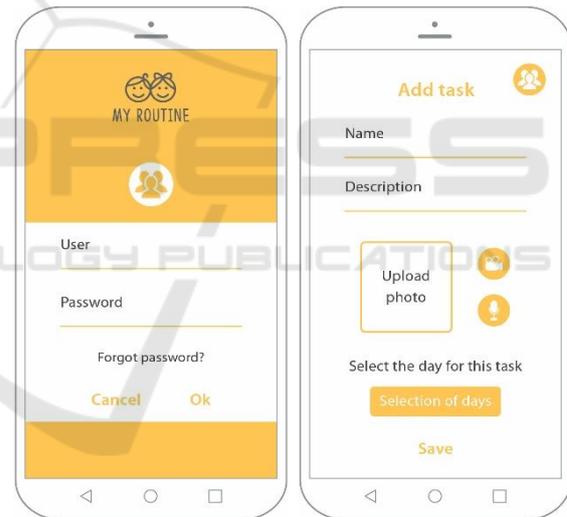


Figure 7: The adult login mode (left) followed by the menu to start introducing tasks (right).

Each task can be composed by several steps. Figure 8 illustrates the introduction of several steps as well as the possibility of its sequential organization. The button on the lower right corner allows adding steps.

The authors also proposed a “Share” button which may allow the information exchange between parents and teachers or special educators.

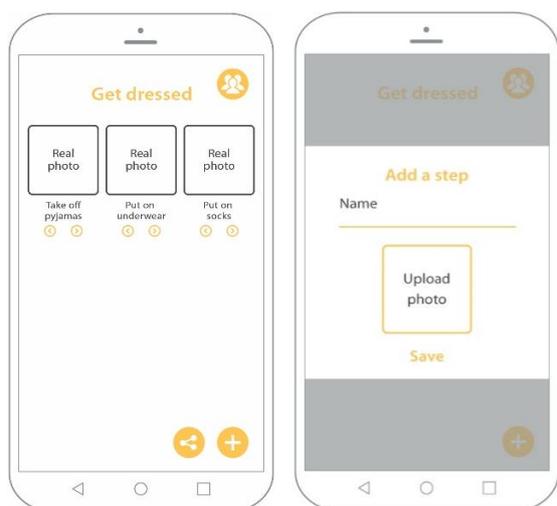


Figure 8: The customization of the task “Get dressed”.

5 DISCUSSION

The more we delved into this research work the more we realized that there is a gap that has to be fulfilled in terms of Portuguese mobile applications for autistic children. Moreover, the lack of data from testing of existing mobile apps within this domain, in other countries, does not help to provide adequate means to evolve this specific technology at a more desirable faster pace.

Nevertheless, with our study, we have learnt some recommendations to be used as a first step to implement the aimed visual schedule app, so we do not reinvent the wheel, but start from existing knowledge, even if it is scarce.

Consequently, the authors decided to propose mock-ups of a visual schedule aiming to start bridging that gap and help improving those children’s skills within a domain that is very relevant to children and their families, on a daily basis.

Simple mock-ups have been defined, which although still incipient, can already achieve/model a variety of tasks and activities and so, once these are tested and enhanced by the autistic children as well as their community of family, friends and educators, can be easily reused for many similar actions that comprise daily routine activities.

Focusing on the proposed mock-ups, for the child profile, we realize that the main parts of the app are the first page and the one that summarizes all activities and from where all functionalities can be accessed. For children, having simple and obvious data, and also their own photo and name can help in creating a “good” relation with an app that they may

be using everyday, several times a day. Also, the use of simple functionalities such as pressing buttons/images in a similar fashion and within the same sequence can again create a routine of use in itself. Other interesting customizations can be added depending on the taste and personality of the child. The simple action of earning points or receiving an encouragement message when an activity is concluded can help improve the engagement in using the app and, therefore, enhancing the learning of the required activities. Giving this flexibility of choice within the parental profile can better help the parents or other relatives to adapt the app to the child’s needs.

As already mentioned, this is only the first phase of this project which we intend to develop and test in the future. There are obviously several characteristics of our proposal that need to be discussed with professionals which work with autistic children everyday as well as study the interactions and feel of the children themselves.

Finally, and according with the application of the new General Data Protection Regulation (GDPR) (European Union, 2016) in the European Union, there are some privacy and security concerns related with the children’s information (photos and some other personal information), which need to be addressed while developing the proposed app.

Limitations. Despite the variety of apps available for autistic children, the authors could not find many digital resources in Portuguese for special education particularly related with visual schedules/routines applications to be used by Portuguese speaking autistic children. Three visual schedules apps were found on Google Play Store but none of them were implemented in native Portuguese and, for one of them, it was not possible to access its full version. Furthermore, during this research, the authors could not engage the final user (the children with ASD). However, the visual mock-ups proposed were designed based on the literature review, the analysis of existing apps in other countries and also on a set of User Interface Design principles. Nonetheless, in future work, we will address these issues and connect with entities related with our study in order to implement our app and perform tests with end users to improve it and make it useful to the community. In this phase, we may experience some difficulty in establishing the first contacts and finding available people interested in working with us as well as we may face some barriers in our approach to autistic children. However, we will make every possible effort to have success in our future work and to achieve all our goals.

6 CONCLUSION

Visual supports can enable children with ASD to learn and communicate more easily with their family, friends and teachers. Traditional tools, however, are challenging to create, use, and maintain. Furthermore, they provide little or no ability to document and monitor use and progress over time. This way, and taking into account the Portuguese reality, it would be very significant for autistic children (and for children with special educational needs in general) if there was a combination of efforts from autistic organizations and teachers, designers and developers to provide easy means to support such community.

This work aims to be such first step in this direction with the development of mock-ups of a visual schedule mobile app, in Portuguese, from Portugal, to support ASD children in their daily routine tasks.

Future work includes the engagement with the ASD related community and especially the children that can highly benefit from such efforts, to test and improve the proposed app.

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