Autism and the Need for Special User Interface Design for Web Surfacing

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Abstract:
In view of distinctive information needs and skills among users, we ought to evaluate if existing information retrieval systems are competent to cater for these users. The present study highlights the feasibility of search engine for children with special needs, specifically children with Autism Spectrum Disorder (ASD). The objective of this study is to investigate the utilization of a search engine for the purpose of learning and entertainment of children with ASD. The shortcomings of the existing commercial search engines in terms of accommodating the needs of these children will be discussed. Finally, based on the survey analysis from the mediators, important criteria of a search engine user interface design for children with ASD were proposed.

Keywords:
User Interface Design; Web Surfacing; Information Retrieval; Autism Spectrum Disorder; Human Computer Interaction

1. Introduction

Web searching is a day-to-day process that is carried out by many individuals with various different tools. Children are not left behind from this process, as technology and the Internet has become part and parcel of their life; information seeking and Web searching has become an important daily activity either to retrieve useful information, for entertainment or simply as a learning tool. The search engines that are on the Web today have adults as their preferred users. The developers of new technologies on the Web appear to have forgotten that the needs of children are entirely different compared to adults (at least in terms of human computer interaction). Even if there exists such search engines designed for children, these search engines are mostly developed based on children without any learning impairment. For these children, obtaining information using search engines would not contribute much of a challenge comparatively to a child with learning challenges. However, if we ought to provide this same tool to a child with Autistic Spectrum Disorder (ASD), there would be many questions arising, such as: (i) is it feasible for children with ASD to successfully complete a Web search using these existing search engines? (ii) how competent are these search engines or tools for an autistic child? (iii) can the child independently use the search engine with minimal guidance from a mediator, and (iv) what are the contributions of these search engines in the lives of an autistic child, as an entertainment or learning tool?

Past research work had proven that autism affects information processing in the child’s brain by altering how nerve cells and their synapses connect and are organized [1]. Their understanding capabilities and
response towards their surroundings is different from other children. Impairments in these children set a disadvantage for them as they have different needs and skills in carrying out a search task [2]. Most children with autism have trouble in relating words and trouble with communication. Some may develop good speech but then would tend to have problems in communicating with others [3].

Impairments among ASD children put them at a disadvantage when developing social, cognitive, and language skills. Children with ASD mainly face this problem because they have special needs and skills in carrying out any task. In this case, autistic children would not be able to immediately adapt to the technology today but may need special training and are required to be taught on the methods of information seeking, also on the information retrieval tools that are available today [4]. One of the tasks explored and discussed in this article is the activity of using search engines (by children with ASD) to retrieve information or browsing the Web in order to access the learning and entertainment applications. The main motivation of this study is to enable children with ASD to independently browse the Web and depend less on parents or educators in the process of Web searching. In order to do that, they need a Web search engine that solely caters for their special needs. Thus, this research will also propose a user interface design that can help these children with their information seeking activity.

2. Literature Review

Most research work on children’s information seeking behaviour are carried out by investigating the response and perception of children towards a search strategy or when using a specific search engine [5]. However, it is also important to understand the children’s pattern of behaviour in seeking information [5]. Before being able to identify the needs of information for children, it is necessary to acknowledge their behaviour and their role as information seekers. In the following we will discuss the problems faced by children in seeking information and also the existing search engine user interface design and its shortcomings for ASD children. In this study, we will also explore related work that had been done by the past researchers in this area of research. It is important to note here that there is very limited research work done within the area of information retrieval for ASD children. Even if they exist, the published work remains scattered.

2.1 Problems Encountered By Children in Web Searching

There are several studies that point out the numerous problems faced by children in general when seeking for information on the Web. Table 1 describes the four categories of possible problems that are generally faced by children in the process of information searching on the Web [6]. Table 1 shows the four major problems namely the insufficient mental model, insufficient vocabulary, chaotic search behaviour and relevance judgment. It can be summarized from the Table 1 that children are prone to suggest inappropriate query to retrieve the information that they need besides being unable to assess which of the retrieved set of documents are relevant to their needs. We hypothesize that with the design and development of an appropriate search engine user interface for children, these mentioned problem could be addressed especially in terms of (i) formulation of queries for information search and (ii) display of minimal but relevant information.

The following section discusses on the features of the existing children search engine and its limitation for children with ASD.
Table 1. Problems encountered by children in Web searching

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient mental model</td>
<td>Mental model is how we elaborate something of the real world using the thought’s process. Children generally are unable to project their thoughts into words and this results in them not being able to develop a proper search query to retrieve information from the Web.</td>
</tr>
<tr>
<td>Insufficient vocabulary</td>
<td>This is a familiar issue among children as they are still developing their language skills and knowledge. With the lack of proper language expertise they would end up not getting the correct information searched for.</td>
</tr>
<tr>
<td>Chaotic search behaviour</td>
<td>This is associated with children who are at the start of an informative search. As they are just getting used to the search technology, they would not be familiar on how to conduct the search, and this may lead to unorganized search behaviour.</td>
</tr>
<tr>
<td>Relevance of judgment</td>
<td>This problem is faced when a child fails to take into consideration the whole document or information but hastily makes a decision or assumption by only taking consideration of the first word or the start of the document.</td>
</tr>
</tbody>
</table>

2.1.1 Children search engine: user interface design and its shortcomings for children with ASD.

2.1.2 In order to explore the suitability of the existing search engines for children with ASD, two search engines namely the For Kid and Yahoo Kids were explored in order to highlight the user interface design criteria that are inappropriate for these children. This was done totally based on observation on the system features on screen.

Figure 1 shows the homepage of For Kid search engine. The search engine provides instant links to games and activities which relates to the likes and desires of children. For Kid generates search results that caters specially for children and the adult contents are ruled out from the search database. However, the effectiveness of For Kid for the use of an autistic child is still vague as they may not be able to interact successfully with the user interface. This is because the search engine does not display items that could be easily recognized by these children with special needs. The images of cartoon characters on the homepage are of interest for children without any learning difficulties but for a child with ASD these cartoon characters may not be an item that they would recognize unless it has been exposed to them previously.

Besides that, based on the observations carried out by the author at autistic centres in Malaysia, the games retrieved by the search engine were not among the type of games that an autistic child could relate to. Based on the observations carried out during the visits to the autistic centres, the more suitable games for these children are shapes and colours identification, building blocks and puzzles to mention some of them. It was also observed from the system that the links to games were given much importance by this search engine, as they tend to dominate the primary links of the homepage. On top of that, the displays of the retrieved links to games are very text oriented and not user friendly for these children. This is because picture based communication has been identified as an important method of interaction with children with ASD.

The layout design of For Kid is very attractive with interesting colours and images but from interviews and observations conducted at the autistic centres, the children need to always relate to audio and video representations. Explaining a shape with words would not help them much, therefore, usually an educator would have an image of the shape that needs to be described to the child. Hence, in a search engine it is important to consider the elements of image and audio to communicate a message to a child with ASD.

Another kids search engine observed was the Yahoo Kids which is one of the projects of the search engine Yahoo. Figure 2 shows the homepage of Yahoo Kids search engine. The layout and design of
Yahoo Kids is perfectly informative and entertaining for children without any learning impairment but the human computer interaction element is still lacking for children with autism. This is because the links, display and information on the homepage does not relate to children with ASD since it gives importance to the cartoon characters, animated images of their favourite cartoon characters and also on children’s movies and thus does not focus on how an autistic child could successfully utilize this tool in retrieving information with minimal guidance from the mediators.

2.2 Importance of Web Searching For Children with ASD

The population of children with ASD around the world has increased dramatically for the past few decades (Davidovitch, Hemo, Manning-Courtney, & Fombonne, 2012). Many researches had been carried
out to cater for their special needs. However, not much has been done in the area of information retrieval especially in Web searching. It has become a necessity than before to cater for the growing population of children with ASD since the growth of digital data has increased exponentially in the past few years. Children with ASD should be given an opportunity to surf the Web through a well-designed Web search engine that could help them obtain the desired information without much hassle and most importantly they could do that independently.

Since mid-1980s, researchers have started working on the use of the computer by autistic children. As the research into this domain progressed, studies in this area began to focus on computer aided learning for autistic children. Today, there are many learning tools specialized for children with autism. These tools have incorporated the best interface to cater for children with autism \[7\]. The method of educating autistic children can be categorized into two parts which are the tools or toys and through education interventions. These educational materials for the autistic children serve the children in different ways. Figure 3 illustrates the types of educational materials that are provided currently for educating autistic children in the best techniques possible.

Visual support can ease the communication challenges and be a great contribution for children with autism \[8\]. Visual aids are considered to be the most powerful approach in communicating with autistic children \[9\]. On the other hand, pictures and written cues assist the children to understand better the actions that need to be taken \[9\]. Depending on the conditions and the severity of the autistic child, there are many approaches that could be used to educate children with autism.

Moving away from the commonly used learning technologies (shown in Figure 3), in this study, we investigate possibility of using the Web search engine for information seeking as part of their learning and entertainment tool. There are efforts taken (although limited) in exploring the needs of children with autism in retrieving information from the Web and also in developing IR system prototypes for information retrieval from the Web \[10\].

For example, Bilal investigated how mediators have played their role in the process of information retrieval for autistic children \[4\]. In order to focus the seeking desires of people with special needs, from the mediator’s perspective, parents, teachers, therapists and family volunteers were selected as samples for data collection. These data were collected in order to understand what kind of information retrieval tools or technology the mediators use to find information to support their everyday life of children with ASD \[4\]. The skills possessed by a child with ASD when using IR systems and other technology tools or

Figure 3. Learning and development technologies for autistic children
application was also investigated in this study. However, the study did not focus on how children with ASD themselves utilize the search engine to seek information.

3. Research Questions

The research questions of interest in this study are:

1. What are the existing education intervention used by mediators to teach children with ASD?

2. Does the existing search engine systems interface encourages effective use by the children with ASD?

3. What are the mediators’ perceptions of the usage pattern of the online ICT applications and search engine by the children with ASD?

4. What are the mediators’ and parents’ perceptions on the benefits of utilizing the Web for the autistic children?

5. What are the important criteria of a user interface design for an effective Web search engine for children with ASD?

4. Materials and Methods

In contrast to the previous studies that focus on the mediators’ information needs, in this study the primary interest is to investigate how the children with ASD use the search engine to access the information they want or even to find the application they want to use. Since this research involved children with special needs, it was still relevant and reliable to obtain information from their mediators. The mediators here are the (i) educators and (ii) the parents of these children. The study, participated by 14 educators and 9 parents ($n = 23$) who played the role as a mediator. A formal and informal method of data collection was used. The formal method involves a survey being conducted. On the other hand, the informal method involved a series of interviews and observations that was conducted at several autistic centres in Malaysia. The age of the children with ASD in the centres ranged from 8 to 15 years of age. Despite the age gap between these children, the group of children who were considered in this study were categorized as child with mild form of autism or also referred as high functioning autism. All the children observed in this study could at least read and write (including the ability to spell simple words).

In this article, the discussion will be based on the findings from the formal method. A survey was conducted at three different autistic centres in Malaysia (Note: The name of the autistic centres was left anonymous on purpose). The main aim of having a survey was to get response from educators and parents on their opinions on how these children are using the Web and the possibility of an autistic child to surf the Web independently with minimal guidance. Table 2 highlights the important survey questions and how it relates to the problems addressed by this study. With the collective response from the educators and parents, the data were statistically analysed and summarized to propose a suitable user interface design for the search engine.

5. Results and Discussion
Table 2. Description on survey questions

<table>
<thead>
<tr>
<th>No.</th>
<th>Survey Question</th>
<th>Description and purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rate mediators’ understanding on: The usage of Web for autistic children. Search engines for autism children</td>
<td>Addresses the issue of awareness among the educators and parents on the current development in teaching autistic children and the possibilities of browsing the Web independently.</td>
</tr>
<tr>
<td>2</td>
<td>Could you rate the child’s skills in using ICT tool? How would you rate the performance of the child in using the search engine and other information retrieval tools?</td>
<td>To identify if the child is given any exposure on the current technology as part of their learning development or entertainment program.</td>
</tr>
<tr>
<td>3</td>
<td>What is your primary concern or what development would you most like to see in the child?</td>
<td>To investigate if skills in using the Web brings any benefits to the child. This is to identify if parents and educators feel that the Web and other technology is important for children with ASD.</td>
</tr>
<tr>
<td>4</td>
<td>In your opinion, what criteria and design should be given importance when developing a search engine for autistic children?</td>
<td>To gather suggestions from mediators on the expected criteria and user interface design of a search engine specialized for autistic child.</td>
</tr>
</tbody>
</table>

5.1 Existing Education Interventions used by Educators

It is essential to know what are the approaches used by mediators to educate children with ASD because through that we would be able to understand the teaching approach that the children could respond to. Figure 4 demonstrates the method preferred by the educators in their daily teachings at some of the autistic centres in Malaysia. The most commonly used educational intervention among the educators in this study was the Applied Behaviour Analysis (ABA) and the Picture Exchange Communication System (PECS). ABA is about using techniques and principles to be able to view changes in behaviour. It is a method to create communication among children with autism by carrying out development gains using educational manuals, education films and public speaking.

On the other hand PECS is an effort used in early intervention of autism to create communication in children with autism. Teaching children to speak out their needs independently with the assistance of visual aids carries out this effort. From the result shown in Figure 4, it was noted that educators used a combination of methods to teach the autistic children. Among the four interventions, the least preferred were the SCERTS (Social Communication, Emotional Regulation and Transactional Support) and followed by SOCCSS (Situation, Options, Consequences, Choices, Strategies, Simulation) [11]. In this study, out of these four types of invention, the design of the search engine user interface will be proposed based on the PECS approach by giving primary importance to (i) independent information seeking and (ii) image based and audio based information retrieval.

5.2 Effective Teaching Methods

It was essential to know from the mediators (based on their experience) on the best method or material to use to teach the children. Figure 5 shows in percentages the various methods used to educate the children with ASD. The preferred method used by the mediators is the video representation, which is 43% of the total educators followed by the verbal communication with 29% where children are verbally taught to perform something followed by action on how to do it. The third most preferred approach is the audio representation with 21%; music could be a great therapy for autistic children.
Besides that, all 14 educators were asked on how ICT applications were used in teaching the children and the results are illustrated in Figure 6. Only 7% of educators stated that they use the search engine in their teaching. Majority of the educators, which is about 79%, stated that Microsoft Word is the software most commonly used in their teaching. This shows that these children are not well exposed to the Web and its usage is minimal for teaching, learning and entertainment purpose. Note that this situation may be different in different countries especially in developed countries due to the technological advancement and developmental processes.

In the survey, mediators (both educators and parents) were asked for their opinion on the issue of getting the children to do Web search using search engines independently. Please note that ‘independently’ here means the child is able to use a search engine to find relevant information to their needs without the help and guidance from their mediators. Table 3 shows the level of agreement of the mediators on this issue with ‘1’ representing ‘strongly disagree’ and ‘5’ being ‘strongly agree’. It can be summarized that mediators did not give great importance to the Web as an information-seeking tool for children with ASD.
In particular, mediators still have doubts that these children could do a Web search by themselves with minimal guidance.

In general, both parents and educators have provided ranking with low agreement with regards to the issue. In Table 3 about 93%, which is 13 educators, have chosen a low agreement (chose level 1 or 2). On the other hand, all parents have chosen low agreement in relation to the ability of their child to browse the Web independently. Through interviews with the mediators, it was found that existing search engines are not user-friendly and it is difficult for a child with ASD to utilize it with minimal guidance. This suggests the necessity of a modified search engine that has a customised user interface and retrieval method that caters specially for the autistic children.

Mediators were also asked to rate the child’s possible performance on the Web with the scale of ‘1’ as ‘not effective’ to ‘5’ as ‘very effective’ for the activities mentioned in Table ??, This was aimed to understand the effectiveness of the application’s user interface on the Web (e.g. search engine) in relation to the interaction with autistic children. Table ?? shows the responses from all the 23 mediators.

Based on the results shown in Table ??, it can be concluded that most of the mediators rated the child’s performance in using applications on the Web as mediocre to “not effective.” This may be because children with ASD are not being able to comfortably and independently navigate on the Web. It was important to obtain feedback from the mediator on what criteria of search engine should be adopted in the user interface design in order to interact successfully with an autistic child. In the survey, mediators were asked to rate certain criteria for a search engine that would be the most important in increasing the usability of the search engine for autistic children. Figure 7 illustrates the responses received from the mediators.
Table 4. Possible performance using various applications on the Web

<table>
<thead>
<tr>
<th>Activities on the Web</th>
<th>Effectiveness ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform a Web search using search engine. (e.g. type in a word in the search bar)</td>
<td>12  4  3  0  0</td>
</tr>
<tr>
<td>Communicate using Instant Messengers or chats.</td>
<td>19  0  0  0  0</td>
</tr>
<tr>
<td>Find option of e-mail and navigate to email from the search engines.</td>
<td>19  0  0  0  0</td>
</tr>
<tr>
<td>Able to use the Web as a source of entertainment. (e.g. find for music/movie and perform a download like in YouTube)</td>
<td>14  5  0  0  0</td>
</tr>
<tr>
<td>Use social network sites on the Web (e.g. Facebook)</td>
<td>19  0  0  0  0</td>
</tr>
</tbody>
</table>

Notes: Participants answered according to a scale of 1-5: 1-'not effective' and 5-'very effective'.

Figure 7. Proposed search engine criteria by level of importance

Referring to the number of responses displayed in Figure 7, the most important search engine criteria proposed by the mediators was to include audio and video features in the user interface. Overall, 21 out of 23 mediators responded that these two features are the most important elements for a search engine. The audio representation suggested here is to incorporate speech recognition to cater for autistic children who can speak. As for the video representation, it is suggested to have a video link for the children in order to help them navigate to the information they need.

Another criteria highlighted by the mediators is that the search options should be well displayed and easy to be accessed by the child for example by categorizing the search (e.g. animals, colours and songs). Other criteria such as display of the retrieved information and the font size used, had 19 mediators responding as highly important. On the other hand, 18 mediators answered that colour representation is highly important for a search engine.

5.3 Proposed Search Engine User Interface Design

This section describes the prototype search engine user interface designed particularly for autistic children based on the findings from the survey, observations and interviews. Figure 8 illustrates the initial
proposed user interface design for the search engine. Since children with ASD were not able to easily spell or know the alphabets therefore it is not an easy task for them to type in letters or words into the search bar. Therefore, an option to select specific alphabet from the interface to be inserted into the search bar is essential.

Children can use the alphabet selection tool to be able to fill in the search bar (if they can recognize letters and spell). Another important criteria is the categorization of search options for easy access. The proposed search engine design incorporates these design criteria by having some important categories that may interest these children like animals, objects, games, and fun. Autistic children interact best with image representation of messages that needs to be conveyed to them. These images are all interaction buttons that allow the child to click and would lead them to a new page with more information (text, video or images) on the subject matter.

As an example, once the user clicks the button "FUN" on the search engine home page (see Figure 8), they would be redirected to the “Entertainment” page. This page would display all the connections to the interesting entertainment links. The categorization on the entertainment page is interactive buttons that would link the users to other related links. For example if the user would like to go to YouTube, therefore the user would only need to click the button “YouTube” in the “Entertainment” page. One of the most important design criteria rated by the mediators was to have audio and video representation. The audio representation has been incorporated into this search engine layout design to allow the child to give search instruction verbally (which should cater their nature of repeating the same words or phrases).

The proposed criteria of user interface design of search engines for autistic children has been compared with two well-known search engines that are specifically meant for kids. The results in Table 5 shows that the proposed user interface design criteria is more promising than the other two search engine user interface since it addresses the needs of an autistic child.

6. Conclusion

In summary, this study has highlighted an issue of the independent usage of the Web by autistic children. This study concludes that the existing search engines were not user friendly and it is difficult for a child
Table 5. Comparison of search engine user interface

<table>
<thead>
<tr>
<th>User interface criteria</th>
<th>For Kid</th>
<th>Yahoo Kids</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attractive colours</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Image representation for buttons</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Clear font appearance</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Easy access to entertainment links (e.g. YouTube)</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Quick links to emails</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quick links to social networking sites (e.g. Facebook)</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Content: Information related to learning and development of an autistic child</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Include alphabet selection to ease typing in words into search bar.</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Voice recognition to enable easy searching</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

with ASD to utilize it with minimal guidance. Besides giving importance to teaching living skills or survival skills for these children to encourage independence in their daily life, independence in terms of learning is possible if these children are exposed to the Web and able to access what they want and need independently. Through survey it was found that audio and visual method of communication are more appropriate for children with ASD to access information from the Web. Hence, the incorporation of these communication techniques within the browsers would help the children to surf the Web independently. However, the limitation of this study was the small sample size, where some mediators would not want to participate in this study. The common reason given by these mediators is ICT skills are not crucial for children with ASD compare to living skills. This scenario is true at least for the developing countries. For future research, it is important to expand the study to include more participants such as mediators and children with ASD. The study would be more effective if a survey in a form of observational study is done on the children directly instead of going through mediators to obtain the data on child’s behaviour in browsing the Web. The design and development of effective indexing techniques and retrieval algorithms that would work hand in hand with the proposed user interface will be a good area for further research.

References


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