Find it if You Can: Usability Case Study of Search Engines for Young Users

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Abstract: Nowadays the Internet is an integral part of the lives of our children. Using the Internet, in particular search engines, children search information for school, their individual interests or simply for entertainment. Unfortunately, research shows that children face many difficulties when searching and browsing for information, even though there are several search engines that were especially designed for children. In this paper, we review recent work in this field and evaluate to what extend current search engines for children are appropriately supporting the motor and cognitive skills of children in elementary school. We base our study on findings of previous research and derive criteria to assess existing search engines. Our results suggest that most of them still require improvements in order to fit the skills and competencies of children.

Keywords: children information retrieval, targeted search engine, HCI, usability, case study

Introduction

Internet usage knows no age limits nowadays. Many children have access to the Internet and explore the web from a young age. An increasing number of households all over the world owns a computer and have internet access. The German study KIM[1] examines the media usage of children from 6 to 13. According to the 2010 KIM study (Medienpädagogischer Forschungsverbund Südwest, 2011), about 60% of the German children use the Internet (see Figure 1) and 70% of them use a search engine.

Children use the Internet not only for entertainment, but it also plays an increasing role in education. About half of the children are searching information for school at least once per week (Medienpädagogischer Forschungsverbund Südwest, 2011). They are looking for facts about historical events, mathematical formulas, the latest news and much more. To do so, children use computers at school or at home. Not every time there are teachers or parents around, who can support them.

[1] KIM is a German acronym for Children and Media ("Kinder und Medien").

60% of the children search the Internet predominantly alone (Medienpädagogischer Forschungsverbund Südwest, 2011). Because of that, there are special search engines for children. Currently, their main purpose is helping children to find child *appropriate* content in the Internet. This is an important aspect of such search engines for children. Another important aspect is the usability of those search engines.

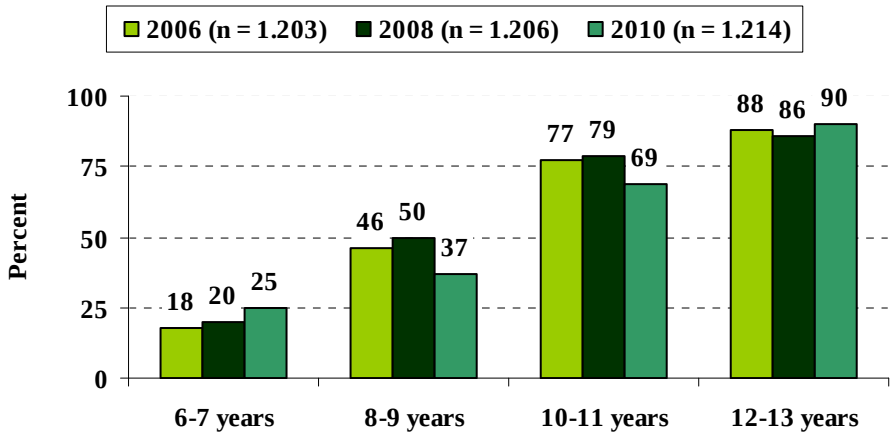

Figure 1: Children's Internet usage in Germany 2006/2008/2010 (Medienpädagogischer Forschungsverbund Südwest, 2011).

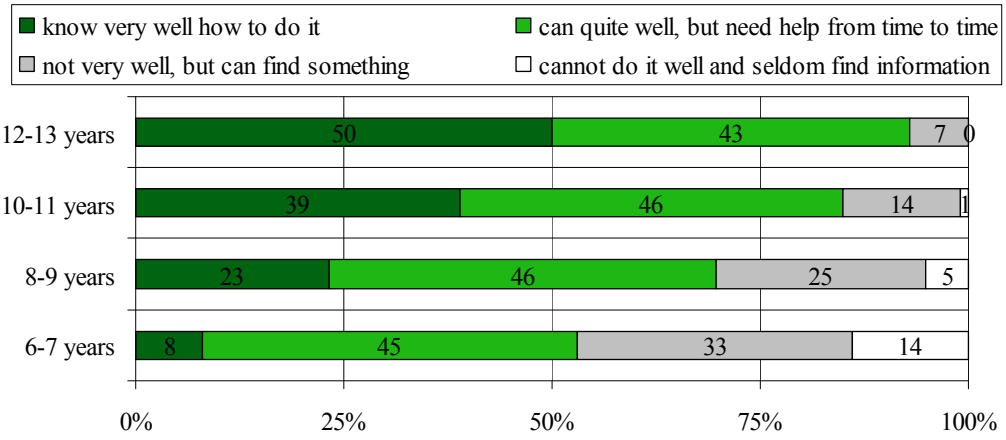

Figure 2: Children's own assessment of their ability to search for information in the Internet and succeed (Medienpädagogischer Forschungsverbund Südwest, 2011).

Children should be able to successfully use a search engine without the help of adults. But, unfortunately, not all children succeed in information inquiry and especially younger children experience difficulties (see Figure 2). Only 8% of six

and seven years old children claim[2] to know very well how to find information on the Internet. A possible explanation of the children's failure is their difficulty to use the search engines due to their insufficient usability. A child[3] is a human being whose cognitive abilities are not fully formed. Children do not have the same abilities and knowledge as adults. Thus, search engines for children should match the particular skills of the children in order to increase their usability.

The usability of web search engines is of special importance for children. It is not only necessary that children are supported according to their skills during search sessions, so that they are able to find good results, but the success in searching also plays a major role in the development of children. Erikson (1963) found that elementary-age children want to learn and to produce. They want to achieve the skills, which seem to be important to their cultural environment and win the recognition of parents, teachers and peers by doing so (Erikson, 1963).

Finding information in the Internet is an important skill that a child needs to develop. If a child succeeds in finding the information, it will feel competent and develops self-confidence. In contrast, if it is not able to find good results, a child may develop a feeling of incompetence. That could even lead to a feeling of inferiority (Erikson, 1963).

In order to avoid those consequences, the user interface of a search engine for children should support children appropriately in finding good results, i.e. it has to be adapted to the special needs of children in their respective age groups. In the following, we have a closer look at those special needs.

In this article we analyse whether current search engines for young users match the motor and cognitive skills of elementary-age children. Therefore, we study the differences between children's and adult's searching behaviour and derive criteria for usability assessment of web search engines for children. Based on those criteria we analyse twelve search engines for children and the popular search engine *Google*, and discuss the results.

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[2] These numbers indicate the subjective feeling of success and may be falsely overestimated.

[3] Within this article, we use the terms "child" and "young users" interchangeably.

Related Research

In general, researchers think that there are various differences in the search behaviour of elementary-age children and adults. These differences result from differences in motor skills, cognitive skills and knowledge. In this section, we discuss the differences in the skills of children and adults and their impact on the design of search interfaces.

Differences in motor skills

In order to use current standard desktop computers, skills in using a mouse and a keyboard are necessary. Many children have difficulties in using these devices because they require high accurateness in movements. Movements of children are not as accurate as the ones of adults because children's information processing speed is lower. These lower rates of information processing cause longer reaction times and inferior performance (Hourcade, Bederson, Druin, & Tière, 2003).

Using a mouse

As target objects get smaller, the time to accurately move the cursor towards them increases (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). This means that larger target sizes allow children to make selections more quickly (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005). Moreover, there are certain mouse interactions which are very difficult for children. Children face difficulties with drag-and-drop interactions because they cannot coordinate dragging and holding at the same time (Strommen, 1994). Also children have problems using multiple buttons of a mouse (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005). Therefore they often do not use complex interactions like scrolling a page (Naidu, 2005), (Gilutz & Nielsen, 2002). As a result the length of web pages for children should be short or at least the important information should be at the top of the page. In order to prevent frustration, web pages for children should in general prefer simple point-and-click interactions.

Using a keyboard

Most children have difficulties with typing. They are not able to type queries without looking at the keyboard (*touch-typing*). Instead they typically "hunt and peck" on the keyboard for the correct keys (Borgman, Hirsh, Walter, & Gallagher, 1995). So typing a query is very time consuming. By looking at the keyboard

while typing, children often do not spot spelling mistakes. The ideal user interface should provide alternative ways like voice querying so that a child can explain his or her information need in order to input the query. It is also possible to use tangible interfaces. For example, Jansen, Bos, van der Vet, Huibers, & Hiemstra (2010) propose a tangible interface called *TeddIR*. The system helps children to retrieve books they are looking for. Instead of typing in keywords, children search by putting tangible figurines on the screen, which represent the search terms. Thus, difficulties in spelling and finding query terms are overcome.

Differences in cognitive skills

Cognition is "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses" (Oxford University Press, 2011). In other words, the term "cognition" refers to all our mental activities, our thoughts and thinking. Cognitive abilities are skills to gain, use and retain knowledge. Cognitive skills affect children's information seeking behaviour, i.e. searching strategy and results selection.

According to the psychologist Jean Piaget human development occurs in a sequential order in which later knowledge, abilities and skills build upon the previous ones (Piaget, 1969). In his opinion intelligence is not the same in different ages but changes qualitatively (Lefrancois, 1995). By designing a search engine for children, cognitive abilities of elementary-age children[4] should be taken into consideration.

Browsing versus searching

In general, there are two types of interfaces for search engines that are currently in use: browsing and keyword oriented search engines. In keyword oriented search engines, the user needs to input a query, whereas in browsing oriented search engines, he navigates through pre-defined categories.

Many researchers agree that the browsing performance of children is better than that of keyword oriented search and that children prefer browsing (Borgman, Hirsh, Walter, & Gallagher, 1995), (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010), (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005).

[4] Elementary-age children are approximately in the beginning of Piaget's concrete operational stage of development. In this stage, children begin to reason logically, but their understanding is limited to concrete and physical concepts (in contrast to abstract ones).

One reason for this preference is that browsing imposes less cognitive load. More knowledge is required to recall concepts from the memory, instead of simply recognizing and reacting to offered search terms (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010).

Moreover, browsing fits to children's "natural tendency to explore" (Borgman, Hirsh, Walter, & Gallagher, 1995) and to the motor skills of children. Whereas keyword oriented search engines require correct spelling and typing, browsing is possible with simple point-and-click interaction (see Section *Differences in motor skills* above). Nevertheless there are potential problems in browsing. Often it is difficult for children to find the right category, because they have only little domain knowledge and a smaller vocabulary than adults (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010).

The limited domain knowledge of children is also a problem in keyword oriented search engines. In order to formulate a search query, the user needs sufficient domain knowledge to find useful keywords (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005). Many children even do not know that they have to select single keywords. So they tend to input full natural language queries (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). Even if they understand that they have to input keywords, it is difficult for children to select the keywords, because it requires the ability of thinking in abstract categories (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005). Children learn to think logically about abstract concepts only from the age of eleven (Piaget & Inhelder, 1969), (Lefrancois, 1995). In contrast, children are able to think in categories from the age of seven (Hackfort, 2003). Hence, selecting categories better matches the cognitive skills of children.

Generally, it is useful to offer both keyword and browsing oriented interfaces. This will allow children to explore both possibilities and to select the one which fits their abilities most.

Backtracking to the homepage

Another difference between adults and children is their navigational style. Children click, repeat searches, and revisit the same result web page more often than adults (Bilal & Kirby, 2002), (Gossen, Low, & Nürnberger, 2011). Children's search behavior can be described by many looping and backtracking actions, with fast reading of the retrieved documents and little focus on the search

goal. These characteristics agree with children's lower cognitive recall. Such *chaotic* pattern of information seeking is also called fast surfing (Sluis, van den Broek, & van Dijk, 2010).

When children start a new search, they often navigate back to the home page first. Therefore, a clear home button is very helpful for children. But even if there is a home button, many children use the back button of the browser (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). That is why search results and links should not be opened in a new window or tab as it inhibits backtracking with the browsers back button. In order to reduce the cognitive load, result storage functionality would be also of help.

Presentation of search results

Another difficulty for children is to find the relevant results among the search results (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). Children have difficulties to judge the relevance of the retrieved documents to their information need (Bilal, 2000). In order to help the children and prevent frustration, the presentation of search results should be well adapted to children's needs.

Most search engines provide the retrieved results as a vertical list where documents are ordered according to their relevance starting with the most relevant result on the top of the list. Each list item is provided with details about the document in form of short summaries (*snippets*). For example, snippets of web search engines are usually constructed from the web page title, URL and a short text excerpt with highlighted query keywords. Snippets should provide short, informative summaries of the content of retrieved pages (Large, Beheshti, & Rahman, 2002). Short summaries support the estimation of the relevance and do not require advanced reading abilities. It is also useful to highlight the query keywords, because they provide clear relevance clues.

Children learn to read usually when they are six or seven years old (Stuart, 2007). After that, it takes several years until they are able to read as good as adults do. Children are able to think in images much earlier than to read. They learn to use and to represent objects by images between the ages of two and seven (Piaget & Inhelder, 1969), (Hackfort, 2003). As a result, it is very useful to illustrate the text summary with pictures or multimedia. In addition, Naidu (2005) found that children generally prefer websites with many pictures and animations.

Another characteristic that can cause reading problems is a small font size. According to the recent usability study of (Nielsen, 2010), font size should be 14 point for young children (age 3-8) and 12 point for older ones (age 9-12).

Moreover, children should understand that results are clickable. Otherwise, children would expect this short text to be already the answer to their information need (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). Unfortunately, there is no understanding yet about what type of presentation children would expect to be clickable. We suggest making the whole snippet area clickable. As children like to explore this would increase the chance of opening a result page. Furthermore, it would also better fit children's motor skills.

Children are also frustrated if the search engine returns a lot of results (Large & Beheshti, 2000). Most children examine only the first three of them (Gossen, Low, & Nürnberger, 2011). As a result, the number of results on one page should be limited.

Finding no results is also a problem which is caused by children's spelling difficulties. Children make twice as many spelling mistakes in web search queries as adults do (Gossen, Low, & Nürnberger, 2011). Spelling problems, in its turn, arise primarily because children are in the process of learning to write (Stuart, 2007) and secondarily because they have difficulties with a keyboard (see Section *Differences in motor skills* above). Especially utilizing keyword oriented search engines, which require correct spelling, is difficult for children. If the query is not spelled correctly, the search engine returns a 'no hit' result, which frustrates a child. Because of that, spelling correction seems to be a good idea. Most children gratefully use the spelling correction tool 'Did you mean' in Google (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). As a result, the integration of any sort of spell checking is very important for search engines whose main target group are children.

Research on information retrieval systems for children

The focus of this paper is on existing web search engines for children and their evaluation. We would like to mention that there is also some recent work in the area of children information retrieval including interfaces for young users. However, these interfaces are research prototypes and not publicly accessible. *TeddIR* (Jansen, Bos, van der Vet, Huibers, & Hiemstra, 2010), *CollAge*

(Gyllstrom & Moens, 2010), *JuSe (*Polajnar, Glassey, Gyllstrom, & Azzopardi, 2011) and *Imagepile* (Akkersdijk, Brandon, Jochmann-Mannak, Hiemstra, & Huibers, 2011) are searching interfaces which are designed for young children, but mostly for preschoolers.

We already described the tangible interface *TeddIR* (see Section *Differences in motor skills* above). Using the *TeddIR*, children search books by putting tangible figurines on the screen, which represent the search terms. This helps children to overcome difficulties in spelling and deriving query terms. The *CollAge* web information retrieval system incorporates search results for children's web queries with child-oriented multimedia results, such as coloring pages and music sheets. For each media query, the system runs a Google image search and returns images as results in addition to existing search results (see Figure 3). In order to support children in determining the relevance of results, researchers (Akkersdijk, Brandon, Jochmann-Mannak, Hiemstra, & Huibers, 2011) proposed a touch interface called *ImagePile* which displays the results as a pile of images where the user navigates horizontally. *Junior Search* (*JuSe*) is an interface that enables searching through adaptable picture dictionaries. Children can construct queries using the pictures. *JuSe* uses categories derived from children's vocabulary lists and parents can adjust the list, e.g. add new words.

Figure 3: CollAge mockup (Gyllstrom & Moens, 2010).

In the following, we present a case study we conducted in order to assess the current state of the search engines for young users in terms of usability.

Method of analysis

In June 2011 we conducted a study to analyse the usability of search engines for children. The goal was to verify whether current search engines are appropriate for the motor and cognitive skills of children. On this account, we analysed twelve search engines, whose main target group are children. For this purpose, we first choose criteria based on the results of previous studies and recommendations in this field. Afterwards, we analysed the search engines and evaluated the results. In the following, we describe the selected search engines, our criteria and present the method we used to evaluate the data.

Selection of the search engines

In order to obtain a good overview of currently available search engines for children in the Internet, we selected seven search engines in English language:

- onekey.com
- kids.yahoo.com
- askkids.com
- dibdabdoo.com
- factmonster.com
- kids.aol.com
- kidsclick.org

and five German search engines:

- blinde-kuh.de
- fragfinn.de
- helles-koepfchen.de
- loopilino.com
- dipty.com

We also analysed the popular search engine Google to compare between the child-focused and the more mainstream search engines. Indeed, a recent user study (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010) indicates, that children are

likely to use Google and even perform better using Google than on special search engines designed for them.

Assessment criteria

Our goal was to analyse the degree of conformance of search engines for children to the children's motor and cognitive skills. For this purpose we defined criteria for measuring the adaption to motor and cognitive skills.

Criteria for matching the motor skills

Size of the buttons

As target objects get smaller, the time to accurately move the cursor towards them increases (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005). This means that larger target sizes allow children to make selections more quickly. As the fine motor skills of young children are not as good as the ones of adults, big target sizes are even more important for child-friendly user interfaces. Therefore, we choose the button size as one of the criteria for evaluation how good the search engines fit children's motor skills.

We examined the size of the 'Search' button on the home page and the size of the main navigation links or buttons. The size was measured in pixel. To compare the button sizes we calculated the area of the buttons with the help of its width and height in pixel. We assessed the buttons using the results of a study by (Hourcade, Bederson, Druin, & Tière, 2003)[5]. They found that the accuracy of clicking on 32 pixel targets was significantly better than on 16 pixel targets for both children and adults. The level of accuracy of the young children got even higher, when the target size was 64 pixels. As website buttons do not usually have a square form, we measured the buttons' surface area and grouped the results into three categories as presented in Table 1. The overall result combines both the size of the search button and the size of a main navigation button.

[5] The monitor resolution used in the study was 1024x768 pixels. We had a resolution of 1366 x 768 pixels using a 16:9 display in our study.

Table 1: Categorisation of the button size

Category	Surface areas of the 'Search' and a main navigation button
0 (not good)	at least one area is $< 32^2$ square pixels
1 (fair)	both areas are $\geq 32^2$ square pixels; and
	at least one area is $< 64^2$ square pixels
2 (good)	both areas are $\geq 64^2$ square pixels

Length of the home page

Scrolling a page is a difficult task for children because they need to use drag-and-drop or the scroll wheel of the mouse. Both alternatives do not match the motor skills of young children (Hutchinson, Druin, Bederson, Reuter, Rose, & Weeks, 2005). Therefore, the page length of a child-friendly search engine should be short to avoid much scrolling (Gilutz & Nielsen, 2002).

We measured this characteristic in the number of screens required to see the whole page. Note that we used a monitor with a resolution of 1366 x 768 pixels, 11.6 inches display and a normal view setting of the browser during the whole analysis. We simply counted the number of screens, which are necessary to see the whole home page. After that, we grouped the results in three categories (see Table 2).

Table 2: Categorisation according to the length of the home page

Category	Number of screens required
0 (not good)	more than 3 screens
1 (fair)	2 or 3 screens
2 (good)	one screen

Criteria for matching the cognitive skills

Type of the search tool

Currently there are two types of search tools in use: browsing and keyword oriented search tools. As discussed above, many researchers agree that browsing better matches the cognitive skills of children (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). Nevertheless it is good to offer both types, because it enables children to search more flexible, and to learn and improve in both techniques. In order to analyse this criterion we checked which type was offered

by the respective search engine. We grouped the results in three categories as presented in Table 3.

Table 3: Categorisation according to the type of search tool

Category	Type of the search tool
0 (not good)	Only keyword oriented
1 (fair)	Only browsing oriented
2 (good)	Browsing and keyword oriented

Support of backtracking

Children very often backtrack to pages that they already visited (Bilal & Kirby, 2002), (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). Additionally, many children first go back to the home page, if they want to start a new task (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010). As a result, children use the 'Back' button and the 'Home' button of the browser very often. Therefore, a clear home button is important for the child-friendliness of a search interface. Moreover, new websites should not be opened in a new tab or window as it inhibits backtracking (see Section *Related Research* above). In order to analyse these characteristics, we checked whether the search engine has a home button and whether result websites were opened in a new browser tab or window. The overall result of each search engine was calculated like presented in Table 4.

Table 4: Method to calculate the overall result for the criterion "Support of backtracking"

Category	Home button	Link opened in the same window or tab
0 (not good)	No	No
1 (fair)	Yes	No
1 (fair)	No	Yes
2 (good)	Yes	Yes

Presentation of search results

As discussed in Section “Related Research”, children often face difficulties to find relevant results out of the retrieved ones (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010) and most children examine only the first three results (Gossen, Low, & Nürnberger, 2011). If combining this with the fact that children avoid

scrolling (Gilutz & Nielsen, 2002), we can advise to place no more than ten results per page.

Furthermore, many elementary-age children are not yet experienced readers. Hence, the result snippet should contain a short text summary. Large font sizes help children to read the texts (Nielsen, 2010) and highlighted keywords give a clue about the relevance of the retrieved result (Hearst, 2009). Also, it is very useful to illustrate the summary with pictures or other multimedia, because images better match the cognitive skills of children than written words (Hackfort, 2003).

We searched for the word "rabbit" in the English search engines or accordingly "Hase" in the German search engines. We counted the number of results presented on the first result page. We also checked whether multimedia was used to present the search results and whether the word "rabbit" or "Hase" was highlighted in the summary. The font size of the summary text (excerpt text) was read out with the help of the development tool of the *Safari* browser and converted to point (pt).

We already discussed, that most children have problems to find the right keys on the keyboard. So they type words very slowly and make many mistakes. This often results in "no hit results", which frustrate the children (Borgman, Hirsh, Walter, & Gallagher, 1995). In order to avoid frustration, any kind of spell checking is very important. We input "encycloedia" instead of "encyclopedia" in the English search engines and "Enzykloädie" instead of "Enzyklopädie" in the German search engines to check whether search engines offer spelling suggestion and/or do spelling correction and return some results. If no kind of spell checking was offered, the search engine got 0 points. Otherwise it got 1 point.

Based on these characteristics, we chose five criteria to analyse the search engines. A search engine can get 0 points (not good) or 1 point (good) for each of the criteria as shown in Table 5. In order to assess the overall search result presentation we summed up the points of five categories and mapped for simplicity the result to the interval from 0 (not good) to 2 (good).

Table 5: Method to value the investigative results of the criterion "Presentation of search results"

Points	Number of results	Font size	Usage of multimedia	Accentuation of keywords	Spelling correction and/or suggestion
0	> 10	< 14 pt	No	No	No
1	≤ 10	≥ 14 pt	Yes	Yes	Yes

Results

In the following, we discuss the results of our usability study with respect to motor and cognitive skills of the children.

Conformance with motor skills

Figure 4 and Figure 5 illustrate the results of our usability evaluation, in particular the grade of matching to the children's motor skills, for each search engine and overall results accordingly. In general, the results are not satisfying. None of the search engine has a good result in all criteria.

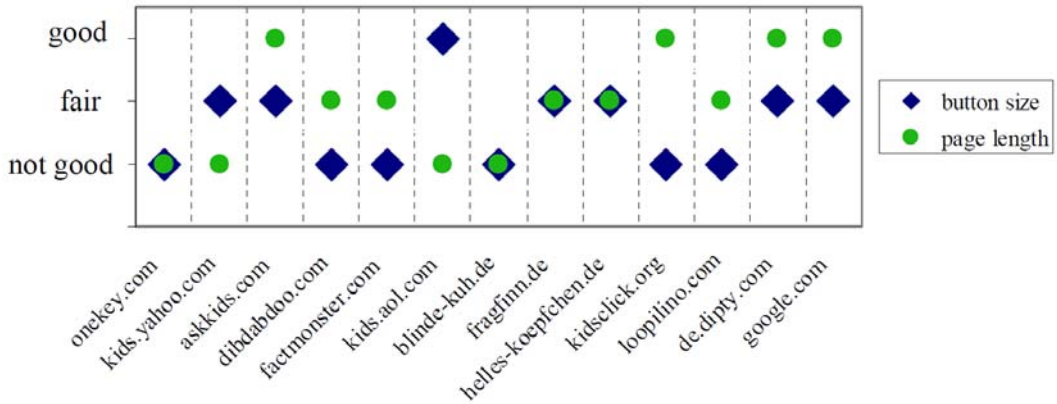

Figure 4: Assessment of conformance with motor skills of children for each search engine.

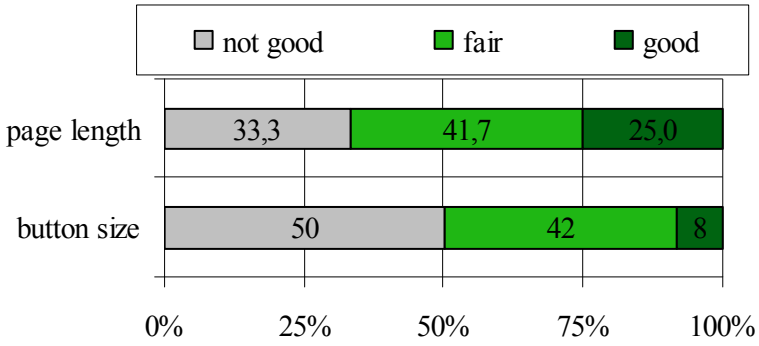

Figure 5: Assessment of overall children's search engines' conformance with motor skills of children.

Problems with handling a mouse are seldom taken into consideration. Furthermore, the home pages of many search engines are very long, which requires scrolling. Three of them even need more than four screens to be shown completely and thus scrolling is necessary and might frustrate children, just as

small buttons might lead to frustration. Only the search engine "kids.aol.com" offers a large search button and large main navigation buttons. All the others are not well adapted to the children's need for big target sizes. Altogether, most search engines for children are not well adapted to the motor skills of their users. They also do not offer observable advantages over the commonly used search engine Google.

Conformance with the cognitive skills

Altogether, only a small number of the evaluated search engines are conformed to the cognitive skills of children (see Figure 6 and Figure 7). This could cause difficulties for children to use them and lead to frustration. In the following, we describe the results for each of the criteria in detail.

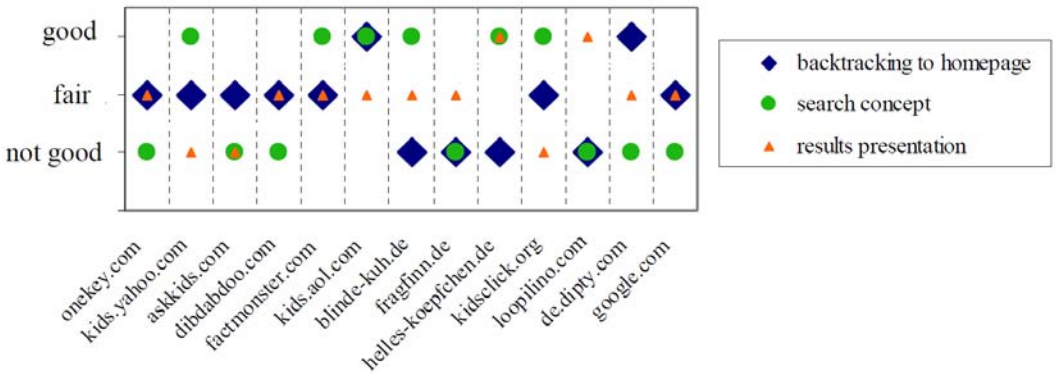

Figure 6: Assessment of conformance with cognitive skills of children of each search engine.

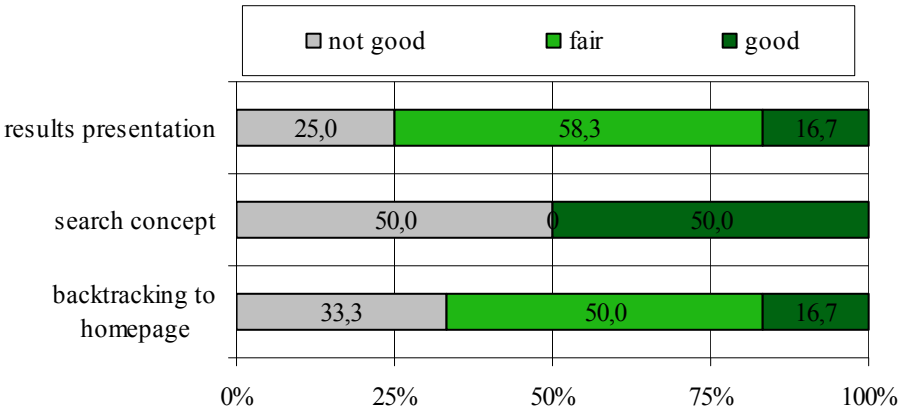

Figure 7: Assessment of conformance with cognitive skills of children of each search engine for children.

Presentation of search results

Table 6 illustrates the results of our usability evaluation: how good the search engines present the results to children, for each search engine and overall results, accordingly.

The best results are achieved by the German search engines "helles-koepfchen.de" and "loopilino.com". Half of the search engines, which are especially developed for children, got worse results than Google. These search engines do not present the results in a child-friendly way. The English search engines "kids.yahoo.com" and "kidsclick.org" even got zero points.

Table 6: Assessment of results presentation to children of each search engine.

Search engine	Number of results	Font size	Usage of multimedia	Accentuation of keywords	Spelling
onekey.com	✔	✘	✘	✔	✔
kids.yahoo.com	✘	✘	✘	✘	✘
askkids.com	✔	✘	✘	✘	✘
dibdabdoo.com	✔	✘	✘	✔	✔
Factmonster.com	✔	✘	✘	✘	✔
kids.aol.com	✔	✘	✘	✔	✔
blinde-kuh.de	✔	✘	✔	✘	✘
fragfinn.de	✔	✘	✔	✔	✘
helles-koepfchen.de	✔	✘	✔	✔	✔
kidsclick.org	✘	✘	✘	✘	✘
loopilino.com	✔	✘	✔	✔	✔
de.dipty.com	✔	✘	✘	✔	✘
google.com	✔	✘	✘	✔	✔

Number of results

Two search engines offer more than 30 results per page: the search engine "kidsclick.org" always presents all search results on one page and the search engine "kids.yahoo.com" always provides ten web search results below the results found in "Yahoo! Kids" directory, which is too overwhelming for children.

About 75% of the children's search engines places around ten results on one page. Ten results still may be a large number for children, because children can process less amount of information than adults (Chi, 1976). As already mentioned,

children also do not tend to scroll a page (see Section *Differences in motor skills*). The search engine "dipty.de" is a good example for a presentation that does not use a long list (see Figure 6). It always fits the results in one page and supports hyperlinking pages by numbers below the result list. Thus, the number of hits is also more intuitive accessible for children.

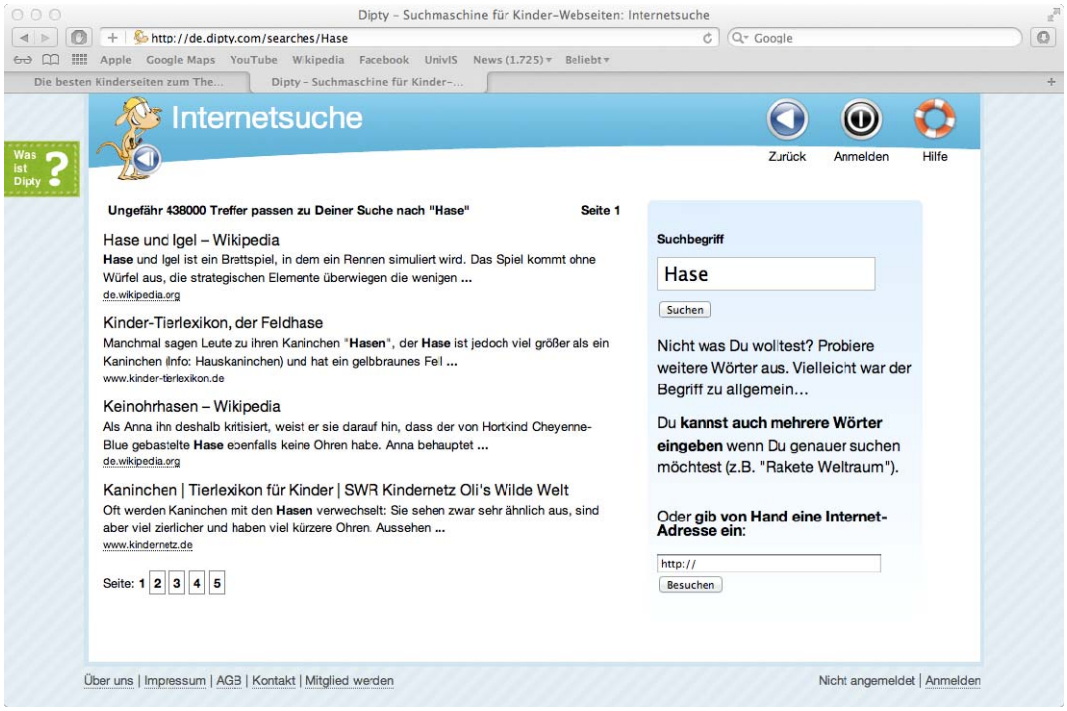

Figure 8: Presentation of the search results in the search engine dipty.com.

Font size

Search engines should help children to find the relevant results out of the list of retrieved results. In order to do so, they should pay attention to the lower reading competence of the children by offering short summaries with large font sizes. Nielsen (2010) found, that 14pt are most comfortable to read for children. Nevertheless none of the search engines offers such a big font size. Only "factmonster.com" offers 12pt font size. In contrast, text summaries of nine sites for children are even smaller than 10pt. This makes it very difficult for children to read and process the given information.

Of cause, there is always a trade-off between the font size, the number of results and scrolling. The larger the font size is the more space is required to present the results and less results can be presented on one page without scrolling. In our opinion, a large font size and an observable number of results are more important

than scrolling. Nowadays children start operating computers and mice very early and elementary school children most likely can handle the mouse. Unfortunately, we did not find recent research papers which would confirm or reject this fact.

Usage of multimedia

Icons and pictures go well together with the cognitive skills of elementary-age children because children learn to think in images from the ages between two and seven (Hackfort, 2003). Nevertheless, only 33.3% of the evaluated search engines for children use pictures to illustrate the search results. An example is the German search engine "helles-koepfchen.de" which offers a picture together with every retrieved result (see Figure 9). This helps children to find the relevant result more quickly. Other kinds of multimedia could also be used, but no search engine adds audio or video to the search results.

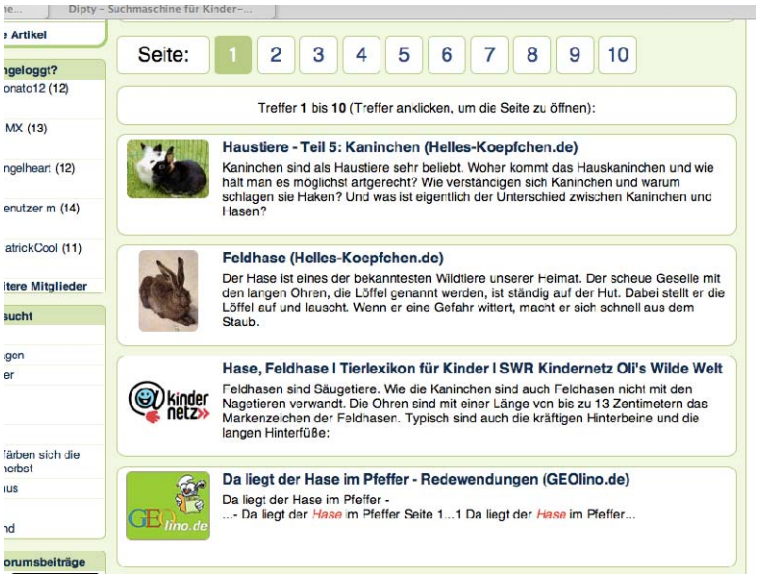

Figure 9: Presentation of search results with multimedia in the search engine helles-koepfchen.de.

Accentuation of keywords

In order to support the judgement of relevance, it is useful to highlight the words of the search query because it gives the children a clue how relevant the result is (Hearst, 2009). This characteristic is taken into consideration by seven in twelve search engines for children. Google also uses the accentuation.

Spell checking

The best results are obtained in this category. Problems of spelling and typing is taken into account by half of the children's search engines, whereas three search engines implemented their own spellchecking tool and three use the Google spell-checking API.

Browsing vs. Searching

As discussed above, many researchers agree that selecting pre-defined categories (browsing) better matches the cognitive skills of children than the input of keywords. Half of the evaluated search engines do offer this possibility. All other search engines offer only a keyword-oriented interface just like in Google.

Navigational style

Search engines for children should contain a clear home button as children tend to go back to the home page whenever they want to start a new search (Jochmann-Mannak, Huibers, Lentz, & Sanders, 2010), (Bilal & Kirby, 2002). Unfortunatelly, only 16.6% of the evaluated search engines for children offer a clearly visible home button.

In general, children often go back to a previous page. Mostly, they use the back button of the browser to do so. For this reason new websites should not be opened in a new window or tab because this inhibits backtracking. This characteristic is taken into consideration by most children's search engines. Only 33.3% open links in a new tab or window.

Conclusion

Children use the Internet and web search engines for various tasks, including education, and it is important to provide them with the necessary tools to succeed. In the design of information retrieval systems, we should always keep in mind that children's cognitive and motor skills are developing and differ from those of adults. Children also require emotional support and a feeling of success. Otherwise, they easily gain feelings of helplessness and even inferiority.

In this paper, we conducted a usability evaluation in order to assess how well existing search engines for young users are adapted to their special needs. In order to derive the criteria for assessment, we used the findings of previous research. Our work can serve as a methodology for usability assessment of web search engines for young users. So far, we suggest using the size of buttons and length of the home page as criteria for assessment how well a web search engine matches the motor skills of children. In order to evaluate to what extend current search engines for children are appropriately supporting the cognitive skills of children, we advise using such criteria as type of the search tool, support of backtracking,

and presentation of search results. A good presentation of search results, in its turn, depends on the number of results, font size, multimedia usage, accentuation of keywords, and spell checking.

Whereas some criteria are independent of each other, some of them have an inverse relationship. There is a trade-off between the font size, the number of results, and scrolling. It is good to have a large font size, to present not too many results on one page, and to avoid scrolling. But the larger the font size is the more space is required to present the results and less results can be presented on one page without scrolling. Further studies with children are required to establish which of the criteria are more important for children.

Our results show that current search engines for children not always match the skills and abilities of children. We also found that most search engines for children do not offer observable advantages over the common search engine Google. This lack of adaption can lead to children's frustration during the search. In order to avoid these problems, it is important not only to take child-friendly content into account. The search interface has to be child-friendly, so that children are able to use it without problems.

In order to design such child-friendly interfaces, more research is needed. Our study offers an overview over the quality of current search engines based on a quantitative analysis. Some usability questions still require an answer, e.g. what do children consider to be clickable, how should elements be arranged on the interface etc. In the future, we are going to verify, enrich and supplement the results of our work through a qualitative study together with children.

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