Design and Evaluation of an Interactive Children's Book

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Abstract

We present the design and evaluation of an interactive children's book. It is implemented as an interactive web site, where children worldwide can create collages around a common theme and add them to the constantly growing book. After a discussion of usability for children and their access to art and computers, we describe the design and implementation of the book. We evaluated our design in two studies with 35 school children between 10 and 15 years of age, using the techniques of thinking aloud and constructive interaction. In the process, we identified and fixed a number of usability problems and gained additional insights for the design of this kind of interactive web applications for children.

1 Introduction

Today's Children grow up with technology as a natural part of their daily environments. Computers and "new media" are as familiar to them as reading and writing to the adult generation. Therefore, they interact with technology without the fear other generations exhibit (Mohr, p. 224). When children use computers as an entertainment medium, they receive feedback and engage actively in the entertainment. The coming generation of users hence is an experienced, ambitious and critical target group, which needs to be studied carefully. In strong contradiction to this, it is still standard practice to test software for children with adults. The results of such tests are unlikely to match the real opinions of the children as the end users (Markopoulos & Bekker).

1.1 The children's book project

The work presented here is part of an ongoing project about the illustration of children's books, which started in the art pedagogic department of our university in 1998. In 2004, Students and 7th grade school children jointly developed a children's book called "chicken or egg" (Huhn oder Ei), in which philosophical questions from the children's world were col-
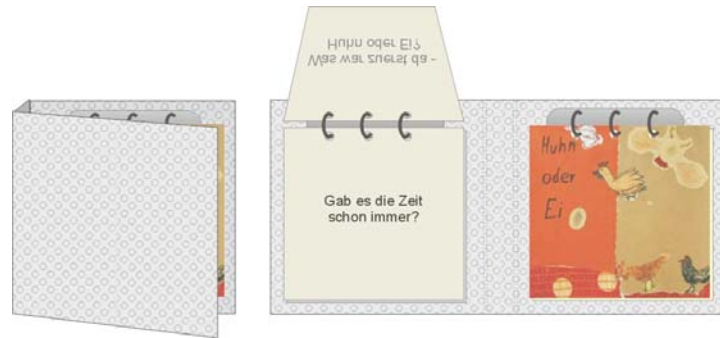
Figure 1: Analog version of the children's book "chicken or egg", in which pages can be turned autonomously in order to create different contexts

lected and illustrated with drawings and collages (see Figure 1). However, the calculated cost of production for a first edition of the physical book was too high. In addition, it seemed tempting to open the project to a much wider audience by producing an interactive version for the internet. The vision of the project was to develop an open book full of questions and illustrations in the form of a permanent interactive website. Everybody (children and adults) should have the possibility to extend and complete the existing book with their own ideas, questions and images. The website should be usable and enjoyable for children and fulfill pedagogical learning goals simultaneously. The challenge was to understand children and treat them as a special user group with strong opinions and needs.

1.2   Related Work

An interactive children's book can be categorized as an edutainment product, because it tries to join entertainment with pedagogical values. Similar types of creative software can be found, both as web applications or standalone programs. On the web, there are various coloring books, drawing or painting programs and collage software, mostly implemented as Java applets or Flash applications (Peggy&Hans, ICB, La Bruja). Unfortunately, they often do not advance creativity to the extent they claim. Stereotypical colors take the artistic decisions from the children and don't make high creative demands. This is particularly true for online coloring books. Existing collage programs (NGA, Kidsville, Pentacom) are better from a pedagogical point of view, but most of them don't provide free form drawing tools. The feeling of success mostly remains an illusion for the children. Another critical point sometimes is the lack of saving and printing options or a bad usability of the software. Particularly online software should also provide the means to publish the artwork produced online.

A stronger support for the creative development is provided by offline tool software. While professional imaging software seldom is made for children's requirements, there are a number of programs especially produced for children, such as Disney Magic Artist (Disney) or Tux Paint (Tux Paint). A well known program, which is sometimes used for creative purposes is Microsoft's "Paint", because most children use their parents' Windows computer, where it is installed by default (Mohr, p. 9). Even though it exhibits a number of usability problems, it can still teach some of the basic concepts of digital drawing.

2   Children's Computer Literacy

More than half of the children between 6 and 13 years in Germany have already been online (KIM). Children from an age of 10 years use the internet more intensively, most frequently at home (Kuchenbuch & Simon, p. 445). They like online games and – with increasing age – use email or chat, and look for information. More than a third (35%) of the children use the computer for creative activities, such as painting, drawing and writing. Usually, their parents taught them how to use the computer and the internet, and the children are familiar enough with the computer devices and the software to just use it. Their media competence, however, is still not fully developed, because they don't have the capabilities to question, select and evaluate the content they encounter. Children do not only have different development states. They also differ in their cognitive capabilities, needs and attention levels (Perdrix et al.). It is therefore helpful to at least concentrate on a single age group, in order to reduce the overall variations in the target group. The target group of the interactive children's book is the group of children from the age of 10 years. They usually have good writing and reading skills and the ability to understand and create abstract concepts, which is necessary for philosophizing and for combining new images. Saving, undo and redo are familiar concepts for them. Children at the age of 10 years navigate a web site naturally and they usually like working on the computer. They read texts fast and can scan and localize interesting parts of the site. They already have a clear and oriented mental model. They can identify most objects on a home page and understand their meaning based on their previous experience (Perdrix et al.). Furthermore, they are able to criticize und have useful suggestions and ideas.

3   Children and Art

During the children's socialization process, picture books are usually their first encounter with media and hence strongly shape their perception and opinions. As intermedial alliances of verbal und nonverbal systems of communication, picture books are intensively integrated in the art- pedagogical practice (Grünewald). Paraphrasing picture stories with the help of experimental drawing techniques, such as collage, allows children to recognize the significant content of fictional reality as modifiable. Already during primary school, children are losing their joy of painting and their artistic productivity. The world becomes increasingly complex while their drawing capabilities remains on an almost permanent level. Hence, the expressive capabilities eventually become too limited to express their world. The results are often stereotypical artistic methods, which seem cramped und clichéd (Glas, p. 11). A method to avoid this and to keep their joy of painting is the collage technique. Pieces of the "real" reality (textile, wood, pieces of paper…) can be integrated in the image and can satisfy the artistic and naturalistic needs. Things are taken from their original context and brought into new contexts and meanings. This method gives the children more artistic freedom and the possibility to experiment and to explore the possibilities of art. The collage therefore became an important part of the drawing program of our website. It contains fragmental pieces of the children's collages from the initial children's book project that can be stamped

onto the digital canvas. New combinations and meanings are formed. The child is invited to combine and extend them. It's a game of fantasy and experience. Recombining objects in a collage and painting with textures is interesting and motivating. The digital working area is not just a canvas, but a kind of stage, on which stories can develop. Digital drawing is connected with very different aesthetical attitudes. Children find new and innovative solutions while drawing on a computer (Mohr, pp. 131 ff.).

4   Children and usability

4.1   The Fun Factor

Usability for children should be extended by the factor fun: „Things are fun when they attract, capture, and hold our attention by provoking new or unusual emotions in contexts that typically arouse none, or by arousing emotions not typically aroused in a given context." (Sim et al.). Children don't want satisfaction. They want entertainment and fun.

4.2   Problems of Existing Web Interfaces

Not all rules for designing (web) interfaces can be applied to children. Their cognitive abilities are not yet fully developed, and they are often impatient. Therefore, they have to be treated in a special way. Design principles and usability criteria for children are the subject of ongoing research. Currently, many guidelines are based on very general assumptions or on informal observations of a small group of children. Large scale user studies with children are still not very common. Nielsen (Nielsen) conducted studies with children and found that they often could not to solve unforeseen technical problems going beyond the pure use of their software, because technology is not familiar to them to the necessary extent. Children and adults often dislike the same things, but there are some additional points to keep in mind when designing a website for children. The most important rule is to keep the website simple and not overloaded. Publicity and banners should be avoided altogether, because they cannot be differentiated from actual content. Children like colorful and simple websites with animations and sounds. Reaction times should be as fast as possible. Often children use old computers with old software. They most importantly want to be entertained. They want to discover the possibilities, and see what's happening on the website. Website authors should not use fantastic names for links, if simple and understandable terms exist. Even children know the most common internet words (Nielsen).

4.3   Usability Testing with Children

Evaluations should – wherever possible – be conducted with the target group, in this case with children. The method of heuristic evaluation is not adequate, because heuristics for

adults are not proven to be valid for children (MacFarlane). Methods, which should be considered for children, are the picture card, thinking aloud or constructive interaction method, but even with these, children might have problems in expressing their thoughts and opinions. It is not always easy to follow user-centered-design principles when working with children. Especially recruiting children as study subjects and collaborative partners is more difficult than recruiting adults. A child's days are filled with school, homework and hobbies, and the agreement of the parents is an absolute prerequisite. In addition, they need to be supervised and entertained, in order to avoid boring waiting phases. For our studies, we recruited two school classes through a personal contact of one of the authors. They visited the institute during class time and their teachers looked after them, thus solving the responsibility problem. Since every single test took several minutes and involved only one or two children at a time, we had to provide distraction for the remaining children. They received breakfast and personal nametags labeled "software tester" and were entertained with games or used for other less formal evaluation tasks at the institute.

5   Design Aspects of the children's book

The interactive children's book was implemented as an interactive web site with a very simple structure. Users can either look at the existing book and leaf through the pages, similarly to the printed book, or they can add content. In order to add new questions or collages, they need to create a login which creates their own "atelier" in which they can then work, and to which they can return later and find it in the state in which they left it. The design of the entire web site is delicately tuned to work as a well-balanced and neutral platform for the children's artwork. The colors used for the background, as well as the typography and the icons are sophisticated and in harmony. You can find a small number of different colors and nuances of grey, even in the written text. The easily readable typography works with the subject of the web site and corresponds with the logo. The individual navigation buttons are building a unit with the other design elements. The collage box is the main palette in the collage drawing program. It offers a varied and motivating collection of picture elements. The colors of the different collage pieces are corresponding to each other. They show smooth color shadings instead of high color contrast, since working with high color contrast is often difficult even for experienced designers. It is easier to create a well-balanced picture by avoiding bright colors and too many different hues. Some of the collage elements are partly transparent, which is an aspect hardly found in simple painting software. Transparency is a specific tool in digital design with a high aesthetic potential. Many paint boxes for non-professionals only offer a few highly saturated colors, black and a small gray scale. This project offers a broad range of colours and shades of grey in different levels of lightness and saturation. This is the basis for designing individual and non-stereotypical pictures that express the artist's mood.

6   Technical Realization

From a technical point of view, the interactive children's book had to provide the following functions: online editing of texts, uploading of images and online drawing of images. Another important requirement was the easy maintenance of the book's website by simple content management functionalities. The Wiki technology particularly fulfilled the latter of these basic requirements. From the many open source wiki engines we chose TWiki (TWiki) because of its powerful plug-in interface and large developer community. We then adapted its functionality to the desired requirements step by step (see Figure 2).
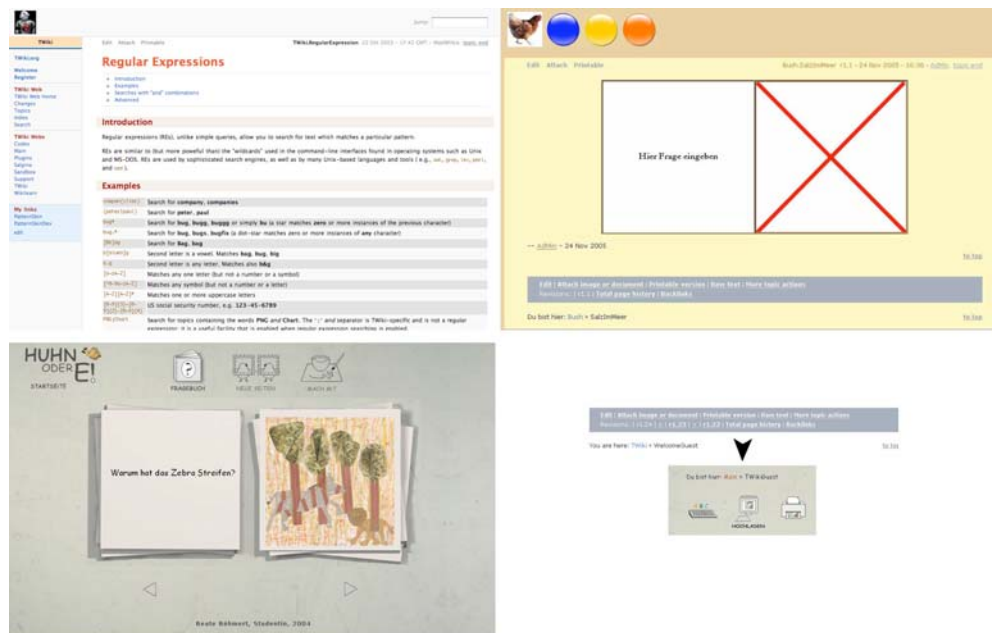

Figure 2: Adaptation of a TWiki to an interactive children's book step by step: The original default appearance (top left), a first modification by just changing the style sheets (top right), the final appearance with modified style sheets and completely redrawn icons and simplified page structure (bottom left and right)

A very useful plug-in was the TWikiDrawPlugin (TWikiDraw) that provided the necessary interface for communication with the server for loading and saving images. The plug-in itself was antiquated and therefore had to be substituted by the open source java applet Child's Paint (Java Boutique). It was restructured to a user friendly plug-in for the TWiki and extended with standard drawing tools and new painting functions, such as collage and texture painting. In the spirit of a wiki, users can complete the website not just with their own ideas, but also with their own images and drawings. In their own "atelier", users can start the drawing applet and create and publicize their own paintings in the book. Users can also draw offline with traditional tools and then upload the image to their atelier. In the discussion areas or the sandbox, even teamwork is possible. The TWiki itself provided a user administration and easy maintenance of the entire site.

7 Evaluation of the children's book

A certain number of children and pedagogues were directly involved in the iterative design and development process and took the role of the user and tester. In addition to frequent informal interviews, a pilot test and a first user study were conducted in this phase. The pilot test was used to fix and test the equipment of the simple usability lab (see Figure 3) and provide a good estimate of the time needed for each subject. The first usability study then concentrated on the online drawing applet, and in particular on its learnability.

7.1 The study setup

In order to record our subjects' interactions with the interactive children's book, we set up a "poor man's usability lab" (see Figure 3) in a dedicated room of our lab.
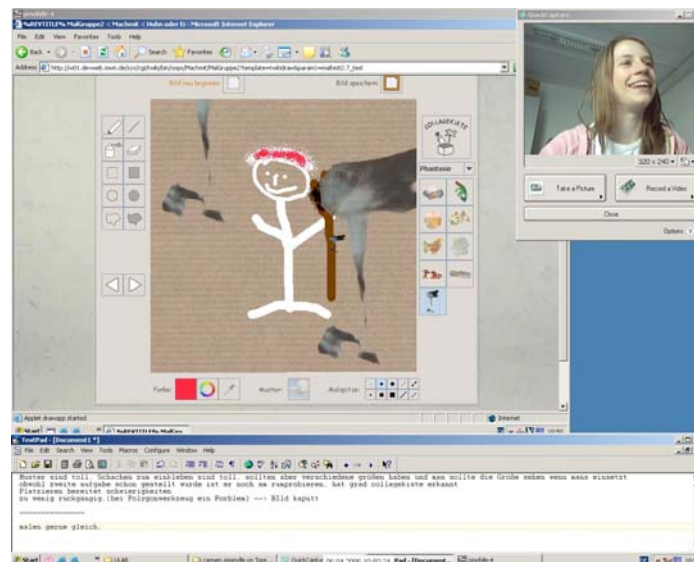

Figure 3: Video Protocol of the drawing interaction, as shown on the supervisor PC screen

The actual setup consisted of a test PC, on which a web browser was opened to run our system. The entire desktop of this test PC was mirrored via VNC to a supervisor PC on the other side of the room. In addition, a webcam and microphone were placed next to the screen of the test PC in order to record facial expressions and voice, and their signals were shown on the supervisor PC as well. Finally, a text editor was opened on the supervisor PC for recording brief remarks during the actual study. By simply recording the screen of the supervisor PC with a screen camera software, we thus recorded the actual interaction, the supervisor's comments, as well as the subject's face and voice in a single video stream, thereby avoiding any potential problems with later synchronization of separate recordings.

7.2   Evaluation of the First Design

The first study involving a class of 21 children tested how children interacted with the software with or without a training phase. We wanted to find out whether they would understand the function and effects of the drawing tools by simply using them. Each subject was given a drawing task and asked to express his/her thoughts verbally (thinking aloud method). The experimental group received an introductory phase in which the functions of the applet were explicitly used and examined without the task to create a certain image. We observed that in this phase, the children embraced the new creative possibilities and were highly motivated and curious. The control group didn't receive this introduction. For the subsequent drawing task, children in the experimental group used the tools economically and unerringly. Their satisfaction was higher than in the control group. Children without training used mostly the tools they knew from other programs and were not very eager to explore additional functions. Part of this can be attributed to the problem, that the visual icons did not communicate their functions clear enough, on the wrong level, or not in a stimulating way. We changed the visual appearance in order to catch the eye of the user and to wake curiosity. Our goal was that everybody should be able to use the program without any training. The appearance of the icons and the terminology was changed: "textures" became "magic paint", because we observed that children didn't know the meaning of the word "textures" yet. The respective icon appeared to them like a background function (see Figure 4).

Figure 4: The appearance and terminology of the texture palette were changed to increase the usability for children. While they didn't understand "textures", the word "magic paint" inspired their curiosity and led to the fact that this tool was used more often and discovered faster.

The collagebox-icon was also labeled and opened by default upon starting the applet. We also found that the aesthetic attitude of children can hardly be generalized. It is very individual and not expressible in quantitative parameters. Nevertheless, we observed that practically all children enjoyed using the program and that they were proud of the results. It helped them to experiment with new artistic ideas. The contrasts between the many different materials are aesthetically inspiring and created surprising effects, resulting in interesting and unusual images. For this study, the method of thinking aloud worked very well. The children were very outgoing and critical and they gave substantial and useful feedback.

7.3   Redesign and Second Evaluation

After fixing the problems discovered in the first study, we conducted a second evaluation. This one was more informal and aimed at providing qualitative statements about the website as a whole. We thereby hoped to find weak points and problems of the interface in general and specifically whether the integration of the drawing applet into the website worked (registration, saving, uploading). In addition to detecting problems, the study also yielded more feedback and ideas for improvement of the interface. The study was executed with 14 children of a class in teams of two. They were asked to interact naturally and communicate with their partner about the problems they observed or discuss what they liked or what they are surprised of. This method (constructive interaction) worked quite well to understand what they liked and what surprised them, but some children began to whisper or were very shy and didn't want to talk a lot with their partner. We mostly attribute this to the unusual situation and the unfamiliar environment in which the study was conducted.

8   Conclusions and Future Work

We have presented the design and implementation of an interactive children's book in the form of an interactive web site. We successfully used the techniques of thinking aloud and constructive interaction with 35 subjects of the age of 10-15 years. In our studies, we didn't attempt to obtain quantitative data or strict significance, but rather collected qualitative data and derived concrete usability problems from observing the actual interaction. Regarding the interface design, we identified a number of usability problems, the most prominent of which were due to visual ambiguousness and misleading or simply unknown terminology. Regarding the interactive children's book as a whole, some useful features could still be added, such as image galleries, control and security functions, WYSIWYG editing of the content, automatic loading of the images into the question book, or a collection of collage material for downloading and printing. The TWiki configuration could be further tuned in order to reduce answer times (e.g., by caching, upgrading). The drawing applet itself might be extended by functionalities for simple slide shows, sounds, a concept of layers, changeable stamps, or a loading function for external collage materials. The project will be continued at the art pedagogic institute in additional directions, while the online version is permanently growing. The vision of an open and endless question book now depends on interested and curious children to fill the online book with their ideas and images.

9   Acknowledgments

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