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Jukka Louhivuori, Tuomas Eerola, Suvi Saarikallio, Tommi Himberg, Päivi-Sisko Eerola (Editors)

Designing New Learning Environments for Music: Implementing the MobiKid Experience

Maija Fredrikson, Netta Iivari & Ruut Tikkanen

Department of Educational Sciences and Teacher Education, University of Oulu, Finland
Department of Information Processing Science, University Oulu, Finland

maija.fredrikson@oulu.fi netta.iivari@oulu.fi ruut.tikkanen@oulu.fi

ABSTRACT

In 2006-2008 a mobile software application MobiKid for children aged 3-6 was developed to allow children to sing, record and listen to the songs independently at home. They could even forward the recorded songs to be downloaded from a server by their teacher and relatives. With not yet completed user interface (UI) features the program offered children a motivating context for singing and musical creativity. The child-centered MobiKid UI was developed collaboratively by different experts of music education and software engineering. MobiKid pilot study was expected to reflect the preliminary requirements for child-centered software and usability features for further development among informal music making and learning. On 2009 additional usability evaluations were carried out to learn about how to improve the application usability from the viewpoint young children aged 5-6. In the present study we explore the background of the earlier MobiKid, and discuss on its design and testing procedure in order to understand the early experiences on the pilot study. Afterwards, we examine the usability of the MobiKid application from the viewpoint of young children as to be implemented on developing additional applications for the future JamMo (jamming mobile) product .

I. INTRODUCTION

The distinctive aspects of mobile learning are its mobility, the informally arranged and distributed participants, and the interaction between learning and portable technology (Sharples et al. 2005). Combining music and mobile technology promises exciting future developments in a rapidly emerging field. Still, only few applications have been developed for young children, such as Tratti (Beloff & Pilchmair 2007) with which children can record their voice and, by moving the device they get playback manipulated by the instrument. With new properties such as ad hoc networking, Internet connection, and context-awareness, mobile music technology offers countless new artistic, commercial and socio-cultural opportunities for music creation, listening and sharing. One of the main challenges in the future is to tailor applications, which provide sound synthesis, sampling, sequencing and touch-screen virtual musical instruments in an educative form for children of different age groups and learners with specific needs. The MobiKid pilot study has taken a step towards this direction, providing young children (4-7 years of age) a sequencer-based application for vocal music-making in an interactive and pedagogically sound form. (Fredrikson & Paananen 2008.) In exploring the pilot study we have already faced the deep ethical issues of privacy and ownership mobile learning will raise especially in working with children. In our current research project UMSIC - Usability of Music for the Social Inclusion of Children (www.umsic.org) these questions are even more and seriously acknowledged.

In MobiKid stand alone application we expected to find some personal models of pro m-solving strategy of young children in their object–oriented actions by studying the event logs distributed with the application. Although these have been discussed qualitatively earlier (Fredrikson & Paananen 2008) we will bring some further observational features into this presentation as well. .Finally we will produce guidelines for the child-centered development of this type of applications as well as guidelines on how to improve the usability of the MobiKid application.

II. MOBIKID SOFTWARE DESIGN

In the original MobiKid, a program was developed on mobile phones to provide children ten songs to sing and work on independently at home environments. Songs were familiar for the children from the music play school group they used to participate. Child centered usability was mainly reached by using the person method of Alan Cooper (Cooper 1995). The basic idea of virtual persons in developing the interface was combined by the virtual music teacher as well. This was implemented by sliding events (introduction/welcome, song selection, recording, listening and sending a song) which were represented via a jigsaw puzzle metaphor. The mobile teacher, who appeared between the activities, was reproduced by video and flash techniques. She gave supportive instructions and feed back to children. The user interface (UI) was made simple to use with touch screen, picture buttons (song icons) and sound instructions. As a result the program could repeat and record sound simultaneously. The singing voice was stored as .wave and .log files on children's personal memory cards. The user interface was dynamic, which meant for example that there were singing buttons available only for existing songs, and only after the user has sung the song a listening button appeared next to the singing button. (Fredrikson & Paananen 2008; see Nissilä 2006 and Malinen 2007.) Two applications were developed by using different programming languages (C++ for Windows and Python for Linux, later also C++) with additional two different hardwares (QTek S200/220 and N770/800). The pocket PC program was technically tested in the device (QTek) straight from Visual Studio 2005 by connecting the device to a computer with Active Sync. (Malinen 2007, 12.)

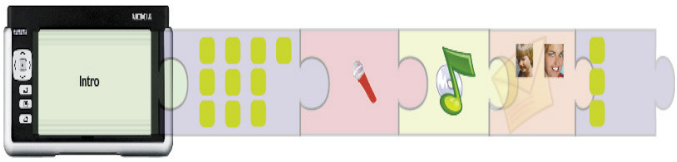

Figure 1. The sliding puzzle of MobiKid (N770) (Nissilä 2006).

The heuristic evaluation (Nielsen 1993, 2005) was used during the whole UI development in this first stage of the MobiKid design. The explorative decisions during the development of the application were actively compared with the heuristics. Two most distinctive ones were "Simple and natural dialogue" and "Speak the users´ language". As the target group was children aged 3-6, in developing the UI the heuristics which were connected to the ability to learn like matching between system and the real world, recognition rather than recall as well as consistency and standards, were most important. (Kuitunen 2009, 37.) As learnability is concerned, intuitive learning is a great challenge in developing user interface to children: a child should know intuitively how to use the device with that knowledge she/he already has captured earlier (see Sinkkonen 2002).

III. CHILDREN WORKING WITH THE MOBIKID

At the beginning of the pilot study MobiKid (see Fredrikson & Paananen 2008), a Finnish music play school group with nine girls aged 4-6 was set up for the study purposes. The group was supposed to form a positive infrastructure for the further development of the basic study. The group worked with their music teacher two short terms on 2006-2007. The song repertoire (n=10) in the software was learned in advance among the other normal music play school group working. In addition to familiar children songs the music play school teacher put some of her own compositions to good use as well. On a period of two weeks on March 2007 this group worked with their own personal mobile phones (N770) independently at home. At the same time one boy aged 7 worked with the program on his own N770 without knowing previously the songs.

The primary research data (N770) was captured as audio (.deb) and .log files on the memory card in the device. These files were uploaded twice over the lifespan of the test for analysis into children's personal folders on the main server. Children's working on the device, the user interface (UI) and the software design were preliminary evaluated by a simple parent questionnaire. The complementary research data with the more advanced program for QTek S200 was captured by video-observing. Two girls aged 5-7 were working on their device independently in the researcher´s room. They were two-way video-observed by one still camera and one zooming camera.

On the .log files of the primary research data on N770 we followed the intervals of different actions on the device, and found that children worked on the device different time periods changing from couple of seconds to maximum 1hour 14 minutes. The time period changed between the children and seemed to be dependent on the age of the child. Different problem-solving procedures, such as choosing the listening time, deciding to repeat the listening, and song preferences were analyzed on the data. Younger girls did work shorter periods with the device and the period was situational and contextually dependent. Some figures on the log show that the device was even carried by the children in the bed.

As our approach was naturalistic, we did not gather any other data from the home situations than the parent questionnaire information on their children working on the device. We can only assume, without any real observation, what really happened and when with the device. Still, all the independent work by the children was captured in their personal memory cards as audio and log files. We may expect that singing, captured in the event logs, like choosing particular songs to sing over and over again, showed some preference, but was mostly just situated to the users´ normal lives at home. Moving around with the device into different situations in the family life gave children new possibilities to share their intentions with the music game.

We may conclude that with the MobiKid application informal music making was experienced by the 4-6 aged children as a natural, motivating context for vocal creativity with some social sharing aspects. It also performed a satisfactory tool for research in the development of singing.

In 2009 an additional evaluation with a slightly different version of the MobiKid program was concluded with the end users. All the MobiKid evaluation procedures carried on in Finland are summarized on the table 1 below.

Table 1. Different evaluation strategies in the MobiKid as April 2009.

Hardware	Evaluation method	Age, sex and amount of the children	Time of the evaluation
N770	Parent questionnaire	4-6 aged girls (n=9) 7 (n=1) boy	Spring 2007
N800/810	Heuristic evaluation Usability testing	**** 5-6 aged both sex (n=2+2)	Spring 2009
QTekS200	Video-observing	6 and 8 aged girls (n=2)	Summer 2007

Evaluation strategies and the results with the N800/810 finished until April 2009 are described in the paragraphs IV-V.

IV. USER INTERFACE EVALUATIONS

A. User-Centered Design and Evaluation

In the evaluation and further development of the MobiKid application, a *user-centered design* approach is utilized. User-centered design can be characterized by its goal of producing usable software products and systems. Also the principles of active user participation, appropriate allocation of functions between users and technology, iterative design and multi-disciplinary design have been associated with user-centered design (e.g. Gulliksen et al. 2003, Iivari & Iivari 2006, ISO 13407 1999). Usability is typically defined as 'the

extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use' (ISO 9241 1998). Another widely cited definition defines usability to consist of learnability, efficiency, memorability, errors and satisfaction - it should be easy to learn to use the system, the use should be efficient, it should be easy to remember how to use it, the users should not make errors or they should easily recover from them, and the use should be satisfactory (Nielsen 1993).

There are numerous user-centered design methods, each having certain strengths and limitations. Despite their differences, all these methodologies emphasize the importance of gaining a detailed understanding the users, their tasks or work practices and the context of use as a basis. Afterwards, one should carefully redesign the tasks or work practices based on that understanding. User involvement in the design process is suggested. User feedback should be sought early, and the design solution should be iterated based on the user feedback. (E.g. Beyer & Holtzblatt 1998, Cooper & Reimann 2003, Mayhew 1999, Nielsen 1993, Rosson & Carroll 2002.)

Usability evaluation is an essential part of user-centered design and should be carried out at all stages in the development life cycle. Usability evaluation should be started early in order that the results affect the design and making changes is not expensive. Evaluation can be of two different types: for providing feedback to improve the design solution or for assessing whether the objectives have been achieved. (ISO 13407 1999.) In an early phase the emphasis is on gathering qualitative feedback. Later during the development one should measure whether the requirements have been met. (ISO 13407 1999, Rubin 1994.)

Usability evaluation methods can be separated into empirical ones, which necessitate involvement of real users and into usability inspection methods that rely on inspectors' expertise and experience, and on guidelines, standards or heuristics. It has been argued that it is essential to have real users evaluate the system. The most common and fundamental empirical user testing method is usability testing, in which representative users carry out realistic tasks by using the system. Usually the users are asked also to think aloud so that the observers can find out what the users are trying to do and why they do what they do. (Dumas & Redish 1993, Mack & Nielsen 1994, Rubin 1994.)

B. User Interface Evaluations with Children in General

In this particular study the 'users' are 3-6 years old children. Therefore, the evaluations had to be adapted somewhat. Altogether, there exists literature particularly giving advice for child-centered design, which is a special instance of user-centered design. There has emerged an increasing interest in involving children in technology design. During the early days the focus was on children as users of technologies and on the consequences and impacts of the technologies on children. Later, however, the focus has moved to involving children testers, informants and design partners, consequently (Druin 2002). A number of usability evaluation, requirements gathering and cooperative design methods to be used with children have been suggested (see e.g. Druin 1999, Jensen & Skov 2005). Druin (1999) suggests that the methods suitable for working with children should advocate a multidisciplinary partnership with children, field research aiming at understanding activities, contexts and artifacts and iterative low-tech prototyping. In addition, Read and colleagues (2002) claim that fun is an important issue when considering children; the products designed for children should be fun to use. In addition, we claim that also methods used should be fun to use by the children. Children have different motivations and desire than adults, due to which child-centered design methods probably should emphasize different quality attributes than those to be used with adult users.

Usability evaluation methods, particularly usability testing, have been experimented with children. Researchers have also discussed the effect of this on the usability testing method and procedure. There are discussions related to the children´s development in the literature; researchers have written about the development of children from different points of view. Generally categorized physical, social, emotional, mental and lingual developments have raised questions how the different fields need to be taken into consideration in usability testing. There are lot of examples, among others by Höysniemi (2004), Hanna et al (2006), Markopoulos and Bekker (2002) and van Kestren et al (2003). Related to children's physical level of development one should ask, if the product and the test environment are fitted to the child.

Related to the area of social development it is important to ask, if the environment is safe for the child and what kind of things should be taken into consideration in the relationship between the adult and the child. The research could support emotional development through creating a supportive, encouraging and safe atmosphere. Mental development offers a challenge on the level of understanding and grasping causalities. Despite of general development trends, it is absolutely significant to recall the fact that every child has a developmental rhythm of his/her own (Höysniemi, 2006). Generally, the younger the child is the more time is needed for background research and planning for the test (Hanna et al, 1997). Hanna and colleagues (2007) argue that children older than 14 years of age will likely behave as adults in a testing situation and should be treated accordingly.

In addition to the age and stage of development, there are also other children characteristics listed by the researches. Druin (1999), Markopoulos and Bekker (2003), Höysniemi (2005) and Hanna and colleagues (2006) have, among others, collected and produced lists of characteristics of children, which should be taken into consideration when testing with children. Most of the work with children takes place in familiar and safe surrounding in a nursery or at school. Progression of the test is governed by the capability of the child to adjust to a new surrounding and social situation. Also the motivation of the child is an important part of the success of the test. In test situation the ability to concentrate of 5-6 years old children is about 30 minutes, older children could concentrate an hour (Hanna et al, 2006). That´s why it is important to distinguish children´s need for a break from signals of poor usability.

Children are used to behave in a quite extrovert way. Their way of communicating with adults has a big influence on test arrangements - children are not necessarily used to discuss with adults. The threshold between adults and children will become lower through casual dressing-up and suitable small talk before the test. Children's will to please adults has an effect on their opinions, and their shyness and fear to give wrong answers

might also have an effect. In these occasions the reliability of the results may go down.

According to Hanna and colleagues (2006) and VanKestren and colleagues (2003), children are not yet capable of thinking aloud, which has a big influence on the test session. Children need support from adults. The cognitive load of the usage of the product can also distract thinking aloud (Höysniemi 2003). Bruckman and Bandlow (2003) emphasize that in test circumstances it is important to accentuate that instead of children, the software is going to be tested. In conclusion, when working with children the researcher should always recall the ethical point of view.

V. MOBIKID USER INTERFACE EVALUATIONS

A. User Interface Evaluation Methods and Procedure

In the MobiKid pilot study, we have carried out two different types of usability evaluations: we have carried out usability inspections according to heuristic evaluation method (Nielsen 1993; see also paragraph 2), and empirical usability testing, in which the representative potential users acted as test participants. The most common usability inspection method is heuristic evaluation (Nielsen 1993), in which several evaluators check whether the system conforms to the given usability principles called heuristics. Usually the evaluators carry out the evaluation first individually, after which the results are combined and the severity of the problems is estimated. During the evaluation session each evaluator goes through the user-interface for several times and first focuses on the general flow, and afterwards inspects various dialogue elements and compares them with the list of heuristics. A result of heuristic evaluation is a list of usability problems with reference to the usability principles that were violated in each case. Fixes to the problems should also be recommended. (Nielsen 1993.) Heuristic evaluation was carried out in the MobiKid pilot study following this procedure. Four evaluators carried out the evaluation first individually, after which the findings were combined.

Related to empirical usability testing, four usability testing sessions were carried out with four children, aged five or six. Two of the participants were boys and two girls. In the sessions, one user at a time was asked to do a given set of tasks under observation. The tests were carried out in a natural setting, i.e. in the homes of the children. The tests were videotaped and analyzed afterwards. Usability problems were identified and a set of recommendations for improvement was produced. (Cf. Dumas & Redish 1993, Rubin 1994.) The children were also interviewed after the test sessions.

B. Evaluation Results

In relation to heuristic evaluation, the researcher group got findings (i.e. usability problems in the MobiKid user interface) related to every heuristic. For example, related to 'visibility of system status', the evaluators noticed that there was no indication on the starting screen whether it was the user's time to act or if the program was still loading, related to the 'consistency and standards', the evaluators criticized that the icon designs were odd and not consistent, and related to 'user control and freedom' they highlighted that there was no 'emergency exit' available in certain places if one wanted to quit the play. Therefore, heuristic evaluation was found to be useful in highlighting many issues related to how to improve the usability of the MobiKid. Heuristic evaluation is also known as a method through which a lot of usability problems can be identified, but they are not necessarily the most serious ones from the viewpoint of the user, due to which empirical usability testing is typically also recommended (Dumas & Redish 1993, Mack & Nielsen 1994, Nielsen 1993, Rubin 1994). In addition, heuristic evaluation helped the adults to orientate themselves to the MobiKid application and to its usability testing with children, therefore creating a supportive background for the usability testing.

There were also a lot of results gained through MobiKid usability testing with 5 and 6 years of age children, and indeed usability testing method has been recommended as the best method for finding out the most serious usability problems as well as a very large number of problems (Dumas & Redish 1993, Nielsen 1993, Rubin 1994). Before the tests, it was decided that the child will play the game without the adult as much as possible. It was also acknowledged that for young children the tasks cannot be very complicated and they should not to be presented in a text format. In the test sessions the children could not play the game without any help from the adult, who, for example, helped to start singing. It was also found that it is important that the songs are at least partially familiar to children or the children should have the possibility to listen to them somewhere and learn the new songs. Children felt comfortable playing with fingers. They liked to touch. However, there were also some children who experienced touching slightly difficult.

Children learned new things through experimenting. They were also interested in logical causalities and enjoyed learning new things. For children, it was found that the puzzle concept (see Figure 1) for moving from one place in the user interface to another was unclear. One should figure out another analogical way of doing it. The children were patient with problems and bugs. However, if something did not function or the child didn't understand something, especially the children 6 years of age easily felt that they could not play the game. "Yes, it was difficult, because I couldn't properly play the game". The child got confused on that occasion and the motivation for playing went down. Children also seemed to prefer very clear, colorful and bright graphics to become inspired to play the game.

VI. LESSONS LEARNED

Clearly, both heuristic evaluation and usability testing proved to be useful in finding out usability problems. However, even though the heuristic evaluation succeeded in highlighting many usability problems in the MobiKid, empirical usability testing with children was very important to ensure that their point of view and problems characteristic to them (that are not necessarily obvious to adults) are noticed.

When there are children as test participants, we emphasize that the test environment should be peaceful and safe for the child. Some kind of introduction, or maybe even becoming acquainted with the child beforehand, is needed. This can be accomplished for example by playing before the test session. This helps the child against nervousness in the test situation.

Typically at the beginning the child needs help from the adult. In some kind of way the adult should safely guide the child to the world of the game. It is problematic if the children feel like the game is too difficult for them early during the test session, because they then tend to have no more interest in the game. During the game children also need a lot of feedback to see their own development and achievements concretely.

The development of the MobiKid application will continue in the future (see www.umsic.org). The results from heuristic evaluation and usability testing of MobiKid will be taken into account in the prospective development work. In addition, in the future, children will take part in the development not only as testers (cf. Druin 2002), which has been the case so far, but also as informants and design partners (cf. Druin 2002). Requirement specification and design sessions will be carried out not only in a music orientated kindergarten in Oulu, Finland but also with school aged children in the UK. These sessions together with the evaluation results will form the foundation for creating and testing prototypes for singing and composition games of the future JamMo application.

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