

## Mobile music for children – experiences of MobiKid

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### ABSTRACT

In the present study, mobile software applications for young children were developed and tested. The pedagogical design is based on IP-/Neo-Piagetian theory of development. The research perspectives were focused on child-centered usability and software development. MobiKid software was developed to allow children to sing, record and listen to the songs, and forward the recorded songs to the server independently at home. The song repertoire in the software was learned in advance in music plays school; a group of nine girls worked on their personal mobile phones. The music play school teacher worked also as the mobile teacher in the hardware. Outside the music play school context, one boy used the device independently at home. (UI) and the software design were investigated by parent questionnaires and video-observations. Children were able to work independently on the device, and the structure of decision-making was suitable for the users. However, some UI-features were uncompleted. Children were highly motivated in singing, learning and decision-making. MobiKid provided a natural, motivating context for musical creativity and social sharing as well as a tool for research in the development of singing.

### I. INTRODUCTION

Since the first palm devices - simple keyboard applications allowing simple sequencing - appeared in the 90's users and developers have pushed the boundaries of mobile applications. As the platform developed MIDI applications appeared. Similarly, the Pocket PC/Windows Mobile platform has allowed developers to explore a range of music making applications from drum machines and sequencers plug-ins and mixing capabilities. A number of applications provide sample editing, synthesis and sequencing. Most of them have root functionality in desktop origins. These applications are usually commercial and targeted to musicians. Some applications, such as miniMusic Sight-reading and Ear-training pads ([www.minimusic.com](http://www.minimusic.com)), are developed for educational use, employing drill and practice technique. 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.

Combining music and mobile technology promises exciting future developments in a rapidly emerging field. Devices such as mobile phones, Walkmans and iPods have already brought music to the ever-changing social and geographic locations of their users and reshaped their experience of the urban landscape. 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.

### II. DEVELOPMENTAL BASIS OF THE PEDAGOGICAL DESIGN OF MobiKid

Spontaneous musical generativity is a universal feature of child development and enculturation. In the present study, the development of musical productivity is regarded as intellectual development parallel to other cognitive domains, following a domain-specific multi-staged developmental sequence, which is reflected in the level of complexity of musical structures in children's musical compositions and improvisations (Kratus 1985; Swanwick & Tillman 1986; Wilson & Wales 1995; Brophy 2002; Paananen 2003, 2006a, 2006b, 2007). The theoretical background of the pedagogical design of the pilot software MobiKid is formed of the model of musical development (Paananen 1997, 2003), which is based on Robbie Case's (1985, 1992) Neo-Piagetian developmental mechanism.

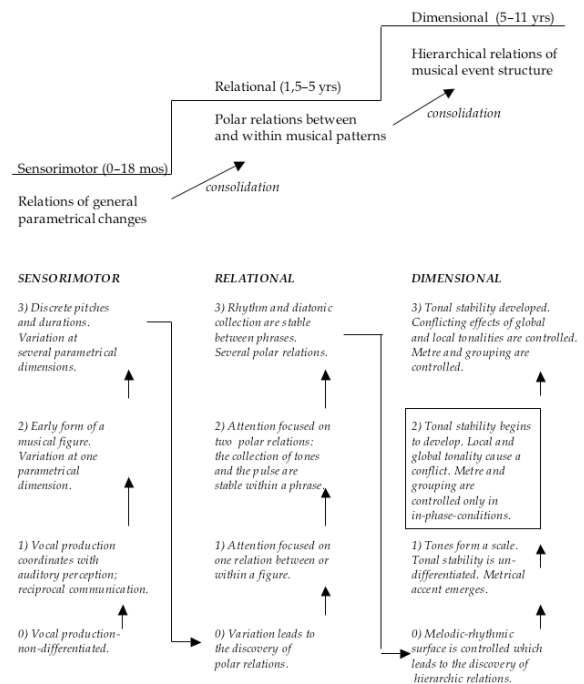


Figure 1. The model of musical development (Paananen 1997a, 1997b, 2003).

In Case's (1985, 1992) theory the main developmental factors are the biological maturation of the central nervous system and the increase of the central resource of *attention*. Development is constrained by a general age-related factor: the short-term storage space. The form of hierarchical integration of executive control structures is common to the development of different cognitive domains, the structures being, however, domain-specific. Figure 1 presents Paananen's model of musical development (1997a, 1997b, 2003) from birth to 11 years of age. This model is constructed applying Case's developmental mechanism in interpreting earlier empirical studies on musical development, as follows: 1) in the sensorimotor stage (4–18 months), the relations of general parametrical changes of sound develop as a result of the coordination of sensory representations and gross-motor schemes, 2) in the relational stage (1.5–5 years), the polar relations between and within musical patterns develop, and 3) in the dimensional stage (5–11 years), hierarchical relations of the musical event structure develop as a coordination of the *melodic-rhythmic surface, metre and tonal hierarchy*. Following Case (1985), each major stage includes substages of 1) unifocal coordination, when a new structure can be applied in isolation, 2) bifocal coordination, when two such units can be applied in succession, and 3) elaborated coordination, when two or more units can be applied simultaneously and integrated into a coherent system.

While at the sensorimotor stage each act of pattern production is regarded as a sensorimotor operation, as a relational structure a musical pattern can be apprehended as a musical unit. According to the present model challenges of the target group, young children aged 4–6 years, is able to control *polar* relations between patterns (repetition, change) and polar relations within patterns, such as the direction of melodic contour, relative duration (long-short), relative tempo (fast-slow), regular vs. irregular speed of release of events, the direction of a melodic interval, the relation of pitch to the reference pitch of the context, and the relative stability/instability.

In MobiKid, also the stages of *decision-making* are represented as *single to polar event structures*, which in turn form *simple chains* (back and forth). For example, by pressing one button, the software starts and automatically leads the child to the first selective decision. This makes the software usable for young children's attention and short-term capacities. In the further software versions for older children, the design aims at a continuum from *polar* (relational stage) to *hierarchical* (dimensional stage) structures of knowledge and decision-making (mode of thinking reflected in the structure of the software), along with a shift from associational thinking and process-oriented improvisation to higher meta-cognitive levels and product-oriented improvisation.

### III. USER INTERFACE AND PROGRAMMING

In MobiKid, a program was developed on mobile phones to provide children ten songs to sing and work on independently at home environments. 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.

The program was implemented by sliding events (introduction/welcome, song selection, recording, listening and sending), which were represented using a jigsaw puzzle metaphor. The mobile teacher, who appeared between these main steps of the procedure, was reproduced by video and flash techniques. She provided supportive instructions and feedback 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 .wav and .log files on children's personal memory cards. The UI was dynamic: for example there were song icons available only for existing songs, and only after the user has sung the song a playback icon appeared next to the song icon. (See Nissilä 2006; 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.

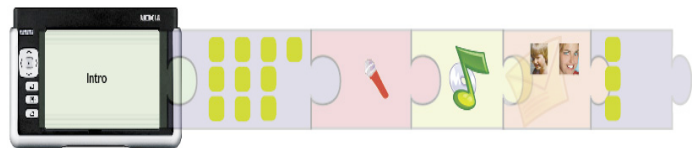


Figure 2. The sliding puzzle of MobiKid (N770) (Nissilä 2006).

The MobiKid functions – selecting, singing, recording, listening and forwarding the recorded songs to the main server to be downloaded by relatives/caretakers – were successfully developed in QTek S200, while N770 did not include the sending procedure. Even the UI design varied meanwhile QTek S200 was more advanced with the UI features supplementing the pedagogical design effectively. The other version (v. 1.0) for N770 was not yet technically accomplished when children got their personal devices home to work on. The later version on N800 is still to be developed.

### IV. TESTING PROCEDURE

In the beginning of the pilot study, a music play school group of 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 in 2006–2007 in Oulu, Finland. The song repertoire (n=10) in the software was learned in advance among play school group working routines. In addition to familiar children songs the music play school teacher put some of her own compositions to good use as well. The ten songs were *The Clown in the Music-Box*, *The Candle Song*, *The Princess in the Castle*, *The Wind-Chimes*, *The Clown Went into the Supermarket*, *The Rag Doll Hopping*, *Hovering Leaves*, *Itsy-Bitsy Spider*, *Tiny Locomotive* and *The Sun*.

Meanwhile the group worked normally with their music teacher, the technical solutions for the programming turned to

be more and more challenging. Finally, in the late spring, the programming of the first version was completed and children got their mobiles to work on. During a period of two weeks in March 2007 this group worked with their own personal mobile phones (N770) independently at home. In May 2007 in Jyväskylä, Finland, a case study was conducted with one boy aged 7 who worked with N770 independently, outside the music play school context. Excepting three songs, the song repertoire was not familiar to him.

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 years 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.

## V. METHODS

The .log files of the primary research data on N770 provided an opportunity to follow the time intervals of different actions on the device, such as which songs of the main menu the children select at a particular moment, how long the children listen to the song selected, when they are ready to listen to it again, when they return 'home' to choose a different song on the menu, and how long the recording takes. The log also reveals the most favoured songs the child chooses to listen, sing along, and record. In other words, the .log makes it possible to explore the strategies children use when working on familiar and new songs. In addition to the log files, we analyzed the comparative data saved on DVD qualitatively including the information of parent questionnaire, and compared the log to the features of the musical learning processes captured in the audio files of the recorded songs, with or without the background music.

## VI. RESULTS

Results of the pilot study MobiKid show preliminary features for a successful mobile environment for vocal music learning and rehearsal. Children were enthusiastic and highly motivated to work with their personal devices. The two applications and hardware were interesting for the children to freely work on. Children varied a lot in learning processes and strategies.

### A. Results from the primary data

Nine children aged 4-6 worked independently at home on ten songs downloaded to their personal devices. Among the research group there were four sisters and one single girl. During the research period the sisters did work mostly separately with their own devices at home. The headphones provided for the personal listening were not in use. The inbuilt microphone in the device was found sufficient for working on

the device. Most of the girls liked to work on them especially in the evenings but there are also records showing the use of device on early afternoon and before dinner time. We could conclude that children were happy to work on the device like listening and song singing in their own time. Children worked on the device different time periods changing from couple of seconds to maximum 1 hour 14 minutes. The time period changed between the children and seemed to be dependent on the age of the child. 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.

Children had different preferences to the songs although the song repertoire did please them generally well. On the log we can explore which songs were sung or listened most often. As we only have the statistics without any observing to show this we can only assume that the chosen songs show some preference, but they also were situated to the users' normal lives at home. They could even move and go around with the device into different situations. Meanwhile in the case of Onni (see below), at least in the beginning of the experiment, there were some novelty value on the songs in the primary research data all the girls were familiar with the songs. Their musical expectations were faced through other novelty aspects like the background accompaniment and the mobile teacher feedback.

Concerning the non-accomplished UI there are some notes to be taken in account: All the parents and children got an early instruction for the use of the mobile phone and the program. At home children were supposed to work alone and independently. We are not sure if that really happened. According to the parent questionnaires the program did not open easily although one girl could come off well depending on her previous experience on mobile phones in the family. Closing the program was not succeeded. The menu with ten gif icons of the songs was an interesting and motivating challenge. Children could record their own songs easily by pushing the right icon button. Moving on to listening required support by parents in all cases.

### B. Results from the complementary data

In the complementary data, which was collected at the late spring 2007 two girls from the music play school group were separately videotaped when working alone with the device that was new to them. They used Labtec headsets with microphone. Additionally the more accomplished program had some novelty features. We present preliminary findings of the UI, how children discover the problem solving paths in their working on the device and how they are and we describe them narrative:

In the beginning, both girls wanted to use the stick for the touch screen. Afterwards they used fingers as well. Compared with the N770 application the QTek S200 application showed different features of the mobile teacher and the working with the program was more accurate. The sliding puzzle metaphor was not easy to find out, and it was discovered but after several attempts by the children. These challenges were found motivating, and the problem-solving did bring children

satisfaction. The actual context for listening and singing with the device was as easy and motivating as in the earlier experiment.

In this more laboratory like situation children had a clear strategy in selecting songs: they chose songs with the preference of most liked songs and went through the whole repertoire. They also liked to listen their recorded songs and showed some preferences in them, too. They liked the working on the device with new features to discover.

### C. Results of the case study: Onni

‘Onni’ (7 years, 8 months) worked with MobiKid independently at home after a two-day introduction period with his mother (=researcher) in Jyväskylä, Finland. He used the version Nokia 770 without headphones. In other words, the recorded audio tracks included both the accompaniment and the vocal production. Onni’s working with the device was constrained by the fact that Nokia 770 application was not a technically accomplished version. It did not include direct playback function (ear icon), but the recordings had to be fetched from the file manager. This operation included seven steps – too many from general developmental and usability viewpoints, but not an obstacle in this case. Moreover, the quality of the recorded vocal sound was rather poor because of background noise (a buzz produced by the device itself). The song repertoire (ten accompanied songs) and other functions including the virtual teacher, however, were similar to Qtek200.

The introduction took 10 minutes in Day 1 and 18 + 6 minutes in Day 2. Mother introduced Onni with the device by starting the program, showing the song icons and demonstrating the listening, recording and playback functions. All ten songs were listened to. Onni commented on the songs that were familiar to him and which ones he liked. He participated in singing with his mother. As soon as he was able, mother encouraged him to select songs and test recording independently. Song selection by pressing the song icon was easy for him. He was motivated in listening all ten songs in the following order: *The Clown in the Music-Box*, *The Sun*, *The Rag Doll Hopping*, *The Princess in the Castle (familiar)*, *Tiny Locomotive (familiar)*, *The Candle Song (familiar)*, *Hovering Leaves*, *Itsy-Bitsy Spider (familiar)*, *The Clown Went into the Supermarket*, and *The Wind-Chimes*. Two of the songs familiar to Onni were also recorded.

After 14 days of the introduction session, Onni used the device independently during one day as long as he was motivated in it. He worked for 38 minutes. After listening to *Tiny Locomotive* three times and *The Clown Went into the Supermarket*, once, he recorded the former one. Then he listened to four more songs, and recorded *Itsy-Bitsy Spider*. After recording these familiar songs, he decided to learn all new songs. He sang one to four phrases in a time. When he did not remember the words, he interrupted the recording and produced new versions until he succeeded in singing the whole song. In between the learning of new songs, he recorded also versions of the familiar songs. He did not listen to the recorded tracks, nor did he ask for help to do that. He was goal-oriented to record all ten songs, and seemed to know when it was time to move on to the next song even without auditive feedback. His strategy can be characterized as linear. He worked without any breaks and was highly motivated in

singing and learning new songs with the device. He commented: ‘*The songs are really good!*’

## VII. CONCLUSION

MobiKid pilot study was expected to reflect the preliminary requirements for child-centred software and usability features for further development among informal music making and learning. We discovered that MobiKid application provided 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 the future, the main challenge in musical engineering and software development is to produce more complex and multidimensional applications for ubiquitous improvising and composing of music, sharing music in different social contexts, tailoring versions for different users and specific needs and for developmental research of music.

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