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Abstract

The aim of this project was to combine printed and digital learning material in order to enrich and enhance the learning experience, and introduce the created concept to the end-users in primary schools. We proposed a hybrid book concept in which traditional school book was combined with a mobile phone. The chosen subject was English as a foreign language (EFL).

User-centric approach and qualitative methods were used in the design process. The main user groups were teachers, pupils and parents. In addition, WSOYpro bookmakers gave their professional insight into the process. This approach made it possible to take into account the user preferences as well as pedagogical and didactical issues. The inclusion of the teacher in the design process from the very beginning proved to be valuable: The teacher was able to interweave the use of hybrid book into her current teaching practises, culture and curriculum; on the other hand she provided the research group with valuable information, which helped the design of the mobile phone tasks.

Our experiences from the project indicate that the mobile hybrid book is a suitable learning material for primary education. The motivation of teachers and pupils was high, and the attitudes of parents supported the use of hybrid book. The society around us is becoming increasingly digitalized and the schools should follow the change taking place in the society. The printed book is probably not enough anymore, but is not yet disappearing from the schools. The idea of combining the two worlds, printed and digital, was well received.

Preface

This project started at KCL from the wish of the KCL owner companies (M-real, Myllykoski, StoraEnso and UPM-Kymmene) to understand better what the role of printed school materials will be in the future, and how print and digital could be combined in an attractive way to provide learning material that would be more that just a book and more than just digital material. The research task has been exceptionally interesting and motivating. We have been able utilize our own expertise on the strengths and weaknesses of print and digital media, as well as our knowledge on possibilities to combine these two into hybrid media. We have also been able to work with people with very different backgrounds to evaluate and improve the hybrid book concept. In addition, we have been able to see how the created concept actually works in real life. We are very grateful for the paper companies as well as Tekes for giving us this possibility.

Our approach in this study was to create something new with the actual end users, the pupils and their teachers. We chose elementary school English as our case study, as in language learning the digital material could so well complement the printed materials. In elementary schools there would also be enough flexibility in the curriculum to carry out research and testing during school hours. Altogether more than 60 children and adults have given their time and insight to test and evaluate our ideas. We would like to express our thanks to all of you. We have been very proud of the mature attitude of the 11–12-year-old pupils, it has been a pleasure working with them. We would also like to thank the WSOYpro WOW!6 book makers for their valuable comments and inspiring discussions.

In the middle of the project all KCL research moved to VTT, and we continued the project in completely new settings. Adding VTT's competence in making our ideas of the hybrid book reality made it possible for us to really utilize all the information collected during the project. It has been a very interesting process to see how technology really can be used in ways that the users want and need it.

Espoo 23.6.2010

Anu, Maija, Timo and Sami

Contents

1. Introduction

New digital applications are taken into use in educational contexts and are being developed continuously. To a large part, the role of books or other print material is very small in the digital applications. Schools' role in creating the habit of reading is very important due to the fact that young people use less and less traditional print media during their free time. It is also not entirely unthinkable to assume that the only connection some young people have with books is at school. In this project, our starting point was a traditional school book that we wanted to bring to a new level by utilizing the technological possibilities that already exist for combining print with digital. The concept of hybrid media has been taken into use to describe the combination of fiber-based and other (electronic) media (Oittinen 2006), and hence, we have used the name hybrid book for the learning material developed and tested in this project. The approach also enables the introduction of new technology to the school environment as part of traditional practices, through studying with the book.

During the course of the project, it became clear that printed and digital school materials are typically developed separately. Today schoolbook publishers provide CD's, internet sites and complementary digital material for teachers as supplementary material, but in practice, they are under-utilized due to the extra effort and time required for their use, both in school and at home. In our approach, printed and digital school materials would be combined into one entity in a way that would be easy to use for both teachers and pupils and that would support the daily routines of both of these user groups. Hence, a user-centric approach was chosen for the development of the new school book, the hybrid book. Furthermore, in order to gain a more extensive understanding of the feasible alternatives in the development of learning materials, experts representing teaching, e-book technology, publishing and e-learning in Finland, UK and the Netherlands were interviewed in our study. The results of these interviews are presented in a separate report, "The future of printed school books" (Grenman 2010).

2. Goals of the study

The goals of the project were:

1) Develop, test and promote new hybrid media product concept(s) for learning environments
2) Improve the learning environment by the hybrid media product concept
3) Deliver strategic information concerning learning and especially on the use and role of print and hybrid media in educational material
4) Understand the role of paper as part of a hybrid media product. This consists of both technological matters and general user based information to be elucidated in the user tests.
5) Develop and test new technological concepts to be utilized in other product areas.

3. Mobile learning

The term mobile learning or m-learning was introduced at the beginning of the millennium when the mobile phone became one of the major communication devices. Hence, m-learning is a relatively recent innovation, enabled through advances in operating system design, lower cost hardware, and the community acceptance of mobile phone technologies (Peters 2005). The classification of technology as being mobile varies somewhat. According to Peters (2005), a mobile technology device should meet three criteria: it must be capable of providing communication and/or information functions, be small enough to be easily carried, and be used, at least part of the time, without a physical connection to a fixed power source or telecommunications services. Mobile, to most, means portable and movable. It also seems to imply personal as opposed to shared use. The terms mobile and personal are often used interchangeably, but a device may be one without necessarily being the other. (Naismith et al. 2004)

The general requirements for mobile learning technologies are that they should be (Sharples 2000):

- *highly portable*, so that they can be available wherever the user needs to learn;
- *individual*, adapting to the learner's abilities, knowledge and learning styles and designed to support personal learning, rather than general work or entertainment;
- *unobtrusive*, so that the learner can capture situations and retrieve knowledge without the technology obtruding on the situation;
- *available* anywhere, to enable communication with teachers, experts and peers;

- *adaptable* to the context of learning and the learner's evolving skills and knowledge;
- *persistent*, to manage learning throughout a lifetime, so that the learner's personal accumulation of resources and knowledge will be immediately accessible despite changes in technology;
- *useful*, suited to everyday needs for communication, reference, work and learning;
- *easy to use* by people with no previous experience of the technology.

Learning using mobile devices is not simply presenting traditional teaching via small, mobile devices. New mobile and context-aware technology can enable people to learn by exploring their world, in continual communication with and through technology. Mobile technology can enable conversations between learners in real and virtual worlds, such as between visitors to a museum, and visitors to its virtual counterpart. Mobile learning offers a way to extend the support of learning outside the classroom, to the conversations and interactions of everyday life (Sharples 2005). The interactivity of mobile technologies creates new teaching and learning opportunities more suited to a constructivist approach where the device is a tool for information and direction, but the structure of the learning is created by the learner. (Peters 2005) Mobile devices can change the nature of the different and relatively stable environments to something more dynamic and alive. In situations such as at a museum or in a nature park they can work as an aid to collaborative knowledge building. (Ahonen et al. 2003)

Can high-quality learning be achieved with mobile devices? A number of projects related to mobile learning found out that the use of mobile technologies can support different parts of the learning experience and interweave into learners personal knowledge, interests and learning needs (Kukulska-Hulme et al. 2009). Experiments have shown that the opportunity to study whenever and wherever has generally increased motivation to study (Leino et al. 2002). New technology offers the opportunity for children and adults to communicate with teachers and fellow learners around the world, to interact with rich learning resources and simulated environments, to call on information and knowledge when needed to solve problems and satisfy curiosity, and to create 'personal learning narratives' through an extended process of capturing and organizing situated activity. (Sharples 2000)

To some extent, printed school books could be seen as m-learning devices. They are highly portable and easy to use without any previous experience. However, by combining them with mobile phones, they also become individual and interactive. Providing a hybrid solution that would suit the present understanding of m-learning, i.e. learning materials that are easily accessed anywhere and anytime has been one of the aims in this project.

3.1 Mobile language learning

In Finland, teaching of the first foreign language can start in the first grade, but more usually in grade 3, when the pupils are 9–10 years old. The objective of English teaching for grades 3–6 is to enable the pupils to communicate in this foreign language in very concrete, personally immediate situations orally and in writing, and to develop good language study habits. According to the Finnish national core curriculum for basic education, the learning environment must be equipped so as to support the pupil's development into a member of today's information society, and provide opportunities for the use of computers, other media technology, and, as possibilities allow, data networks (Finnish National Board of Education 2004).

Learning English involves memorizing and practicing a large vocabulary and numerous grammatical structures. Vocabulary learning is a key aspect of learning English, because vocabulary comprises the basic building blocks of English sentences. For this reason many studies have attempted to improve both efficiency and performance in the learning of English vocabulary. (Chen & Chung 2008)

Collins (2005) outlined a variety of content that can be developed for language learning by using mobile phones' capabilities. Some of them were waiting to become available in 2005, but today these features are reality:

- Short dialogs as conversational models
- Read-alongs, recorded audio stories with the ability to follow printed text while listening to develop both listening and reading skills
- Picture dictionaries with illustrations of common objects and actions, plus audio playback of the new language and translations into users' languages
- Phrase books for travelers
- Preparation for tests

- Ability to integrate a wider variety of media, including animation and short video
- Ability to submit sound files for evaluation of pronunciation and speaking, including automated evaluation
- Establishment of learner communities for interactive learning using shared tools and content
- Ability to obtain location-specific content, using GPS technologies.

In an overview of mobile assisted language learning Kukulska-Hulme & Shield (2008) remarked that so far very few studies include activities that support learner collaboration or communication. Another area that was mentioned to require further investigation is the ways in which different mobile technologies can be employed by different pedagogical approaches and in different more or less formal learning contexts.

3.2 Mobile devices and reading

Reading takes on a range of forms, is done for a variety of purposes and is associated with a diverse set of other activities (Sellen & Harper 2002).

In other words: there are lots of different types of reading, depending at least on the purpose, situation, content and reader's personal preferences. Furthermore, reading habits are changing due to increasing reading from screen and the variety of mobile devices, as well as due to new contents and production methods.

Purposeful *reading to learn* associated with students is a variable activity involving non-linear access to content and the use of multiple documents, and it is alternating between skimming and focused reading (Marshall & Ruotolo 2002). It is notable that this kind of purposeful reading usually takes place in association with different forms of writing (Landoni 2008). Typical forms of writing in this sense are for example notetaking and annotating.

Marshall & Ruotolo characterize reading practices on the handheld devices as quick reading, skimming, and scanning to meet the needs of a highly time-constrained, highly-fragmented day. This type of reading from mobile devices favours secondary materials, i.e. shorter readings such as instructions (Marshall & Ruotolo 2002). Furthermore, the type of reading typically taking place in *mobile learning contexts* is by character task-oriented, fragmented, skimming, con-

versational and tailored. It is reading short texts in short periods of time adjusting to the current context and task, and it can include interaction with other people (Kuula & Harper 2009).

Based on these definitions we must consider that reading with mobile devices does not meet all the needs of students. Mobile devices support only certain types of reading in certain contexts, and for example very focused reading is often excluded. As a strength, the conversational type of reading supports interaction and thus may enhance collaboration in learning. On the other hand, according to Sellen & Harper, paper supports different types of reading especially well, and it also supports notetaking and annotating. This is an obvious strength of printed learning material.

4. Methods

4.1 User-centric design process

A user-centric approach was chosen for the development of the hybrid school book. This approach made it possible to get important feedback from the pupils and teachers not only related to the hybrid school book concept, but also about the attitudes towards printed school material in general.

In user centric design, the user is involved as an essential part of the design process (Kuutti 2003). The user-centric design process should start at the very early stages of the project, usually when the initial concept for the product or system is being formulated (ISO 9241-210:2010). The standard determines four activities that should be repeated iteratively until the system meets the requirements:

1. Understanding and specifying the context of use
2. Specifying the user requirements
3. Producing design solutions
4. Evaluating the design.

In the development process of the hybrid school book these activities were carried out as the following steps in the Figure 1.

In the iterative design approach, feedback from users becomes a critical source of information. Iteration allows preliminary design solutions to be tested against real world scenarios, with the results being fed back into progressively refined solutions. The first activity, understanding and specifying the context of use, includes the characteristics of the intended users, the tasks the users are to perform, and the environment in which the users are to use the system. Specifying the user and organizational requirements should define the allocation of functions: the division of system tasks into those performed by humans and those

performed by technology. Producing design solutions involves developing design proposals, making the design solutions more concrete using simulations, models, etc., presenting the design solutions to users and allowing them to perform tasks, altering the design in response to user feedback, and managing the iteration of design solutions. Evaluation of designs against requirements can be used to provide feedback which can be used to improve the design, to assess whether user and organizational objectives have been achieved, and to monitor long-term use of the product or system. (ISO 9241-210:2010)

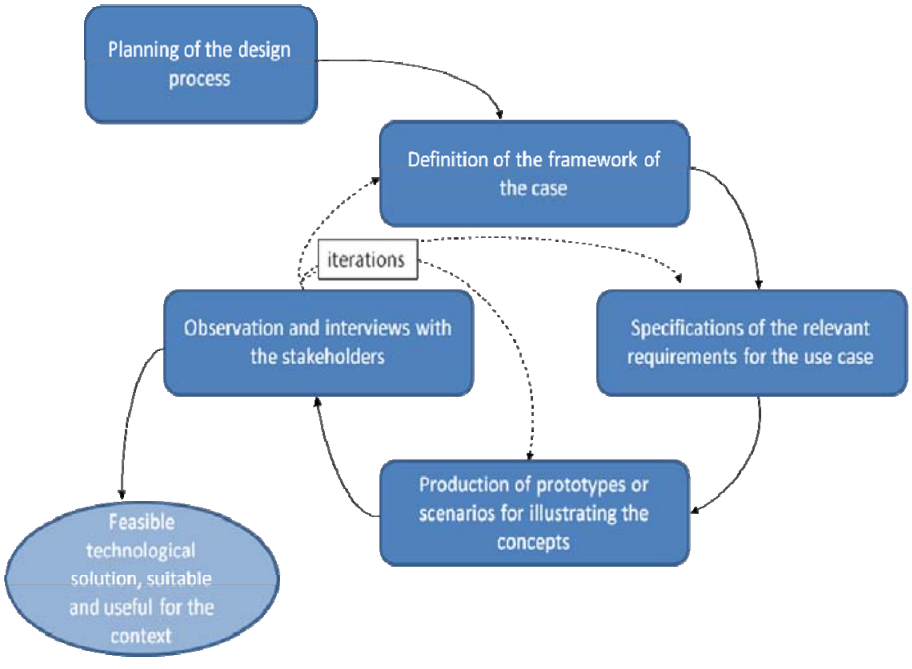

Figure 1. Design process for the development of the hybrid book (based on the ISO 9241-210 standard 'Human-centred design for interactive systems').

The hybrid school book development process was an iterative study-design-build-evaluate process consisting of four parts as shown in Figure 2. In each phase, the hybrid school book concept was presented to the users, the users were interviewed and the results obtained were utilized in the next phase. In phases 1, 3 and 4 a proto type of the hybrid book was prepared so that the users could actually use the hybrid book and give feedback based on the experience. In phase 2 the concepts were presented as comic strips representing different kind of use situations. In the phase one, only teachers were interviewed and in the

later phases both teachers and pupils gave the users' viewpoint. In phases 3 and 4 also parents of the pupils were included in the interviews. In addition, the book makers of the WOW!6 English book took part in the evaluation process and gave some valuable comments based on their experience. Each of the iterations has been discussed in more detail in the publications from the project and is referred to in Figure 2. Selected publications from each phase may be found in the Appendices.

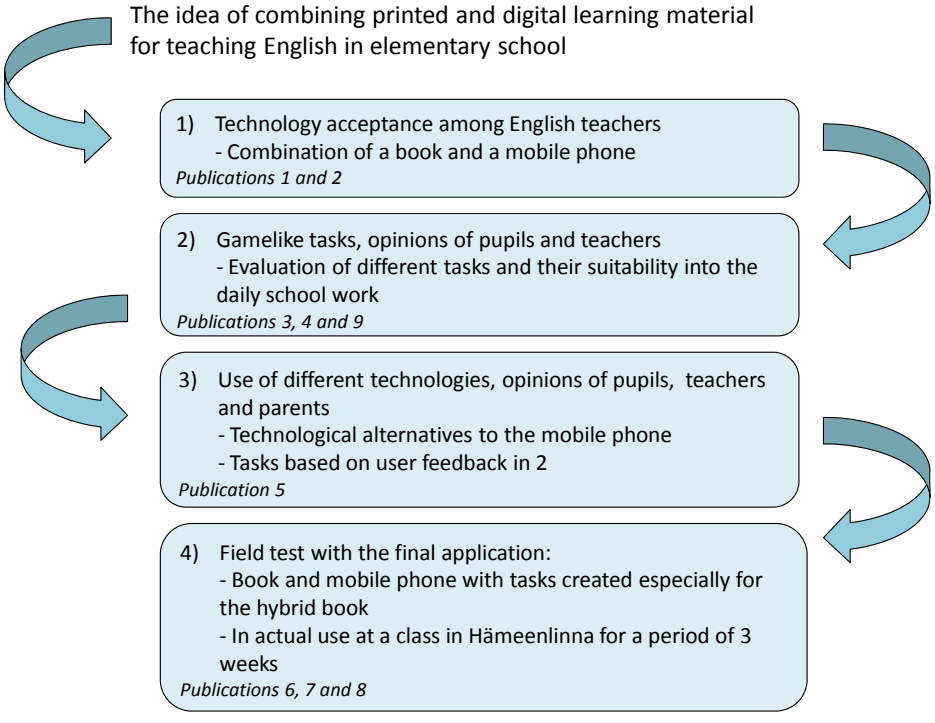

Figure 2. The development process of the hybrid school book.

4.2 Qualitative research

The research material gathered in this study is based on qualitative interviews. In qualitative research, the object is examined as comprehensively as possible. The purpose is to reveal the facts rather than to verify existing statements. (Hirsjärvi et al. 2007) It is not the aim of qualitative research to produce a statistical generalization (Tuomi & Sarajärvi 2002). The purpose is to understand the

phenomenon being studied and to see it from the subject's point of view (Järvenpää & Kosonen 1999).

The most common methods of data collection are interview, inquiry, observation and data collection from different documents (Tuomi & Sarajärvi 2002). In these methods, the researcher takes part in the research process and is not an objective outsider as in the case of quantitative research (Järvenpää & Kosonen 1999). User information tells who, when, and why the product is finally used and it gives detailed information about how and why users behave and what they want. Based on user information a new, useful and enjoyable product can be created for its actual users. (Hyysalo 2006)

There are lots of descriptions in qualitative studies of how research analysis has been tackled. Usually analysis includes two phases: reduction of observations and solving the problem. Observations are examined and connected with a view to finding the things that are essential on the grounds of the research questions. Solving the problem corresponds to the interpretation of results in quantitative research. The purpose is to make an interpretation of the phenomenon based on clues from the material. (Järvenpää & Kosonen 1999)

The interviews were carried out as theme interviews (Hirsjärvi & Hurme 2000). This method is suitable when there is some defined field that the researchers want to gain more knowledge of, but also totally new aspects are expected to appear. The main emphasis is on learning to understand the practices and needs of the interviewee based on his/her individual experience. The themes of the interviews were prepared in advance, and some questions were defined but during the interviews, free discussion and new thoughts were encouraged. The course of the interviews was allowed to vary, depending on the interests of the interviewee, and the remarks and the observations made during the interview. The adults were interviewed individually, the children in pairs.

4.3 Involving children in the development process

The children that were recruited for the study for evaluating the prototypes were 11–12 years old. Children at this age can already verbalize their thoughts clearly and are used to talking to adults who they are not acquainted with. Also, the themes of the interviews were in no way personal nor did they include any subject that would be confusing or difficult for the children to discuss. Therefore the interviews could be carried out largely in a similar way than with adult inter-

viewees, as outlined in the previous chapter. The following steps were however followed in order to take into consideration the young age of the interviewees:

- Pilot interviews were carried out with children that were familiar to the research group. The purpose was to check in advance the adequacy of the prototype testing procedure and the questions for this age group.
- The parents of the children were informed of the study well in advance with careful explanation of what is studied and how the results will be presented. The parents were asked for a written permission to allow their child to participate in the study.
- In the beginning of an interview, the researchers explicitly introduced the goal of the interview and the role of the interviewees, emphasizing that there are no right or wrong answers, the English skills of the children are not assessed and that the insights of the children as actual end-users are essential for the study. (Höysniemi et al. 2005)
- Prototypes of the concepts or comic strip scenarios were presented as the basis for the discussions (Druin 1999)
- The children were interviewed in pairs in order to establish a more relaxed atmosphere. (Höysniemi et al. 2004)
- The interviews were not video recorded since this has been noted to be uncomfortable for many young interviewees. (Druin 1999)
- In order to encourage the children to speak in their own words and to freely discuss, open questions were used (as in any interview).
- The researchers paid special attention on that they allowed the children to formulate the answers without hurry and that they didn't interrupt the children.

Interviews were mostly carried out during school hours which helped the researchers to motivate the children to contribute; the children regarded the testing of prototypes and interviews as nice variation to school work. On the other hand, this made it even more important to critically evaluate the interview data during the analysis. There is an obvious risk that the children don't criticize as easily as they give positive feedback, partly because they wish to be able to use electronic devices in schools more frequently, partly because they don't want to be 'unfriendly' to the interviewer.

4.4 Technology acceptance

User acceptance can be defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support. To be accepted, a technology must satisfy basic usability requirements and be perceived as useful by its intended user community. Numerous studies have demonstrated that innovations affording relative advantages, compatibility with existing practices and beliefs, low complexity, potential trialability, and observability, will be more extensively and rapidly accepted than an innovation with the opposite characteristics. (Dillon 2001)

One of the most widely used technology acceptance theories is TAM (Technology Acceptance Model). TAM predicts user acceptance of any technology in terms of two factors (Davis 1989):

- Perceived usefulness, i.e. the degree to which a user believes that using the system will enhance his or her performance.
- Perceived ease of use, i.e. the degree to which the user believes that using the system will be free from effort.

Research by Davis et al. (1989) indicated that although ease of use is clearly important, the usefulness of the system is even more important and should not be overlooked. Users may be willing to tolerate a difficult interface in order to access functionality that is very important, while no amount of ease of use will compensate for a system that does not do a useful task.

Huang et al. (2007) have extended TAM to explain and predict the acceptance of mobile learning. Their study investigated the future acceptance of the emerging m-learning technology rather than its current use. To understand the user perception of m-learning, Huang et al. integrated two individual external variables into the proposed model: perceived enjoyment and perceived mobility. Perceived enjoyment denotes the extent to which an individual finds the interaction with m-learning intrinsically enjoyable or interesting. Perceived enjoyment is seen as an example of intrinsic motivation, and has been found to influence user acceptance significantly. The perceived mobility value denotes user awareness of the mobility value of m-learning: mobility brings the ability to guide and support users in new learning situations when and where necessary.

TAM has also been applied in a study by Haaparanta (2008). The model was utilized for exploring the attitudes of Finnish elementary school teachers towards technology, and how the attitudes correlate with the teachers' well-being at

work. The study revealed that the perceived usefulness of computers in teaching predicts more accurately the teachers' future use of ICT than their computer skills. Based on the study it was recommended that in the future, the emphasis on teachers' ICT trainings should be concentrated on how to feasibly incorporate ICT in teaching in a useful way, instead of training technological skills. Kaasinen (2005) has also proposed a TAM for Mobile Services. According to that model, user acceptance is built on three factors: perceived value of the service, perceived ease of use and perceived trust, but perceived ease of adoption is also required to get the users from intention-to-use to actual usage. Kaasinen also proposes design implications for each user acceptance factor.

TAM was especially used in the first phase of this study, where we wanted to reveal teachers' attitudes towards using a book and a mobile phone side by side for learning. However, throughout the study perceived usefulness, perceived ease of use and perceived enjoyment have been the factors we have taken into account in all the hybrid book concepts. In the interviews, we have also included questions to find out the importance of perceived mobility in this context.

5. Results

5.1 Enthusiastic response from the teachers

The starting point of the project was to combine printed and digital learning material, i.e. a school book and some electronic device with which elementary school children could easily move from one kind of learning material to another. Most effort was put into combining the book and a mobile phone, but other alternatives were also tested. In each phase of the project, teachers' comments were collected to ensure that the hybrid school book would be well suited for the field test in a real school environment.

Already in the beginning of the project, when the first prototype of the hybrid school book was presented to the teachers, very positive feedback was obtained. Two major benefits were mentioned by the teachers: motivation for studying and mobility of the hybrid book. Half of the teachers interviewed in this phase thought the hybrid book would motivate pupils to do English exercises. An exercise on paper is very school-like, but the same exercise would be inspiring and fun to do with a mobile phone. Computer-assisted tasks are unquestionably motivating, but a mobile phone is even closer to pupils. One teacher believed that pupils think "English is my thing when it comes to my mobile phone".

Teachers thought that when exercises and audio files are in your mobile phone, they are always with you. Pupils could do English tasks while on their way to school, e.g. listen to a chapter on the bus. That would make the hybrid book multipurpose. Even at home they would not have to sit at a table while doing their homework. Pupils could become hooked on a hybrid book in a positive way, which is something that a traditional school book would be unlikely to do. Teachers also mentioned that a hybrid book enables self-study in a meaningful way. It encourages pupils to study at their own initiative, because it is avail-

able all the time. Instant feedback and correct answers to exercises were thought to be a good feature.

The teachers hoped that the hybrid book would also support differentiated teaching. This was also mentioned by the WSOYpro book makers. There could be exercises on many levels of difficulty, some easier and some more difficult suiting different learners. As one teacher said:

> *--- teacher is doing it [teaching] along the golden mean, hoping to give enough to the fastest, but on the other hand trying to see whether the slowest can keep up. In which case this device could bring… if a pupil feels that he or she can do these [exercises] by him/herself, the pupil could select his or her own level ---*

Listening and grammar exercises were found to be especially suitable tasks for a hybrid school book. Listening is very important in language learning right from the start. With the prototype, pupils could listen and do listening exercises effortlessly and much more often than before. With a mobile phone and a headset, listening would be easy at one's own pace and everywhere. One teacher remarked

> *--- I think this is working well, you can listen to a chapter… especially at our school, where there are pupils who travel and are away from school sometimes as long as a couple of weeks and we can't give them tapes and CD-ROMs to take with them ---*

Multiple-choice exercises are highly suitable for mobile phones and are regarded as useful for practicing grammar. Exercises must be simple so that the user knows intuitively what to do and needs no instructions. Grammar exercises must also be unambiguous, because there may be many ways to translate or interpret a sentence. The hybrid book would be good for a quick recap of grammar.

Vocabulary exercises can require writing, but writing exercises were not regarded as suitable for a mobile phone by the teachers. Although pupils are considered experts in writing text messages, teachers thought that writing even one sentence would be too difficult. In addition, pupils like to hear songs in English classes and they could listen to them via a mobile phone. They could take pictures with a mobile phone, name pictures (e.g. 'cat') and download them to some shared gallery.

The biggest challenge the teachers mentioned in using a hybrid book was the use of mobile phones in a school environment. Pupils have mobile phones, but they are not allowed to use them in elementary school. All pupils should have

the opportunity to use a mobile phone – if not their own, then a borrowed or leased one. Schools should first acquire these new devices and adopt new ways of working. Some teachers were worried about how pupils would keep their mobile phones safe. Mobile phones are small and frequently get lost. When a pupil's mobile phone becomes a learning device, responsibility passes to the school e.g. in the event that it breaks down or gets stolen. The use of mobile phones at school could increase inequality. Not all pupils have mobile phones provided with all the features that are required for using a hybrid book.

Eight out of the ten teachers interviewed in the first phase of the study were willing to use a hybrid book for teaching if it was available. One was interested in using all new technical devices, while another would like to encourage pupils to use a hybrid book for self-study. One teacher previously thought that a mobile phone is not her device, but during the test she realized that it is actually quite an exciting thing.

Two teachers were not particularly interested in using a hybrid book in the first place. One felt that relative to its benefits, the hybrid book would take too much time in class, although it would save paper. The device was too slow and using it felt like just messing around. The other teacher liked the listening option, but thought the hybrid school book was too individual and not appropriate for the classroom. This teacher also experienced difficulty in using the hybrid book herself.

In the overall evaluation the hybrid book was found to be interesting. New learning environments were a current topic for discussion in schools. Teachers thought the types of exercises in the user tests would be familiar to pupils as they have used similar computer programs in language learning.

Using a computer in teaching has its own difficulties. Pupils are excited when they have a lesson in a computer class, but from the teachers perspective some extra effort may be required. First the class has to move to another classroom, switch on the computers and try to remember their passwords. If they studied with mobile phones, they would just pick up their devices. One teacher said she could not simply request laptops for all 20 pupils, but the pupils already have mobile phones. As a device, a mobile phone is closer to people's everyday life than a computer. It would also be easier for a teacher to give a pupil homework that requires a mobile phone than a computer.

5.2 Print and digital work together

The ultimate dream of the project group as a technological solution for the hybrid learning material was specified as follows:

- A printed paper book that is as lightweight and durable as traditional books, and works also as standalone.
- The digital content would be presented on a small mobile device, and the content could be accessed directly and wirelessly from the book's intuitive user interface wirelessly.
- The solution should already have been tested out so much that it could be applied for demonstrations and user tests in the project.

These specifications relate to some of the strengths of a printed book as learning material that were considered important to preserve: easy to use, robust, mobile, intuitive and independent.

An interesting demonstration was published in the O'Reilly Tools for Change in Publishing conference in 2007 by Manolis Kelaidis (O'Reilly 2007). He presented a book that was over-printed with conductive ink and equipped with a processor in the back cover of the book. When the conductive ink hyperlinks on the pages of the book are touched, the processor connects via Bluetooth to a nearby computer and activates different actions.

Despite this inspiring example, our specifications for the hybrid book turned out to be hard to conform to without substantial technological development, which was not in the scope of the study. The main challenge was the production of touch access activation from paper to launch digital content, in a scale that would enable user tests for a whole class. In addition, the demonstrations that we encountered used computers instead of mobile phones for presenting the digital content. These challenges resulted in several technologies being explored in the study in order to demonstrate both commercially available solutions and some potential future opportunities.

The technologies that were applied in different phases of the project for establishing a link between the printed and the digital material were:

1. Two-dimensional codes

   2D codes, or barcodes, are based on well-established and widely utilised technologies that are simple and inexpensive to produce. Their use

is straightforward with a mobile phone equipped with a camera. (Nokia Mobile codes website)

2. PaperPoint application and digital pen

   A research group in ETH Zurich has studied and developed interactive paper applications that can be used to control applications from paper (Signer 2008). One example is the PaperPoint presentation tool (Signer & Norrie 2007) that allows a Powerpoint presentation to be controlled and annotated from printed handouts. The tool is based on Anoto digital pen and paper functionalities. The absolute position of the digital pen can be detected due to the camera on the pen and the special pattern of tiny dots on the Anoto paper. This enables the addition of functionalities on certain positions of the paper that can then be triggered by touching them with the digital pen. In this study the technology was utilised in a prototype where each pupil could fill in a line in a balloon of a comic strip by writing the text on paper. The inputs were immediately visible on the screen for everyone in the class.

3. Printed electronics

   A research partner delivered an example of a printed book with touch access to the digital material for testing. The prototype consisted of book covers with printed buttons from 0 to 9, and buttons for ‘Reset’ and ‘Send’. In the prototype exercise, the teacher presents multiple choice tasks on a screen for the class. Each pupil presses the number corresponding to her choice for correct answer on the book cover, and submits the answer by pressing the send-button. The printed electronic components in the book cover register the selections and transmit the information wirelessly through an infrared-receiver to the teacher’s computer. After each task, a statistic of the answers is presented for the teacher (or the whole class).

4. Image recognition

   In the last prototype an image recognition application, IMediaLink, developed by VTT was utilized for converging the printed book and the digital material (Chen et al. 2010). To trigger the digital content of the printed book, the user starts the IMediaLink application from her mobile phone and takes a photo of a page in her schoolbook. The ap-

plication sends the image to the server, where it is analyzed, and the equivalent web link is searched from the database and returned to the user's phone. The phone's web browser opens a link which contains a list of school exercises for that specific chapter of the book.

The benefit of this technology is that the appearance of a print product doesn't need alteration when taking hybrid elements into use. In contrast to 2D codes, the layout of the book does not have to be redesigned, and in addition, those who don't have the opportunity to use mobile phones in studying are not distracted by unnecessary tags.

RFID/NFC-technology was also considered for connecting the printed and the digital content but in this case it would not have been applicable without special arrangements. In a book, several NFC tags may be on top of each other on consecutive pages on the same spots, in which case the reading device cannot distinguish which tag is actually pointed at.

The user evaluations of the above described technologies indicated that the concept of combining a book and a mobile phone would receive most support from all the stakeholders, and it was also seen as the most uncomplicated solution to take into active use both at home and during the classes. The availability and familiarity of the mobile phone were regarded as strengths of the solution. On the other hand, some children ranked other technologies higher specifically due to their novelty and oddity. After the three phases of demonstrations and user interviews, the hybrid school book for the three-week field test was defined: It comprised of an ordinary English study book for sixth graders, a smartphone, an image recognition application on the phone and a set of mobile phone tasks. The tasks were also developed together with the stakeholders, as described in the next chapter. An important guideline throughout the process was to highlight the affordances of both printed and digital content, and to utilize them accordingly for learning.

5.3 Listening to the users is worthwhile

Based on the encouraging results from the interviews with the teachers and the book makers, the next stages of the project concentrated on providing well suited tasks for the hybrid book. In order to make the tasks enjoyable, game-like elements were brought into the tasks.

Games or game-like features have a lot of potential to enhance learning. This is because they have the ability to motivate and engage people (Bogost 2007). People have intrinsic curiosity (Malone 1980) which makes people want to try and master challenges. Games provide these challenges in a meaningful environment which also allows people to try out things that would not be possible otherwise. Attitude and positive experiences are important for learning. According to Markovíc et al. (2007), positive experiences help the penetration of the learned material into long-term memory. Games can bring these positive learning experiences for students because they can offer meaningful tasks that students like to pursue.

Technology is also often a motivating factor and makes students enthusiastic at least in the beginning. If the benefit of using technology is easy to see, both students and teachers usually like trying out new technical devices. This makes utilizing technology and games in schools challenging because they should be easy to incorporate into the curriculum and should not demand too much effort from the teacher.

In this study, the game concepts were used as a tool for differentiation and for motivational factors. Emphasis was also put on how to take into account the difference in class and home environments when carrying out the learning tasks. These issues were especially pointed out by the teachers and book makers in the first interviews made. Differentiation, in the form of adaptive difficulty levels in the games, gives more freedom to the student and provides an optimal learning curve for any given play sessions. Motivational factors for playing the games can be enhanced by giving extrinsic goals for the student, where the games produce resources needed to achieve the extrinsic goals. In language education, the class setting favors social communication, verbal interaction and listening comprehension tasks. The home environment is suited for reading and writing, or other tasks where social interaction is not necessary.

Based on the feedback obtained from teachers and pupils, the tasks that were chosen as the most interesting were listening tasks, a crossword puzzle (mainly emphasized as an enjoyable task by both girls and boys) and a grammar exercise with differentiation (mainly wished for by teachers and bookmakers). The tasks chosen were all considered as useful for learning a foreign language. In addition to that, our emphasis was on making the application easy to use, bringing additional usefulness by combining printed and electronic material and on designing the system so that it would fit well into the everyday practices of the teachers and pupils.

In the case of the listening exercises, ease of use and mobility were the most important features for choosing them. Listening exercises are available for the pupils already, but using them at home requires some extra effort and at school everybody listens to a CD that the teacher plays. Making them available through the hybrid book made the exercises easier to access and increased their usefulness as the pupils could now listen to the chapters at their own pace. The pupils are very fond of the songs in their English books, and therefore the songs were also included in the hybrid book.

The crossword puzzles were considered as fun to start with, but in order to make the most out of the print-digital combination, the hints for the puzzle were audio files. In the case of the grammar exercise, differentiation was based on whether the answer to a question was right or wrong. Carrying out the exercise could go through very different paths as the questions became easier with more wrong answers and more difficult with more right answers.

Both teachers and pupils gave very good feedback on the exercises chosen, and the use of the hybrid book was found easy. Using mobile phones during classes was not found to be a problem, and during the three week test period the teacher came up with some own ideas on how to make use of the mobile phone even more. The pupils were eager users of the mobile technology, but they also value printed material highly. Most of the pupils were not willing to abandon the book.

5.4 Book alone is not enough

Printed school books have changed very little over the years. They have become more colourful and contain more and more pictures, but they are used in a very similar manner today as they were when the first school books were printed (in Finland that was in the end of 1880's). Digital learning material has been available since the 1990's, and during the 2000's the children have also received a CD with audio files together with the printed books (Figure 3).

Figure 3. The development of the school book.

Based on the interviews made during this study it is clear that the role of printed learning material in the elementary school level is still very strong. However, the society around us is becoming increasingly digitized and the children become very talented users of different digital devices already before starting school. Hence, it is also clear that the schools, learning materials and teaching have to follow the development taking place around them and include new technological solutions in their everyday work. The prerequisite for these solutions is though that they have to work well, they have to be easy to use and they have to fit into the everyday practices of the teachers and pupils.

As mentioned by Grenman (2010), books have indisputable strengths that currently can't be attained through any other medium. Books are stable − and although the inability to modify their content can be seen also as a disadvantage, in the learning process it's often also a strength. You can be sure you will find the same information in the same place it was before, which makes reviewing easier. Also, in unexpected situations, like power failures, you can still count on at least the book to work. It is also obvious that printed information can't be updated easily, and in some subjects school books age quickly. Some subjects benefit from the more illustrative approach that can be achieved with computers. With books alone there's no instant feedback and often no possibility to think again about the correct solution if you think you got it right the first time.

Combining school books and mobile phones may be one possible way to utilize the strengths of both printed and electronic learning materials, and providing

a solution that may be easily adapted into everyday practices. Mobile phones would provide possibilities otherwise impossible for the book. Based on the experience from the field test (reported in appendices 4 and 5), the teachers mentioned that it was easier to allow the pupils to proceed at their own pace with the hybrid school book than without it, even in the classroom. For example, the teacher usually plays a text from a CD-record for the whole class. Using the mobile phones and headphones for listening resulted in less distractions, and each pupil could pause and rewind the audio file whenever he or she needed to. The teacher also appreciated the features of the application that made it easier to check if the pupils had done their homework and how they had performed.

6. Conclusions

The starting point of the project was to combine printed and digital learning material in order to enrich and enhance the learning experience, and to introduce the created concept to the end-users in primary schools. Our experiences from the project indicate that the mobile hybrid book is a suitable learning tool for primary education. The motivation of teachers and pupils was high, and the attitudes of parents supported the use of hybrid book. The printed book is probably not enough anymore, but it is not yet disappearing from schools. The idea of combining the two worlds, printed and digital, was well received.

The mobility of the hybrid book allows pupils to study anywhere and anytime, and the hybrid book would motivate pupils to study because it is interesting to use. Pupils would be able to carry out English tasks on the move, for example listen to a chapter from the book on a bus. The hybrid book enables self-study in a meaningful way. It can offer new kinds of tasks and instant feedback from exercises. The hybrid book could also support effortless differentiated teaching; supplementary material can be integrated in the book as links instead of a teacher collecting it case-specifically. As a conclusion, our project verified the high potential of the mobile hybrid book in schoolwork. A longer test period is required to gain more profound knowledge about the impact on learning however.

We also saw that our intervention caused some changes in normal school practices. Even though these changes were most probably caused by the short test period and, in this sense, the situation was unnatural, we saw that the use of mobile technology is likely to change familiar practices. One of these practices is related to the costs of primary education. In Finland, cost-free primary school is an important value. The use of mobile technology must therefore not incur direct costs to the user. This was emphasised by the interviewed teachers and the parents. It may also be pointed out that the use of the hybrid book does not require severe investments on the school infrastructure. As a technology it can be taken into use in a fairly short time span.

According to the socio-cultural perspective of learning, a school subject, such as English language, is a historical, cultural, and social construction (Lund 2003). This should be taken into consideration when introducing new technology related to a specific subject in schools. On the other hand, especially teachers are important in the sense that it is through their practices learners are apprenticed into exploiting technologies as part of the total learning environment. Teachers' encounters with ICT and how they integrate ICT in their work constitute a complex and multi-faceted phenomenon (Lund 2003). In the case of this research, the printed book served as a historically and culturally familiar artefact, whereas the mobile phone was a new tool in the school environment. Thus, the teacher was able to combine the familiar with the new; to combine the "easy" with the "complex". Recent discussion around ICT use in Finnish schools has pointed out the reluctance of Finnish teachers to take ICT practices into everyday use. Based on our experiences, the teachers appeared very motivated and had a positive attitude towards using the hybrid book. This may be partly explained with the "old" and "new" combination, i.e. instead of aiming at a larger technology leap, we aimed at taking small steps towards the use of new technology.

The inclusion of the teacher in the design process from the very beginning proved to be valuable: The teacher was able to interweave the use of the hybrid book into her current teaching practises, culture and curriculum; on the other hand she provided the research group with valuable information about didactics related to EFL (English as a Foreign Language), which helped the design of the mobile phone tasks. In the very early stages of the design process, the pedagogical framework much based on socio-constructivist and socio-cultural theories (including ideas of e.g. problem-based and collaborative learning) was introduced to the teacher. The idea of enhancing collaboration with technology was seen as important, but in this project it wasn't yet actualised. This is an obvious challenge and possibility for the future research.

The adoption of new technology also generates negotiations between multiple stakeholders, and in this case the parents were included as end-users and interviewees, in addition to the pupils and teachers. We saw that involving these three user-groups in the process is essential in order to create a useful concept. However, the social network involved could be seen as even broader, and include for example curriculum writers and other policy makers. In further research of the subject and introduction of the hybrid technology in schools, the whole community with its rules and division of labour should be even more extensively recognised (see Engeström 1987).

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Appendix 1: Publication in the IADIS mLearning Conference in Spain, Feb 2009

HYBRID MEDIA APPLICATION FOR LANGUAGE STUDIES IN ELEMENTARY SCHOOL

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ABSTRACT

The aim of the study was to develop a new hybrid media product for learning environments and to evaluate its suitability and potential for studying English as a foreign language in elementary school. The prototype made for the study consisted of an English book linked to a mobile phone through 2D codes. By using the code reader the user was able to carry out listening tasks and interactive grammar exercises which opened up in the mobile phone's web browser. The hybrid book concept was evaluated by ten elementary school teachers.

According to the user tests with the teachers the hybrid book would motivate pupils and allow them to study regardless of time and place. The interviewed teachers had a very positive attitude to using a mobile phone side-by-side with the text book in order to carry out tasks not possible with the text book alone (e.g. listening tasks). Most of the teachers were willing to use a hybrid book for teaching if it was available. All the interviewed teachers thought that pupils would be interested in using a hybrid book, and hence it will be interesting to observe how the pupils themselves evaluate the use of the hybrid book in the next phase of the study.

KEYWORDS

m-learning, hybrid media, language learning, mobile devices, 2D codes

1. INTRODUCTION

Hybrid media, i.e. a combination of print and electronic media, has been a popular research field in Finland for several years (Hakola & Linna 2006, Forsell et al. 2007). Especially combinations of print products and mobile phones have gained attention due to the fact that these lines of industry are very important for the national economy. Hybrid media is a way to extend the role of paper in conjunction with digital media, in order to be able to utilize effortlessly the strengths of the both types of media. One recent example of using hybrid media is a bus timetable application carried out in Helsinki (the European Regional Champions Awards 2008 shortlist on Nov 19th, 2008 http://www.theparliament.com/_regionalchampions/shortlistinfo#31). However, hybrid media is by no means only a Finnish phenomenon. Several examples of hybrid media applications using very similar technology have also been published elsewhere, also in the context of learning (see e.g. a study carried out at Western Reserve University in the USA http://blog.case.edu/case-news/2008/01/29/2dcodes and a book series offered by Bidimobile http://www.bidimobile.com/mlearning.html). Our research group has been focusing on the possibilities offered for print products by adding functionality to them. An interesting area for hybrid media is learning, and especially applications for elementary schools, where printed material still has an important role. In addition to the text books and busy books, the publisher provides a CD for the pupils containing audio files of the material in the text book. There is also a substantial amount of ready made extra material both in printed and electronic form for the teachers, but the material is underused due to lack of time. Hence, the target in this study was to test an easy and suitable way of utilizing some extra material in a hybrid book, where the text book and a mobile phone would be used in parallel with each other.

Finnish parents buy the first mobile phones for their children at pre-school age, which is notably earlier than in other European countries. Nowadays almost all first grade pupils in Finland have a mobile phone. Hence, the introduction of a hybrid media solution where mobile phones are utilized should be straightforward even on elementary school level, as the children already have excellent capabilities in using the devices, as e.g. in a study by Alamäki (2003).

2. PROTOTYPE OF A HYBRID BOOK

The target of this study was to make functioning prototype of a hybrid school book for user response tests. The design process was based on human-centered approach (ISO 13407:1999). The book chosen for the tests was an English book for children in the sixth grade. The actual users of the hybrid book would be children at the age of 11-12, and it would be their fourth year of learning English. The hybrid book was the first prototype in the project and hence, it did not have to be ready for use in actual school teaching. The book consisted of an existing schoolbook, optical codes, a mobile phone with a code reader application and five tasks that are completed with a mobile phone's web browser. A printed code in the book can be read with the camera of the mobile phone, whereby an

exercise suitable for that context, e.g. a listening task, a grammar exercise or a vocabulary repetition, is launched in the phone (Figure 1 and 2).

Figure 1. Reading a 2D code with a mobile phone.

Figure 2. Enlargement of two 2D codes in the school book.

The prototype was tested by teachers outside the classes. The aims were to evaluate the hybrid book concept and to improve the functionality of the prototype based on the user tests. By involving the teachers into the concept development, pedagogical views of the hybrid book could also be obtained. The user tests were carried out at the end of May 2008. Ten tests were conducted in eight different schools located in southern Finland. Eight of the participants were female and two male. Their age distribution was 29-58 years, and they had been teaching English in elementary school for 1-28 years. The participants carried out the exercises of the hybrid book by themselves and then they were interviewed. The extended Technology Acceptance Model, TAM (Huang et al. 2007) was utilized in forming the interviews in order to not only get feedback from the usability of the hybrid book but to also discover the participants' attitudes towards this new learning concept.

3. RESULTS OF THE USER EVALUATION

The general opinion of the teachers was that the hybrid book device was fun to use and fairly good grades were given in the evaluation (average 8.1 on a scale from 4 to 10). Many of the teachers had some difficulties with the small screen of the mobile phone and in browsing with it. However, after learning to use the mobile phone, the users thought that the hybrid book was nice and exciting. When the teachers evaluated the hybrid book from the pupils' point of view, the grades given to the device were even higher (average 9.0). All the teachers thought that pupils would be interested in using a hybrid book, and that a large proportion of the pupils would find the hybrid book fun to use. There would be "many eager experimenters in a class". On the other hand, some of them thought that using a hybrid book would be interesting "at least in the beginning".

Two major benefits were found: motivation for studying and mobility of the hybrid book. Some teachers thought the hybrid book would motivate pupils to do English exercises. An exercise on paper is very school-like, but the same exercise would be inspiring

and fun to do with a mobile phone. Computer-assisted tasks are unquestionably motivating, but a mobile phone is even closer to pupils. According to one teacher, the pupils would think "English is my thing when it comes to my mobile phone".

Teachers thought that a hybrid book enables self-study in a meaningful way. Pupils could, for example, complete some English tasks on their way to school, e.g. listen to a chapter on a bus. Even at home they would not have to sit at a computer for utilizing digital media in language learning. The use of a hybrid book would encourage pupils to study at their own initiative, because the mobile phone is available all the time. Instant feedback and correct answers to exercises were also thought to be a good feature.

Listening and grammar exercises were found to be the most suitable tasks for a hybrid book. Listening is very important in language learning right from the start. With the prototype, pupils could listen and do listening exercises effortlessly and much more often than before. With a mobile phone and a headset, listening would be easy at one's own pace and everywhere. One teacher remarked:

> --- I think this is working well, you can listen to a chapter… especially at our school, where there are pupils who travel and are away from school sometimes as long as a couple of weeks and we can't give them tapes and CD-ROMs to take with them ---

Multiple-choice exercises were seen as highly suitable for mobile phones and are regarded as useful for practicing grammar. Exercises must be simple so that the user knows intuitively what to do and needs no instructions. Grammar exercises must also be unambiguous, because there may be many ways to translate or interpret a sentence. The hybrid book would be good for a quick recap of grammar or vocabulary. On the other hand, writing exercises were not considered suitable for a mobile phone.

Besides the listening and grammar exercises contained in the hybrid book, teachers proposed many new types of exercises. One was an exercise in which a pupil hears a word and has to connect it to a correctly spelled word. In addition, the multimedia features of mobile phones could be exploited by including videos in exercises. A video could present e.g. authentic conversation and take vocabulary closer to real world situations, or the pupils could even make their own short movies.

A hybrid book could also support differentiated teaching. There could be exercises on many levels of difficulty, some easier and some more difficult suiting different learners. As one teacher said:

> --- teacher is doing it [teaching] along the golden mean, hoping to give enough to the fastest, but on the other hand trying to see whether the slowest can keep up. In which case this device could bring… if a pupil feels that he or she can do these [exercises] by him/herself, the pupil could select his or her own level ---

The comments obtained from the interviews were very well in line with the distinctive features of m-learning defined in the MOBIlearn project (Sharples et al. 2005). The mobility of the learner was emphasized as well as learning being interwoven with other activities in the everyday life. In addition, also in this study the issue of mobile learning both complementing and conflicting with formal education was raised. The biggest challenge in using a hybrid book was the use of mobile phones in a school environment. Pupils have mobile phones, but they are not allowed to use them at school. Hence, if a hybrid book was taken into actual classroom use, this would most probably require some discussions on acceptable use of mobile phones during school hours. Some teachers were worried about how pupils would keep their mobile phones safe. Mobile phones are

small and frequently get lost. When a pupil's mobile phone becomes a learning device, responsibility passes to the school, e.g. in the event that it breaks down or gets stolen. It was also pointed out that the use of mobile phones at school could increase inequality. Not all pupils have mobile phones with all the features that are required for using a hybrid book.

An overall opinion was that the hybrid book was interesting. New learning environments were mentioned as a current topic for discussion in schools. Teachers thought the types of exercises in the user tests would be familiar to pupils as they have used similar computer programs in language learning. The teachers emphasized that introducing the hybrid device at school should be made simple. It would be very important to produce instructions on how to download material to a mobile phone and how to make the code reader work. However, as a device, a mobile phone is closer to people's everyday life than a computer. It was also considered to be easier for a teacher to give a pupil homework that requires a mobile phone than a computer.

4. CONCLUSIONS

Two major benefits of hybrid books were revealed in the study. The mobility of the hybrid book allows pupils to study anywhere and anytime, and the hybrid book would motivate pupils to study because it is interesting to use. Pupils would be able to carry out English tasks on the move, e.g. listen to a chapter from the book on a bus. The hybrid book enables self-study in a meaningful way. It can offer new kinds of tasks and instant feedback from exercises. The hybrid book could also support effortless differentiated teaching; supplementary material can be integrated in the book as links instead of a teacher collecting it case-specifically.

Currently books have an essential role in elementary school teaching. However, digital material extends opportunities for e.g. taking into account the needs of an individual pupil. Hybrid book offers a way to bring these advantages as a natural part of everyday studies.

For further development the hybrid book should be made easier and faster to use. Exercises should be more varied and longer, and have more interactivity. These comments will be taken into account in the next phase of the project.

5. FURTHER RESEARCH

Two new issues have been considered after completing the study described above; game-like approach in the exercises to be carried out and other technologies than the 2D codes as the access technology. New exercises have been designed in co-operation with game researchers from the Hypermedia laboratory in the University of Tampere. The main focus has been in solutions aiming at communication between the pupils, i.e. group exercises in some form, and in tasks that would on the one hand help the slower students to keep up with the class and on the other hand motivate also the faster pupils. The designed exercises have been presented as comic strips to teachers and pupils, and their comments will be taken into account in the next version of the hybrid book. Several new technologies have also been evaluated and some of them will be taken into closer examination in the beginning of 2009. Our aim is to have the next version of the hybrid book available in April 2009, and to have the following user tests completed before the summer.

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Appendix 2: Publication in the CGAMES Conference in the USA, Aug 2009

CREATING A DESIGN FRAMEWORK FOR EDUCATIONAL LANGUAGE GAMES UTILIZING HYBRID MEDIA

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KEYWORDS

Video Games, Educational Games, Language Learning, Hybrid Media, Game Design, Design Framework.

ABSTRACT

Recent years have seen growing interest in educational games. At the same time, there has been interest in the research of hybrid media. Hybrid media is a combination of print and electronic media. In this paper, we present a study on the design of educational language games for a hybrid media platform. Based on scenario interviews and supportive research, we present a design framework which can be used to aid in the design of educational language games. For our study, we interviewed six elementary school teachers and 16 6th grade students. We also interviewed four study book authors and examined currently used educational language games.

INTRODUCTION

Recent years have seen growing interest in the use of video games in education.. The importance and capabilities of educational video games have been noted by many authors. Games are considered to be efficient tools for learning, as they are able to motivate the learner (e.g. Prensky 2001, Gee 2003, Kiili 2005, Bogost 2007, Annetta 2008). Aguilera and Méndiz reviewed the research on the subject from the 1970s to 2003 and concluded that "[F]or learning, video games are of unquestionable importance, and can be used… at different academic levels." (Aguilera and Méndiz 2003).

Hybrid media, i.e. the combination of print and electronic media, has been a popular research field in Finland and around the world. Especially in Finland, the combination of print products and mobile technologies has gained great interest, as these two industries are important for the national economy (Seisto et al. 2009).

The combination of educational games and hybrid media has not been studied rigorously before. Game-based learning and new technological solutions could open up new possibilities in education. Educational games combined with hybrid media solutions is an interesting research area as educational games are gaining more interest and print media still has an important role in schools. An earlier study has shown that teachers are interested in using hybrid media in education (Seisto et al. 2009). Educational games in a hybrid media format could be more successful than traditional educational games which are often considered to be extra material, i.e. something that does not belong to the core of education. As the study book is often the core of learning materials, merging educational games into that platform through hybrid media solutions might ease the use of games in education.

Learning by Hybrid Media (*LehMa*) is a research project where the aim is to develop educational games for a hybrid media platform. The research focus is on English education for 6th grade elementary school students (11 to 12 year-olds). This paper presents the design framework for educational language games which was created in the early phase of the project in the end of 2008. In this paper, we focus on describing the design framework and its creation process.

The design framework was created based on scenario research and supportive research. The scenario research consisted of interviews with six elementary school teachers and 16 pupils. The supportive research was based on a literature review, an interview of the authors of an English study book currently used in many elementary schools in Finland and an informal examination on the current educational English learning games available from a Finnish online education service.

HYBRID MEDIA

There are many concepts and words to describe the combination of two or more media (multichannel, multiplatform, cross-media, integrated media, etc.). Most of these definitions exclude print media, however. The concept of hybrid media is used to describe the combination of fiber-based and other (electronic) media. But it is not an unambiguous definition either. Different levels of convergence between print and digital are included under the single term of hybrid media. Thus, there are different levels of hybrid media (Figure 1 on the next page). A common aspect of these different levels is, however, that hybrid media means an application that combines print media and electronic media in a way that the service is complete and adds value to the end user only when both media are used.

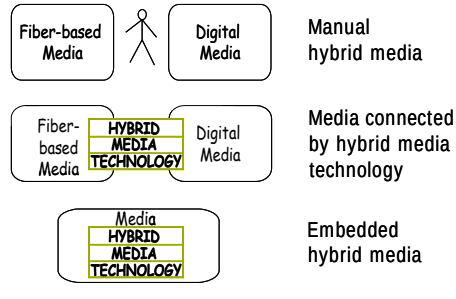

Figure 1. Different levels of the hybrid media concept (Oittinen 2006).

RELATED WORK

Educational games have been studied extensively and their potential to assist learning has been widely recognized. Yet, designing an effective educational game remains difficult. The main reason why there are not that many good educational games available is the gap between educators and game designers. Educators usually know how to teach efficiently but they do not understand game design and vice versa. There are clearly two sides to the design of educational games and this has to be taken into consideration in order to improve the quality of educational games (Fortugno and Zimmerman 2005).

Reeves (1994) has presented 14 pedagocical dimensions that can be used as criteria for understanding, describing and evaluating computer-based education. The dimensions include high level issues like *epistemology* (*objectivism vs. constructivism)* and *underlying psychology (behavioural vs. cognitive)*, for example. Reeves' dimensions do not cover games especially, but they can be applied to educational game design.

Some of the first design heuristics for games were presented by Malone in 1980. According to Malone, the three essential design principles for good games are *challenge*, *fantasy*, and *curiosity*, and each of them contains several sub-components (Malone 1980). After Malone's design heuristics, many other models for both evaluation and design of leisure games (e.g. Federoff 2002, Desurvire et al. 2005, Korhonen and Koivisto 2006) and educational games (e.g. Quinn 1996, Albion 1999, Squires and Preece 1999, Kämäräinen 2003, Kiili 2005) have been presented. Evaluation guidelines are mentioned here because they can also be used to aid design as stated by Quinn (1996).

Prensky has studied digital game-based learning and identifies several factors that make games engaging and contribute to good game design (Prensky 2001). Gee has done similar work and presents learning principles that good games incorporate. He presents 16 principles which are characteristic of good video games and these should also be found in educational games (Gee 2005). Both Prensky's and Gee's listings aid in educational game design, but they are a bit vague when it comes down to practical game design.

Henriksen presents eight dimensions of educational games, which can be used in the development process (Henriksen 2006). These dimensions have been created to bring education and games closer to each other. Henriksen's dimensions do not present exact instructions on how to design a learning game but offer assistance and directions on what to focus on during the design process.

Thomas has designed guidelines for designing pervasive learning games, which means educational games that are on around the clock and have context-sensitive features (Thomas 2007). She has identified four categories which include a total of thirteen principles that should be followed when designing pervasive learning games. The categories are: *community*, *autonomy*, *locationality*, and *relationality*. These principles are intented specifically for pervasive games but most of them can also be used in other types of educational games. These thirteen principles are already quite precise and offer good assistance for the design of an educational pervasive game. However, these guidelines are too specific to be used fully in other educational contexts.

Although there are various frameworks, heuristics and guidelines available, we decided to create a new design framework

for several reasons. Firstly, none of the earlier guidelines focus especially on language learning games. Secondly, the practicality of the earlier guidelines is questionable when considering the actual design process and concrete solutions to design questions. Thirdly, hybrid media, as we have described it, has not been present in any form in the creation of these earlier models. Therefore, we decided to build our own design framework which would be based on a user-centred design ideology.

RESEARCH METHODS

The basis of our research was user-centred design as we had no prior experience in creating a design framework for educational language games. Rather than relying solely on literature and on our own preferences, we recruited the intended end-users (i.e. teachers and pupils) as informants for our study.

User-centred design and scenario research were succesfully used in an earlier research project in the *Games Research Lab* (Ermi and Mäyrä 2005). Like *LehMa*, the earlier project featured the use of new technology and game concepts. This encouraged us to follow a similar path and to select scenario research as our main research method. We also conducted supportive research in the form of a literature review, an interview of the authors of an English study book and an informal examination of educational language games for learning English. The goal was to acquire essential information on factors that would be beneficial when designing language learning games. In addition, attitudes toward hybrid media were also probed.

Scenario Research

According to Ermi and Mäyrä (2005) scenarios are a prevalent way to bridge the gap between users and designers.

"They are short fictional narratives that describe a use situation and the interaction between users and proposed systems, and can be used to discuss and picture different kinds of future-use situations of technology" (Ermi and Mäyrä 2005).

Like Ermi and Mäyrä, we found it important that the concrete nature of scenarios helps to create a common understanding of the proposed technology and its capabilities. It would be easier to discuss educational games and hybrid media with the interviewees through scenarios. The goal of the scenario research was to gain ideas and inspiration in consideration to the design framework for educational language games.

We had both adults and children as our informants, so we also decided to use comic-strip scenarios, which are illustrative and easy to comprehend, as is stated by Ermi and Mäyrä (2005). Although the scenarios portraided finished game concepts and complete hybrid media solutions, their purpose was to act as starting points for the interview discussions. The discussions were considered to be the most important data in the study as they were used as the basis for creating the design framework.

Designing Scenarios

The comic-strip scenarios were created within the research team in collaborative brainstorming sessions. There were ten preliminary scenarios, but eventually they were cut down to six. During the supportive research, early versions of the scenarios were shown to the authors of the book,

whose comments were used to finalize the scenarios. The scenarios featured different kinds of use situations both in school and at home, which featured educational games, language learning and hybrid media in different forms. All scenarios did not combine each of these three elements and some of the scenarios were more provocative than others.

During our research, there were no technological specifications available for the hybrid media platform which would be used later in the project. Therefore, we were unable to attach any specific technological solution to the scenarios or to the design framework. However, for the scenarios, we defined three different fidelity levels which represented the different features in the technology solutions. The fidelity levels were called low, medium and high accordingly.

The low fidelity level is based on using two-dimensional codes in the pages of a printed study book. These two-dimensional codes can be read with a mobile phone, which has a camera and identification software. The user would focus the mobile phone's camera on the two-dimensional code which would then start an educational application which runs in the mobile phone (e.g. Louho et al. 2006). The earlier study which probed teachers' attitudes towards hybrid media was based on this fidelity level (Seisto et al. 2009).

The medium fidelity level is based on a printed study book which contains electronics. The electronics would be different kinds of radio transmitters, using Bluetooth technology, for example. Instead of two-dimensional codes in the study book, the pages would feature a touch-access button which would activate the radio transmitter. The radio signal would then start an educational application on a mobile device or laptop computer.

The high fidelity level represents a blue sky solution where the study book would be a standalone platform with a thin bendable full-color display and touch sensitive interface used either by hand or a stylus pen. This bendable display would also contain multimedia capabilities with audio input and output. The high fidelity level is a vision of a futuristic study book which could be available in the years to come. Although this fidelity level is unreachable within the scope of the *LehMa* project, it was illustrated in the scenarios to inspire discussion and widen the design space.

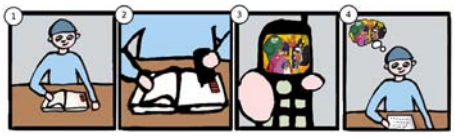

Figure 2. An example scenario featuring a low fidelity hybrid media solution.

It is not possible to go through all the designed scenarios within the scope of this paper, but to give an idea about the scenarios, one example is shown above in Figure 2. In this scenario, the pupil scans the two-dimensional code found on the study book's page. As a result, a video is shown which illustrates an important grammar issue in the English language. The last frame shows that the pupil is doing good in the following day's exam as he remembers the exciting learning situation with hybrid media. In our scenario illustrations, there were descriptive text beneath each frame explaining the scenario in a narrative form.

User Study

The user study consisted of scenario interviews, where each scenario was shown to the interviewees and discussed accordingly. We interviewed six elementary school teachers (three male, three female) and 16 elementary school pupils (eight boys,

eight girls). The pupils were in the 6th grade (11-12 year-olds) and they all studied English as their second language.

The teachers were interviewed one-on-one, but the pupils were interviewed in pairs by one interviewer. It has been noted in other studies that interviewing young children in pairs makes them more relaxed and open for discussion (Höysniemi et al. 2004).

During the interviews, each scenario was shown to the interviewees one by one. After examining the scenario, the interviewee filled up a short feedback form and the interviewer continued with specific questions related to the scenario at hand. This was repeated until all six scenarios had been shown. The interviewees ranked the scenarios from the best to the worst and after the scenarios, the interviewer asked general questions related to games, education and hybrid media. The interviews lasted from 35 to 50 minutes and they were recorded for further analysis.

Supportive Research

The supportive research consisted of three different smaller studies. The first was a literature review on educational game design, which was discussed in the related work section earlier in this paper. The second was an interview of the authors of a current English study book used in many elementary schools in Finland. The third was an informal examination of current educational games used for teaching English in Finnish elementary schools.

Authors' Interview

The research team interviewed the four authors of a current English study book which is commonly, but not exclusively, used in Finnish elementary schools. The purpose of the interview was to discuss the early versions of the scenarios and the use of educational games in learning English in general.

Game Examinations

An informal examination of educational English learning games was performed to gain an understanding of the current situation. Due to the short timeframe in the early phase of the project, it was not possible to do a complete formal analysis based on several different sources. The research team selected one major Finnish online service which provides learning materials and educational games for many subjects including math, biology, physics, foreign languages, etc. This particular service was selected because it is well known and used by the school from which teachers and pupils were interviewed in the scenario research. The researchers, who have expertise in game design and evaluation, focused on several games which were related to studying English and played them until they had a clear understanding of them.

THE RESULTS

In this section we present the key findings of the scenario research and the supportive research.

Scenario Research Results

From the 84 instances where a scenario was presented, there were only six cases in which the interviewer had to clarify the scenario for the interviewees. In addition, only in three cases the interviewees asked a question related to the scenario shown. This implies that the scenarios were well understood. The comic-strip format proved to be useful and both the teachers and the pupils were able to give feedback based on the scenarios.

All interviewees had positive attitudes towards using video games in education.

Regardless of gender, hybrid media was seen as an interesting platform, especially among the pupils. The teachers and the girls stated that new technology and video games especially intrique boys. The teachers and the girls voiced similar gender-based statements throughout the interviews. Many times it was considered that the boys would be the most excited, or that they would benefit most from the implementation of new technology and video games into education.

Some teachers and girls stated that a new technology should actually be useful in a new way, meaning that the technology would actually bring added value to the learning process. Some teachers thought that the presence of technology might spring up disruptive behaviour. For example, pupils have a tendency to start playing around with their mobile phones in a classroom (hence the use of mobile phones during class is widely prohibited in Finnish schools). This possibility of disruption might be an even worse problem in a homework situation. In addition, mobile phones present a challenge due to the various different models available. This might result in unequal learning opportunities.

Currently, the school that we studied allows the use of mobile phones in some classes. In math, for example, mobile phones are used as calculators. Sometimes the pupils use their mobile phone cameras to photograph their homework from the chalkboard. Although a new technology has a novelty value, some pupils noted that educational games should also have depth, because the novelty value will run out soon. Teachers also considered that innovative technology has a positive effect on motivation to learn, but it might not last for long unless the actual content is interesting.

Current educational games were considered to be boring by both teachers and pupils. They were considered to be too simple and repetitive. One teacher expressed that the gap between commercial leisure games and educational games is too big. Some of the students also mentioned this but added that playing inferior educational games in school is always better than no gaming at all. Both the teachers and the students stated that usually online service is used once a week for the duration of one class, i.e. 45 minutes. Some teachers and students felt that this time was too short. When discussing the length of one play session, 15 minutes was considered appropriate. This means that after 15 minutes, the game is changed so that interest lasts.

Everyone wanted more complex games. Especially open-ended virtual worlds or world-building games were considered to be good in education. Games which have persistent worlds and continuity were favored over simple games that one must start from the beginning in every class. Commitment and long-term character development was praised as well. Interestingly, it was considered that virtual worlds and characters could be used to teach some of the more difficult topics, like ethics and morality, in practice.

One statement from an English teacher was that educational games for English should try to foster the three-layer model in language learning: identify, apply and produce. She added that educational games should make the pupil think and not simply perform tasks mechanically. However, mini-games, i.e. short games which are quick to start and finish, were seen to be useful especially in a group work situation where one group is finished and waiting for the others to finish. In this situation, educational mini-games would be a good way to pass time and keep the

pupils occupied, which would then also maintain order in the class. Of the classic study book tasks, the students stated that vocabulary tasks such as crossword puzzles were the most enjoyable to do.

Some teachers were of the opinion that educational games could be used as a substitute for formal exams when applicable. The teachers, and some of the pupils, thought that one of the benefits of educational games would be their ability to give instant feedback and automate error checking which is usually a very laborious task for the teachers. Automatic differentiation, or adaptive difficulty, was seen as an important feature in educational games by the interviewees. Another important feature would be the possibility to monitor, evaluate and report the performance of a pupil. One teacher stated that educational games in general should be simple enough so that the older generation of teachers could understand them.

Collaboration and group work was emphasized by the teachers and the pupils alike. Sometimes it was considered to be a bit laborious, especially for the teachers. Both the teachers and the pupils promoted peer support and one of the boy pairs stated that you learn by helping others. Generally, social interaction in class work was valued highly by everyone. The girls were as excited about group work as the boys, but many girls stated that boys tend to disrupt the group work process in class. Some focus-oriented tasks, like listening comprehension excercises, were stated to foster order in class. Some teachers noted that listening comprehension excercises, which are held in a normal classroom instead of a spesifically designed audio classroom, might be awkward to organize if every pupil needs to have their own gear for it.

Extrinsic motivational factors were considered to be exciting. Especially if it would be possible to mix educational gaming at school and leisure gaming at home. In this example, playing an educational game at school would also benefit leisure gaming at home. One girl pair stated that if you could get reward points for playing at school and be able to spend those points at home on your favorite game, it would be a good method of showing to your parents that you are doing well in school. One teacher was of the opinion that this might be too much gaming, however. The pupils thought that even boring subjects would be a lot more fun if there were special rewards present. However, these rewards should be possible for everyone to achieve, so that that the class would not split into elite pupils and less fortunate ones. One female teacher noted that there are clear motivational differences between boys and girls, and the rewards should be considered accordingly. One boy pair stated that focusing too much on the reward might actually be counter-productive, as you would not necessarely learn anything. One of the teachers stated that her class collects “smiley faces” which are achieved by doing one’s homework. A certain number of “smiley faces” results in a reward and the pupils seem to be very motivated by this practice.

Supportive Research Results

In this section, we present the key findings of the authors’ interview and of the informal examination of current educational games for learning English.

Authors’ Interview Results

The study book authors highlighted three issues concerning educational language games. The first issue was related to the environmental context of educational English learning games. During classes,

the emphasis should be on social interaction and on the verbal use of the language. This naturally also emphasizes hearing comprehension tasks. Homework, on the other hand, is focused more on reading and writing. The second issue was differentiation, which was seen to be very important and the authors told us that traditionally there has not been enough differentiation for advanced students. This could also be seen in practice as the authors' study book features extra materials for the slower learners but not for the faster ones. The third issue brought up by the authors was related to the design of educational games. They should be simple enough so that the older generation of teachers are able to understand how they are played and what they try to achieve from the perspective of learning.

We showed the early versions of the comic-strip scenarios to the authors and they considered them to be understandable and effective for creating feedback and discussion.

Game Examinations Results

Examining educational English learning games brought up several issues which should be taken into consideration when designing educational language learning games.

The games examined resembled classical titles such as *Pac-Man* (maze), *Super Mario* (platformer), *Mah-Jong* (puzzle) and *Tic-Tac-Toe* (parlour). The most basic issue was that gameplay and learning were not intervowen in any way. For example, in a Pac-Man style maze game the player guides his character through the maze collecting valuables and evading ghosts. When the player picks up a certain item, a dialog with a translation exercise pops up, where the player is asked to click on the correct word out of three possibilities. Regardless of the outcome, the player continues the maze game after choosing the word. In this case, gameplay and learning are separated and they do not seem to support each other in any way. The player does not really learn anything while guiding the character in the maze and the pop-up dialogs interrupt the flow of gameplay.

The online service keeps a record of when and how many times a player has played the games. Otherwise there was no support for continuity or persistant gameplay. If a player comes back for a game, she has to start all over again. In addition to the repetitive nature of the games, many of the games featured the same game mechanics and the only difference was the visual outlook. Some of the games were really short and it took more time to get the games started than to actually play them. There was no differentiation used in the games in the form of adaptive difficulty levels. Lastly, the games suffered from basic usability and playability problems. For example, sometimes the games ended up in a stalemate, and the only option for the player was to reset the game and start all over again.

DESIGN FRAMEWORK

The findings of the scenario research and of the supportive research were transformed into a design framework containing ten items (Table 1). The findings were used as inspiration for creating the framework and they were not considered to be be-all-end-all laws of design. Naturally, the research team's expertise in game design and evaluation is present in the framework and it was created to cater for the needs of the research project. However, it was also our goal to produce a practical and illustrative design framework which could be used by others, as well. Notice that the framework is not tied

to any technological solution. This was because at the time of the study, there was no certainty about the hybrid media solution which would be used later in the project. Due to this we wanted to keep the design framework free from any technological constraits. The design framework table consists of a running item number, item title, a short description of the item and a practical example of how the item could be used in game design.

DISCUSSION

In this paper, we have presented a design framework which can be applied to the development of educational language games. The role of hybrid media could be seen as irrelevant in this paper, especially as none of the framework items are directly related to hybrid media. However, as the ultimate goal is to create viable educational games for a hybrid media platform, it would have been unwise to exclude the technology from the scenarios. We did not know how the absence of hybrid media would have affected the interviews nor did we have specifications for the final technology solution. Therefore, it was a safe bet to implement different fidelity hybrid media in the scenario illustrations, although the framework itself does not contain items related to hybrid media.

Our findings are very general and vague when it comes to hybrid media. All teachers and pupils seemed to like the idea of using hybrid media in learning. The ease of use, ability to network both at school and at home, the technological equality of pupils etc. were all expected and axiomatic findings. When the actual hybrid media platform is ready and available, only then is it possible to evaluate it and create design guidelines aimed at that specific platform.

The scenario research method proved to be useful but laborious. This was also noted by Ermi and Mäyrä in their earlier study with scenarios and user-centred game design (Ermi and Mäyrä 2005). The supportive research definitely had its place, as we were able to triangulate, i.e. approach the design framework from multiple viewpoints.

Based on our experiences with current educational language games, we strongly suggest that designers take advantage of the current game design and evaluation guidelines presented in the related work section. If there are basic usability and playability problems in any type of games, the user will certainly get frustrated and quit playing. In addition, pedagogical design factors must also be taken into consideration, applying the guidelines which are currently used when designing learning materials. Numerous learning theories (e.g. Quinn 1996) and regional cultural factors have their own effect in the design outcome.

It became apparent that neither the teachers nor the pupils are satisfied with the current educational games. Closing the quality gap between commercial leisure games and educational games might not be possible due to resource limitations. Therefore, we suggest that educational game design should focus on transforming traditional study book exercises into playful, game-like applications. Both short- and long-term intrinsic and extrinsic motivational factors are powerful, and through them the gap between playing an educational mini-game for exam points, for example, or doing a repetitive tasks in *World of Warcraft* to gain levels might not be as wide as expected. However, as Fortugno and Zimmerman state, both educators and developers must co-operate to increase the quality of educational games (Fortugno and Zimmerman 2005).

Virtual worlds and world-building games surely have their place, especially when smaller games are attached to them through reward mechanics. Although some authors, at least implicitly, consider drill and practice games old-fashioned (Squire 2003), they have their place in language learning (Rothschild 2008). We believe that there should be both smaller and larger games, and also explorable open-ended worlds where learning is not as explicit as in other types of games. This kind of multi-layer game system, which would be connected to the study book curriculum, could be captivating and motivating for the pupils to play both at school and at home.

The teachers thought that issues such as morals and ethics, which are difficult to teach according to the teachers, could be visualized in practice in virtual worlds, where the player sees the consequences of her actions. The downside of these game worlds is that they require a lot of time for pupils to comprehend. For example, it took 6-7 hours of game play for middle school students to understand the basic concepts of the *Civilization III* strategy game (Squire 2005). If the pupils are motivated to play educational games also at home, the burden to play at school would definitely decrease.

Combining educational games and hybrid media seems to be an interesting research field with lots of possibilities. Hybrid media, especially in wireless networked blue sky form, is related to *ubiquitous computing* (e.g. Sakamura and Koshizuka 2005) which has gained a lot of research interest. Hybrid media in its different forms requires more research to open up new educational possibilities.

Table 1. The design framework for educational language games.

#	Title	Description	Example
#1	Context adaptation	The games should support different use contexts: class and home.	The game supports verbal social interaction in class environment, while at home the emphasis is on solitary tasks such as listening, reading and writing.
#2	Multi-layer game system	The game should be seen as a large system containing different modes for play.	The games are tied in with the study book curriculum. Campaign games are featured in each chapter of the study book throughout the semester. Mini-games represent tasks that can be played through quickly at any time. There is also a persistent background virtual world, which the player can manage.
#3	Mechanics and learning	Game mechanics and learning should be intervowen.	The games require the skills that are needed when using a foreign language. Identifying contexts, social interaction, verbal communication, reading and writing skills. Playing and learning are not separated.

#4	Automatic differentiation	Differentiation (adaptive difficulty) should be automatic and it should be possible to adjust the difficulty in both directions.	Advanced learners who perform well receive harder tasks, whereas slower learners receive easier tasks. The goal is to find the optimum level of difficulty for each pupil, so that the challenge is in balance and learning is efficient.
#5	Multi-layer rewards	There should be instant, short-term and long-term rewards. The purpose of these rewards is intrinsic and extrinsic motivation.	The learners receive different kinds of points from the games. For example, mini-games produce an instant score which can be used to customize the player's character. Campaign games produce points which can be used to build the virtual world. The last task of a campaign game, i.e. the last exercise of a chapter, features a more difficult task and succeeding will result in a special reward.
#6	Customizable character	There should be a virtual character which is customizable.	The character is always present and visible when any of the games is played. The character can be customized by using scores received from mini-games. The character is able to assist the player and perform simple interaction.
#7	Tried and true concepts	The games should be based on exercises that have been found to be useful and motivating.	Mini-games feature exercises such as crossword puzzles and other vocabulary tasks. Campaign games feature more demanding tasks like listening comprehension excercises, grammar puzzles, group work in a class room context, etc.
#8	Identify, apply, produce	The complexity of tasks should increase gradually.	Different campaign games in chapters contain various tasks which are related to the identify, apply and produce process. First, a new concept is introduced to the learner (identify), then she is made to use that concept in a controlled context (apply) and, lastly, she is expected to understand the concept and use it freely (produce).
#9	Group work	Group work should be supported when applicable.	In a class environment, the games should support working in pairs or in larger groups. Games could produce partial information for each member, who would then have to work together to finish the task.
#10	Performance measurement	The teacher should be able to monitor, evaluate, compare and report a pupil's performance.	Performance in games is logged into a server, which makes it possible to analyse the data and pinpoint problem areas that need extra attention.

FUTURE WORK

The *LehMa* project is a part of a larger research effort in the area of learning combined with hybrid media. Language studies, especially in elementary schools, is the field which we believe to benefit most from utilizing both printed and digital media side-by-side. The role of the book is strong, even indisputable in the time frame of a couple of decades. However, more convenient ways of merging the essential digital content (e.g. listening tasks) into everyday studies are needed.

Today, study book publishers provide CD's, internet sites and complementary digital material for teachers as supplementary material, but in practice, they are under-utilized due to the extra effort and time required for their use, both at school and at home. That said, if new hybrid products are not brought to the market in the near future, the most convenient solution might be a mini laptop or an e-book, even though some unique advantages of paper would then be lost. In order to gain a more extensive understanding of the feasible alternatives in the development of learning materials, another project has been running side-by-side with the one presented here. In that project, experts who represent teaching, e-book technology, publishing and e-learning in Finland, UK and the Netherlands have been interviewed.

For the next phase of this project, hybrid school book prototypes have been prepared for user tests with elementary school pupils, their parents and their teachers. The prototypes were prepared in the beginning of 2009, and the user tests will be carried out during the summer of 2009. Based on these user tests, a final version of the hybrid study book will be designed and taken into actual class room use and evaluation in the autumn of 2009.

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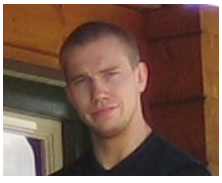
BIOGRAPHY



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Appendix 3: Publication in the MindTrek conference in Finland, Oct 2009

Playful Learning with Hybrid School Books

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ABSTRACT

This paper presents the preliminary results of a hybrid school book study. Books were designed and tested to make learning more playful, and to enlarge the role of printed book in school work.

1. INTRODUCTION

Myriad of new digital media technologies, such as interactive whiteboards, laptops, or collaborative e-learning tools are diffusing to class rooms and affecting the ways teachers and pupils are communicating with each other [1]. However, the role of book in the school environment is still strong. Books have ubiquitous-like features such as very easy usability and it seems unlikely that printed books will disappear from schools in the time frame of a couple of decades.

Introducing new technologies to such a complex context as a class room can be a mixed blessing. On one hand it might enhance the learning experience but on the other hand it might make it confusing and stressful for both pupils and teachers. Only the real life experience eventually shows the usefulness of new technologies. We see it important to study how old and new learning technologies could be converged in useful and motivating ways for pupils and teachers as well as parents. Our approach was to combine print and digital media into a hybrid school book in a way that learning could be more playful.

The preliminary results presented here are part of a larger project, 'Learning by Hybrid Media'. This paper presents the design and implementation phase of the user experience study where five hybrid concepts were tested on real users.

2. 3 TECHNOLOGIES, 5 CONCEPTS

Three hybrid media related technologies, digital pen, wireless smart paper, and smart phone were used for designing exercise concepts for learning English in elementary school (age 11–12). We came up with 13 exercise concepts, out of which we chose five most promising ones for further user experience testing. The decisions were made in collaboration with two professional elementary school learning material designers. Collaboration, differentiation and mobility were emphasizes in the decision.

The chosen concepts were: a collaborative quiz on wireless smart paper, a collaborative cartoon caption competition using a digital pen and real time power point streaming [2], a mobile crossword puzzle, adaptable grammar exercise and a listening task which could all be fetched to a smart phone via a camera phone readable 2D code from the school book.

3. USER TESTS

After choosing the concepts a user experience study was designed and implemented. The objective was to ensure appropriate usability and to get some overall reactions on the concepts from 5 teachers, 10 pupils, and 4 parents. The testing was done by asking them to complete given concept exercises. Tests were carried individually with the adults and pair wise with the pupils using talk aloud method. After each exercise the user was interviewed on the overall reaction, learnability and system capabilities of the given concept.

4. MAIN FINDINGS

1. Among teachers and parents the mobile phone tasks were chosen as the most potential tasks for learning purposes.

2. The kids liked the mobile phone tasks as well, but sometimes the novelty and oddity of other technologies (digital pen and smart paper) made them more popular

3. The kids have different learning styles, preferences and needs; the teachers want to have variety of solutions for adjusting their teaching to these differences. The concepts presented in this study were seen as potential for supporting this.

4. Hybrid school book was seen as a promising approach among teachers. Teachers' motivation is essential when introducing new technology in schools.

In the next phase of the study we will utilize these results to further optimize the concepts and carry out long term user tests in real school environment.

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MindTrek 2009, September 30th-October 2nd 2009, Tampere, FINLAND.

Appendix 4: Publication in the IADIS mLearning conference in Portugal, Mar 2010

INVOLVING THE END USERS IN THE DEVELOPMENT OF LANGUAGE LEARNING MATERIAL

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ABSTRACT

This study aimed at a user centric design of a hybrid book concept for elementary schools. The user groups of interest were 6th grade pupils and their teachers, and the concept was tested for language learning materials. It is quite common that the printed and digital learning materials for elementary school children are developed separately. In our approach, the printed and digital materials were combined into one entity by enabling the access to the digital material through images in the book. We paid special attention into mobility and easy usability of the hybrid book. The concept was tested by pupils, teachers and parents of the children, after which a final application was made and given to one class for actual use and evaluation for a period of three weeks.

The feedback from the users was very positive. As the end users, the children and the teachers, had been involved in the design process and the tasks were selected and modified based on their preferences, the tasks received excellent comments. The teachers and the parents saw many potential benefits of utilizing mobile phones for learning purposes. In addition, the teachers saw the concept of a hybrid book as a promising and motivating approach. The children have different learning styles, preferences and needs for which

the teachers want to have a variety of solutions in order to adjust their teaching to these differences. The concept of a hybrid book enables differentiation in a convenient way. The children were also excited of using mobile phones for school work. They were able to give very mature comments on the advantages of the hybrid book and were interested in taking part into the research. As the children are so well accustomed to use mobile phones in general, their basic attitude was positive and they found the use of the application easy. The children were active users of the application also outside the school hours. On the other hand, it is possible that the novelty of the application made them more interested in the school tasks during the test period.

KEYWORDS

m-learning, hybrid book, language learning, mobile devices, user experience.

1. INTRODUCTION

New digital media applications are taken into use in educational contexts and are being developed continuously. Interesting language learning projects have been reported, e.g. an application for using mobile phones for improving pronunciation (Ally and Tin 2009). So far books or other print material are rarely taken into consideration in the digital applications. However, the role of book in the school environment is still strong, even indisputable in the time frame of a couple of decades. More convenient ways of merging the essential digital content (e.g. listening tasks) into everyday studies are needed (Seisto et al. 2009).

During the course of this study we have become aware of the fact that printed learning material and digital material for elementary school children are often developed separately. Use of digital material is seldom regular, as it can not be assumed that every child would have access to a computer at home, and the number of computers at schools is also limited. Hence, there is a clear need for a combined development of printed and digital material, as well as an easy way to access the digital material. The field in which we believe there will be most obvious benefits of utilizing both printed and digital media side-by-side is language studies. Some additional features are needed in order to have a printed school book with which one may communicate and which would adapt to the proper knowledge level. This has been the starting point for our project.

In this project, we aimed at game like solutions for elementary school English education, in which a traditional printed school book would be combined with a mobile phone. The resulting book is called a hybrid book in the following. The study was based on user-centered approach where the elementary school pupils and teachers as well as parents of the children were used as informants. During the project, the research team created several scenarios in the form of comic strips, which were used as interview stimuli for 6th grade pupils and their teachers. The scenarios portrayed different situations at school and at home where hybrid school book, learning and games were combined. Demonstration versions of some of these scenarios were presented to the pupils, teachers and parents, and finally the hybrid school book was tested in real life environment for a period of three weeks. Our aim was to find out how the hybrid book would function in everyday use, where it would be used and what kinds of benefits the use of the hybrid book could bring in comparison with the traditional printed school books.

2. METHODOLOGY

The basis of our research was user-centered design. Rather than relying solely on literature and on our own preferences, we recruited the intended end-users (i.e. teachers and pupils) as informants for our study. Also the opinions of the parents of the pupils were taken into account from the viewpoint of acceptance towards combining mobile phones with printed school material.

One of the most demanding aspects in product development is to make sure that the product is what users really want and need (Faulkner 2000). Users' attitudes towards a certain product can be studied with the notion of user experience which combines both task and non-task oriented aspects of product use. Katz et al. presented already in 1973 that the pleasure connected to the use of any media depends on the content, exposure to media per se and the social context of the media use. Developing hybrid products in which print and digital are combined into one entity requires consideration that goes beyond the user experience of one medium. In contrast to plain digital services, user experience of hybrid services consists of both the virtual and physical domains. Connections between the physical and virtual have previously been studied e.g. by Magerkurth et al. (2004) who present a model for the connections between the different domains. They studied computer games and saw the addition of physical and social elements as a way to enrich the user experience.

In this study, we aimed at a final hybrid application that would be well suited for actual use from the teacher's viewpoint and at the same time would be interesting for the children. Therefore, information from both user groups was gathered in the development phases. In total, 26 pupils and 15 adults (11 teachers and 4 parents) were interviewed in the preparation phases. First the pupils and teachers commented comic strip scenarios representing different tasks for the hybrid learning material and in the second phase they tested the tasks. After that, a field study was carried out with a class of 25 pupils using the hybrid books in their studies.

3. GAME LIKE FEATURES FOR THE HYBRID BOOK

Total of six comic strip scenarios were designed and shown to the informants, who then commented and discussed about them with the interviewer. The scenarios were designed to address specific issues that would be apparent in using educational games in both class and home environments. The purpose of these scenarios was to bring the designers and the end-users closer to each other by offering a springboard which could be used in discussion and ideation. The method used and detailed results and conclusions have been published by Paavilainen et al. (2009). An example of a scenario is presented in Figure 1.

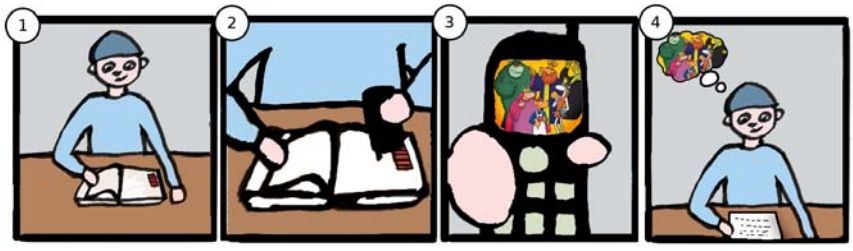

Figure 1. Example of a comic strip scenario used for user interviews on game like features in the hybrid book.

Overall all the scenarios got positive feedback although some negative sides were also recognized. The pupils were not only paying attention to the game like elements and entertainment value in the scenarios, but were also concerned about their own learning and how to improve it. The boys considered that the best tasks at school are crossword puzzles, word finding and math problems. They were also interested to see more complex games that model real life in some way. These kinds of games would also be played at home. Computer and mobile devices were very familiar to the boys and new technology was considered very exciting. The girls considered that games in general are interesting from the educational point of view and all the scenarios were exciting as they are so different from the current reality. Like the boys, the girls also liked crossword puzzle tasks the most. They were also keen to use new technology in school environment, but one pair stated that there should not be too many gadgets at school, as this would leave too little time for actual learning. This was an interesting point of view, which underlines that new technology could be interpreted as something that is only fun, not something that could be educating.

All the teachers considered that using game like activities during the classes would be a good thing. However, there should be enough room for traditional school work also. The games in general should make the pupil think, not forcing them to react mechanically into a certain stimuli. Computer and mobile technology is already used in the school but in limited fashion. The pupils have little time to use computers during a week, but the use of mobile phones is more frequent. Mobile phones are used as calculators during math classes and sometimes the pupils copy their homework assignments from the whiteboard by taking a photograph with their mobile phone. The teachers considered that checking the students' tasks is very burdensome and technology could help in that. The educational games must have some sort of evaluative aspects so the teachers can monitor the pupils' advancements. Simplicity and clarity were considered as the most important aspects in an educational game, so that the teachers would also understand them easily.

4. CHOICE OF THE DIGITAL CONTENT

From the viewpoint of the final application, it was important to take into account the mobility and easy usability of the hybrid book anywhere and at anytime. We aimed at solutions that would support the language learning at school and would be in line with the teachers work. On the other hand, the tasks should also support learning activities

outside school hours. Therefore, the mobile tasks that we chose to implement for the field test were: crossword puzzles, grammar exercises with differentiative features and listening tasks.

As the crossword was one of the task types the children found especially interesting, it was an obvious choice for the final hybrid book. However, as our aim was to combine printed and digital learning materials, the crossword contained words from the specific chapter of the book that was studied, and the hints were audio files. After launching the task from a page of the book with a mobile phone (Figure 2), the child would first listen to the hint from the mobile phone, and then write the word into the crossword.

In the grammar exercises we demonstrated the possibility to differentiate the tasks simply by the pupil getting an easier multiple-choice task than the previous one if he or she answered wrong, and a more complicated task if the answer was right. The grammar exercise was also based on the specific chapter of the book that was studied in the class.

Finally, listening exercises were included in order to combine the possibility to read the text from the book and to listen to the text with the mobile phone at the same time, regardless of the time and place. With this task we also wanted to make the listening of the language easier, and thus more frequent than currently, for the pupils.

Demo versions of the tasks were presented to a group of pupils, teachers and parents prior to the actual class room test, and some minor modifications were made. By the time when the tasks were finalized and the access from the images of the book to the digital material was implemented, the children in the class taking part in the three week test period were already very eager to get started.

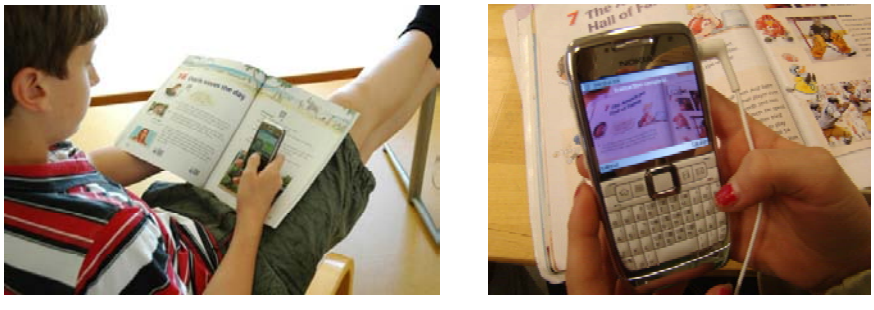

Figure 2. Launching a task with a mobile phone from a page of a book.

5. "WHEN DO WE GET THE PHONES?!"

In the earlier phases of the project valuable input from the end-users for the development of the hybrid learning material was gathered in interviews with short demonstrations of the prototypes. In order to more reliably evaluate the developed concept, a user study with the hybrid learning material in real environment was set up. The field trial would also allow the actual end-users more freely to create new ideas for utilization of mobile phones in language learning. A class from Hämeenlinnan Yhteiskoulu agreed to take the hybrid learning material prototype into use for three weeks. The pupils are on the 6th

grade in the elementary school and they study English for the fourth year. There are 25 pupils in the class, 11 girls and 14 boys. They have two English lessons per week.

The pupils and the teacher were provided with the Nokia E71-smartphones with internet connection, 3.2 megapixel camera and 2.4" display. The applications and the settings of the phones were pre-installed so that they would be as easy-to-use as possible for the tasks. Mobile phone tasks (described in the previous paragraph) were developed for two chapters of the ordinary English study book. An image recognition application created at VTT was used for linking the digital material and the book. When the user opens the image recognition application in the mobile phone and takes a photo of the page of the printed book, a web site with the digital content relating to those pages of the book is opened.

During the trial the pupils kept diaries on how often they used the hybrid school book and where, and made other remarks about their observations. At the end of the trial the diaries were collected, each pupil answered a questionnaire, and eight pupils were interviewed. Also the teacher and four parents were interviewed.

The children were very eager in the beginning and felt that they were privileged as they were the only pupils in the school that were allowed to use mobile phones in the classroom and for homework. Naturally the excitement settled somewhat during the test period, and the amount of time that the children spent doing English exercises "just for fun" decreased. The time frame of the user study is too short for evaluating reliably any actual long-term effects on learning, e.g. the effect of enhanced opportunities for listening to vocabulary and texts of the chapters. It seemed however that these kinds of exercises motivated many of the children. The children generally mentioned interest in the use of the new technology and more interesting lessons with variability of exercises as reasons for their improved motivation.

All the pupils said that they would like a frequent use of mobile phones for studying. None of them thought that the use of the mobile tasks felt laborious. The use of the application and the new phone was quite easy for the children as only one third of the pupils said that they had to learn some or many new things before getting started with the hybrid book. Most of the children realized, however, that mobile tasks couldn't entirely replace all the other learning materials. The following motivations were mentioned: "Half with a book, half with a mobile would be good, in case e.g. the battery runs out." and "The book has more diverse exercises." The thought about the school without any printed books felt confusing for the most of the pupils.

Parents' attitudes towards using mobile phones for learning were mostly positive. The idea that modern technology is utilized more effectively in learning materials was appreciated, and it was considered important that the schools would not be too distant from the leisure time and everyday media environment of the children. Some of the parents brought up concerns over potential expenses and inequality in case acquisition of a smart phone to a child was required for learning purposes.

The teacher valued the hybrid learning material that enabled variation from the routines more easily. It was also easier to allow the pupils to proceed in own pace, even in the classroom. For example, the teacher usually plays a text from a CD-record for the whole

class. Using the mobile phones and headphones for listening resulted in less distractions, and each pupil could pause and rewind the audio file whenever he or she needed to. The teacher also appreciated the features of the application that made it easier to check if the pupils have done their homework and how they have performed.

Furthermore, the teacher came up with some own ideas of utilizing the mobile phone. In some cases the pupils would send text messages after completing English tasks. The pupils could also record spoken language in a form of small plays and deliver these files to the teacher for extra credit. After the trial, the pupils suggested ideas for further development, too. For example mobile chat and pronunciation exercises were proposed.

6. CONCLUSIONS

Very positive feedback was obtained from a three week test period with the hybrid book in actual class room use. Combining digital material with the traditional printed book by utilizing the image recognition application in a mobile phone was found suitable for elementary school children both from the mobility and usability viewpoints. The children were motivated to carry out English tasks with the phone, and the application made it possible for the children to proceed with different kind of tasks in their own pace also during school hours. Earlier interviews among teachers indicated that the use of a hybrid book would be motivating also for the teacher. This was verified in the field test, although comments for further development were also obtained. Based on our experiences with the hybrid book we can warmly recommend an effort to combine printed and digital learning materials instead of keeping them separate.

It is clear that a three week test period is not enough to draw any conclusions from the viewpoint of learning efficiency. Longer test periods would be needed for testing the actual effects on learning, and for making sure that the novelty of the application is not the main motivating factor for carrying out the tasks.

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Appendix 5: Publication in the MobileHCI Conference in Portugal, Sep 2010

Cross-use of Smart Phones and Printed Books in Primary School Education

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ABSTRACT

The adoption of new technologies in primary schools has fallen behind in terms of children's everyday use of technology. The use of mobile phones has been proposed as a promising field for learning. To date, the mobile learning technologies have rarely been integrated with current educational practices, however. Here, we present the results of our intervention study in which a mobile hybrid media system that combines the use of the traditional printed book with the mobile phone was used in English as foreign language (EFL) education in primary school. The results revealed an increase in learning motivation but also some conflicts when the boundaries of the school world and everyday life were blurred through the use of new technology.

Categories and Subject Descriptors

K.3.0 [Computing Milieux]: Computers and education – General

General Terms

Design, Experimentation, Human Factors

Keywords

Education, mobile, intervention, print, user experience, English as foreign language, EFL

1. INTRODUCTION

The everyday lives of children have been affected by a myriad of new digital media technologies. Ever-younger schoolchildren may have their own handhelds for digital media creation, capturing and sharing, while printed books and pencils are still the primary media technologies in schools. If mobile devices are finding their way into classrooms anyway, through pupils' pockets, educational practices could also include the use of these technologies in productive ways [6]. This is a challenge for the current culture in schools.

The development of learning technologies has previously been strongly divided. Printed books and digital learning technologies have been developed separately. Considering the wide use of digital technology in everyday life and the trend to continue using printed material in schools into the future [5], we saw a clear need to converge the two worlds. In this paper, we present our intervention study in which a hybrid media learning system, a combination of digital and printed media, was used as part of primary school education. In our case, the combination of digital and print meant converging the mobile phone with the printed book.

We believe it is important to explore the possibilities of combining digital and print in the school environment for two reasons. Firstly, we feel that new technologies should primarily be introduced because they benefit the end-user and not for, for example, political or economical reasons. This is also important in a learning context. Secondly, we see the end-users as three primary stakeholders: pupils, teachers and parents, who all should react positively to the new learning technology. Also the stakeholders should be on the same page with regard to the limits and possibilities of the technology. We consider these issues relevant to the MobileHCI community, because whenever we design new technologies we should take into account current practices and take care of usefulness of the new technology.

We ended up with two research questions: 1) How is mobile hybrid media used in primary school teaching? 2) What is the user reaction to mobile hybrid media in primary school teaching?

To study the implications of the hybrid media learning system in primary school teaching, we conducted an intervention study in a Finnish primary school. As a case system, we used a convergence of the printed schoolbook, IMediaLink image recognition software developed by VTT (Technical Research Centre of Finland), and three types of mobile hybrid media exercises that were developed during the earlier phases of the project.

1.1 Related research

In the field of mobile learning, English language is a particularly popular subject for research. According to a number of studies, mobile technology offers easy access to audio-visual materials and thus possibilities to enhance English learning [1][7][8]. Learning on the move, the opportunity to listen to podcasts and instant access to the Internet are examples that have been listed as key benefits of using mobile technology in language learning [4]. “Fun” and “coolness” were also reported as benefits [7]

The results of a study comparing vocabulary learning from a paper book and a portable eBook device showed that pupils preferred paper books for their portability, ease of use, lack of strain on the eyes and because they could annotate the text. The mobile devices, however, enabled them to perform tasks such as quickly looking up the meanings of words [3]. These results clearly indicate that digital and printed media both have special advantages, and from our viewpoint the two should be combined.

1.2 The mobile hybrid media learning system

To trigger the digital content of the printed book, the user starts the IMediaLink application from her mobile phone. With the IMediaLink, the user takes a photo of a page in her schoolbook (Fig. 1 left) and the application sends the image to the server, where it is analyzed and the equivalent web link is searched from the database

and returned to the user's phone. The phone's web browser opens a link which contains a list of school exercises for that specific chapter of the book (Figure 1 right picture). From this list, the user then selects the exercise he or she wants to do.

We developed three exercise types. First, in Missing words the user is given multiple-choice questions in which he or she tries to select the correct word from a list to complete a sentence. The exercise is adaptive, i.e., the user is given easier or more complicated sentences, depending on her previous performance. Secondly, in the Crossword the user is given an audible hint from the phone and tries to write the correct word in the crossword on the phone. Thirdly, in the Listening exercise, the user listens to the chapter text from her phone and is able to follow the text in the book at the same time. Our system also contained a web interface for the teacher to follow when a pupil had accessed an exercise with her mobile phone.

The exercises were developed in the early phase of the project in collaboration with professional developers of school material. The development process was an iterative study-design-build-evaluate process. This intervention study was the evaluation phase of the fourth iterative round. Prior to this intervention, book designers, pupils and teachers were interviewed about the needs of new learning technologies, a number of concepts were designed and built, the concepts built were evaluated in user tests, and exercises were chosen for the intervention study (see [5]).

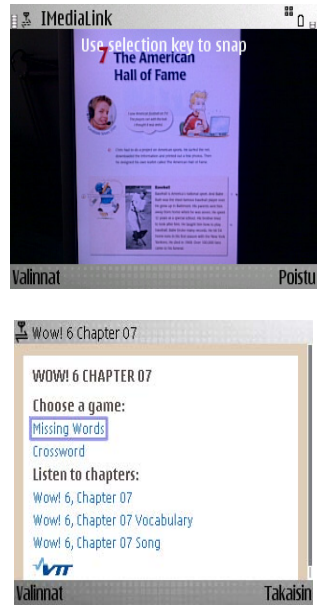

Figure 1. User's view of the phone screen when linking the printed book to the mobile exercises.

2. THE INTERVENTION STUDY

To study the implications of the system, we conducted an intervention study. The study was carried out at a primary school in Southern Finland. We recruited a Year 6 class (25 pupils aged 12: 11 girls, 14 boys) and their English teacher to use our hybrid media learning system. The English teacher also participated in some of the earlier concept development phases. We chose a state primary school for a natural representation of the Finnish basic education system. We used a mix of qualitative (interviews and personal diaries) and quantitative (questionnaire, logs) methods to capture subjective views of the system and data on the interaction with the exercises.

All the pupils and the teacher were given Nokia E71 smart phones and free, unlimited data plans. The technological infrastructure was pre-installed and the phones

were ready to use. The participants were introduced to the phones, IMediaLink and the exercises in a group session in which everyone tested that her system worked properly. The class used the system for three weeks. During the study, the pupils had six English lessons and used the system as part of the learning material. The pupils were allowed to use the phones freely in their everyday lives, including outside school. The only restriction was that the calling time and SMS use were limited to a moderate amount.

Eight pupils, the English teacher and four parents were interviewed after the study. The pupils were interviewed in pairs to ease nervousness during the interview. The interview consisted of questions about the interviewees' demographics, their relationship with the school environment, prior experience of information technology, user experience of the mobile phone during the study, and user experience on the hybrid media system as part of the learning experience. Approximately five hours of interview data were gathered. The data logs contained time stamps of each pupil's use of the exercises: the number of times an exercise was accessed and the user's result when he or she completed the exercise. The data logs were used to monitor the activity and select active and inactive pupils for the interview sessions. A shortcoming of the data was that we did not have the individual user's data from the Listening exercise. The questionnaire contained questions on the user's experience of the tested system. The questionnaire was a modification of the one used by Brooke [2] All the pupils filled in the questionnaire after the intervention phase. Each pupil was given a personal diary in which he or she was able to make notes on whether he or she used the system in or outside school and what kind of positive and negative experiences he or she had had with the system. The diaries were used in the interviews to make it easier for the interviewees to remember their experiences during the intervention phase.

3. FINDINGS

In this part we describe how the system was used inside and outside school, and how each stakeholder responded to the system.

3.1 Use of mobile hybrid media in education

From a broad view, the system fulfilled the main functionality for which it was designed, as part of the educational material for learning English as a foreign language in a primary school context. Although the system was new to all the stakeholders and some usability issues arose, the overall user experience was positive and pupils learned to use the system quite easily. As the teacher said: "The kids are so clever with all the new technology." None of the interviewees thought the system was pointless. The exercises were used quite actively. Table 1 shows how often each exercise was loaded and the ratio of pupils who loaded them.

Table 1. System activity among the pupils.

	Missing words	**Cross-word**	**Cross-word**
Times loaded	40	21	54
Pupils who loaded it at least once	72%	48%	~100%

3.1.1 Use in the classes – motivating but requires pre-planning and induces loss of control

In the classes, the exercises were carried out under the supervision of the teacher. The use of the new system required the

teacher to prepare for the classes from a new angle. As she said: "A normal class timetable would not have worked." The teacher did not feel that the pre-planning was too laborious however.

In the classes, the teacher instructed the pupils to do the Listening exercises. This was the main reason that the listening exercise was loaded most (Table 1). First, the pupils listened individually to the chapter on their phone and then they continued working in pairs, face to face. The mobile phone listening exercise replaced the CD that the teacher had played for the whole class during the lectures. As a result, the pupils were able to go at their own pace, and there were fewer distractions. The Missing Words and the Crossword were given as extra exercises or homework. They were not mandatory and the teacher did not use the results in the assessment. Nonetheless, 72% had loaded the Missing Words and 48% the Crossword at least once.

The technology itself seemed to motivate the pupils to concentrate on learning. According to the teacher, with the exciting technology, she was able to "lure" pupils to learn. Some pupils made the same observation: "This might be motivating to pupils who do not like to study so much." – girl, 12 years.

In several interviews it came up that when the teacher had instructed the pupils to do exercises with the phone, some pupils had played games or browsed the Internet without the teacher noticing. Pupils have of course always done things that are not allowed, but it seemed that in this case, the technology had given them more freedom to do activities in secret from the teacher: "Some boys only played the formula game and the teacher did not notice at all." – girl, 12 years.

3.1.2 Use outside the classroom – New rules and new explicit social interaction

The pupils were allowed to take the phones home with them, and the teacher had given them our mobile exercises for extra homework. The opportunity to use a smart phone with an unlimited data plan brought up new challenges at homes.

Many of the interviewed pupils said that their parents were interested in hearing about the new system, but did not have the time to learn in more detail what the pupil did with the system. None of the interviews (parents or pupils) revealed that a parent had actually tried how the system worked. The interviewed parents said that they have set limits for their children's Internet usage at home. It seemed that many of them did not realize that a smart phone with an unlimited data plan was much like a computer with Internet connection however. As one father said: "It is very hard to believe that my daughters would use the Internet on the phone." One mother had set strict rules that the computer (including the Internet) could only be used after homework had been done and not after 8 pm. She found that her son was still browsing the Internet on his phone after bedtime however. After that, they made new rules for the phone use too.

Doing homework with the system allowed the teacher to use the teacher's web interface to monitor when a pupil had accessed the exercises. The teacher did not think it important to use the monitoring system in this case, however, because this was a study and the exercises were "kind of extra work". Instead, she had instructed the pupils to send text messages to her when they had done their homework. This, she said, was an explicit way to communicate with the children outside the

school: "Some otherwise shy kids sent text messages and that felt really good."

3.2 User reactions to mobile hybrid media

In a nutshell, the response was positive. The stakeholders' views of the system echoed this on some things but differed on others.

3.2.1 Teacher's reactions – "Like magic, but should be easy"

The teacher was committed to trying the system with her class. In her own words, she was not very "tech savvy": "I am this kind of average bumbler with technology." Despite not being "tech savvy", the teacher did not seem afraid to use the system. Usability issues came up when the teacher described how some of the pupils were unable to access the exercises using IMediaLink. During the interview, the teacher emphasized ease of use of the mobile exercises, though she said that the system was generally effortless for the pupils and herself to use.

According to the teacher, the combination of a printed book and a mobile phone was a welcome update. She was not ready to give up printed books, however, but felt that mobile exercises were a flexible and motivating addition to traditional educational material.

The teacher also wanted to raise the issue of free education in Finland and emphasized that Finnish law states that everyone has the right to free basic education. Parents can therefore not be required to pay for smart phones and data transfer.

3.2.2 Pupils' reactions – "It's a phone not a book"

The pupils were keen to have smart phones and excited because they were allowed to use their phones during classes. Adding an everyday media device like a mobile phone to a class context was something they were not used to, and it felt exciting. The pupils were able to adapt quickly to the technology, and they actively helped each other if anyone had problems using it.

After the study we asked the pupils to evaluate the printed book and the smart phone in educational use. We asked whether they wanted to use mobile phones often for learning. Out of 21, 20 answered 4 or 5 on a scale of 1 to 5 (5=strongly agree). When we asked whether they thought the printed schoolbook could be put aside completely, only 9 pupils clearly agreed (answered 4 or 5).

3.2.3 Parents' reactions – "Finally some update from our times, but what would this cost?"

All the interviewed parents thought that an effort to update educational material from their times was very welcome. As one parent said: "Teaching is still awfully outdated."

All of them also said that the printed book should not be replaced, however, and that it is important to work with something concrete that is also long lasting: "It is important that pupils get something that will last. Print supports that. Otherwise everything might vanish into cyberspace."

Some also brought up that some just like to use the printed book and some a mobile phone. A combination of the two would allow a greater proportion of pupils to be motivated.

All of the parents also talked about the financial requirements the new technology might bring. Many made a strong statement on how education in Finland is provided by the government from the taxpayers' money. It should not require people to pay extra and put people in unequal positions because of their wealth. Some of the interviewees said that they might be ready to pay some minor extra costs however.

4. CONCLUSIONS AND DISCUSSION

Our experiences from the test period indicate that mobile hybrid media is a suitable learning technology for primary education. The motivation of teachers and pupils was high, and the attitudes of parents supported the use of hybrid media. A few problems with the technology did not seem to reduce the enthusiasm of the pupils and teacher. We see that combining the familiar with the new, in this case print and digital, helps to integrate new technologies into current practices within the teacher communities.

It is worth noting that the phones were probably not seen very much as tools for schoolwork by the pupils, but as tools for doing other things outside the school context. The sense of "forbidden fruit" may have affected the pupils' opinions positively during the test. Our user study verified the high potential of the mobile hybrid media in schoolwork however. A longer test period is required to prove actual benefits for learning.

We saw that our intervention caused changes in normal school practice: the teacher had to plan "mobile lessons" differently and she created the SMS task herself. Manual reporting by SMS worked better than the automatic monitoring interface, and there was a new kind of explicit interaction between the pupils and the teacher and some blurring of the line between school and leisure. The parents' understanding of the mobile phone tasks was probably not as clear as of the usual school tasks, and they had to put some extra effort into controlling their children's' use of the test phones as well. Even though these changes were most probably caused by the short test period and, in this sense, the situation was unnatural, the use of mobile technology is likely to change familiar practices. It is therefore important to pay attention to all the stakeholders when introducing new technologies such as the mobile hybrid book into schools.

To conclude this paper we present some implications for design. Some of them are classical findings of human computer interaction, but we see it important to remind about these in learning context.

- In order to enable innovations by the teachers the technology should be flexible and easy to understand.
- The appropriation of new learning technologies is a socially constructed process where multiple stakeholders negotiate the rules and conventions for technology use. Thus real life experiments are in important position in devolving new learning technologies.
- A two-way manual homework reporting system supports explicit interaction between the pupil and teacher, and can be more pleasant than a fully automatic monitoring system.
- The system should also provide access to digital learning materials offline. Uploading content from the Internet each time it is used is often too slow, unreliable and costly.
- The extent of Internet access via mobile phones should be carefully planned in school context.

- In Finland, cost-free primary school is an important value. Mobile learning must therefore not incur direct costs to the end-user. Some minor costs may be acceptable however.
- A combination of the printed book and mobile phone supports different learning styles and gives the teacher flexibility in her teaching.

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Title

Book alone is not enough

Enriching printed learning material with digital mobile technology

Abstract

The aim of this project was to combine printed and digital learning material in order to enrich and enhance the learning experience, and introduce the created concept to the end-users in primary schools. We proposed a hybrid book concept in which traditional school book was combined with a mobile phone. The chosen subject was English as a foreign language (EFL).

User-centric approach and qualitative methods were used in the design process. The main user groups were teachers, pupils and parents. In addition, WSOYpro bookmakers gave their professional insight into the process. This approach made it possible to take into account the user preferences as well as pedagogical and didactical issues. The inclusion of the teacher in the design process from the very beginning proved to be valuable: The teacher was able to interweave the use of hybrid book into her current teaching practises, culture and curriculum; on the other hand she provided the research group with valuable information, which helped the design of the mobile phone tasks.

Our experiences from the project indicate that the mobile hybrid book is a suitable learning material for primary education. The motivation of teachers and pupils was high, and the attitudes of parents supported the use of hybrid book. The society around us is becoming increasingly digitalized and the schools should follow the change taking place in the society. The printed book is probably not enough anymore, but is not yet disappearing from the schools. The idea of combining the two worlds, printed and digital, was well received.

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