CamQuest: Design and Evaluation of a Tablet Application for Educational Use in Preschools

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ABSTRACT
This paper describes the design, testing and evaluation of CamQuest, a tablet application intended for educational practice in preschools. CamQuest enables children to search for and photograph geometrical shapes in their surroundings with the tablet camera. In this paper, the results of three encounters with preschool children aged four to five are presented and discussed, as well as the design and concept of CamQuest. Each encounter with children was carried out with a different approach; testing, co-designing, and evaluating. The application can be used as a pedagogical tool, which enables preschool children to recognize and explore geometrical shapes in their environment through using digital media.

Categories and Subject Descriptors
H.5.m [**Miscellaneous**]

General Terms
Design

Keywords
Ipad; application; tablet; preschool; education; children; collaboration; camera; geometry; geometrical shapes; spatial interaction; interaction design; digital media; GUI.

1. INTRODUCTION
The curriculum states that children in Swedish preschools should be introduced to digital media and technology [8]. As a consequence, the use of tablets in preschools has increased which in turn has led to related issues. Many preschool teachers lack in knowledge of how to work with the tablet in order to achieve an activity where the children can learn, and have not been educated on how the tablet can function as a pedagogical tool. In addition, there is a lack of proper applications developed for educational use. Most applications used in Swedish preschools are based on one-player games, which results in individual play without any involvement of other preschool children or teachers. Since collaboration is given a great significance in the curriculum [8], this type of use is not appropriate for preschools. The aim of CamQuest is to enable children to learn about two-dimensional geometrical shapes by exploring the surrounding environment by using the tablet camera together with fellow preschoolers.

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This paper presents related work and describes the design and evaluation of the CamQuest prototype. We describe three studies of children aged four to five years old and discuss the results.

2. RELATED WORKS
Some related works that have been looked into are SketchCam [4], Tangicam [5] and Urban Alphabets [6]. SketchCam is a camera which is reduced to a single touch screen, enabling children to capture images by sketching directly on the screen with their fingers. Tangicam is a mobile device used for capturing and editing photos and videos. Instead of viewing the photos and recordings on a screen, the device can be connected to a DiamondTouch table. Urban Alphabets is an application for smartphones developed by a student at Media Lab Helsinki, where the user can photograph letters in the surroundings in order to create a personal alphabet.

Since CamQuest is an application that will eventually be released for downloading, we looked into existing geometry applications for tablets. We were unable to find any application that uses the tablet camera as a tool for recognizing shapes in common settings. All of the applications consisted of screen based activities. Most of them were recommended for children aged five to ten, and very few applications aimed at preschool children were found.

3. CAMQUEST
CamQuest is a tablet application aimed for educational use in preschools that enables children to explore their surrounding environment by using a tablet. The children are set out to find and photograph geometrical shapes with the tablet camera, which has an integrated image of the shape the children are supposed to search for during the quest. The integrated image provides guidance on what to look for, and helps the children to aim at the objects of interest. Four different shapes can be chosen; circle, square, rectangle, and triangle.

The purpose of CamQuest is to integrate the use of tablets in active play, where the children are not focused on the screen. Instead, we want the tablet to work as a link between them and the objects or shapes they search for. The application is supposed to enable children to interact with each other, and with the surrounding environment. Even though CamQuest can be used individually, our belief is that its full potential is reached when the application is used by children collaborating in pairs.

Since the application is intended for educational purposes, it relies on involvement of the teacher. For instance, CamQuest itself does not force the children to collaborate; it is up to the teacher to decide how the application should be used. To ensure that the teachers are informed about the pedagogical potential of

CamQuest and how it can be used, a short text-based information guide is implemented in the application. In order to achieve a meaningful learning experience, the children would benefit from being introduced to the different geometrical shapes prior to using CamQuest. The photos taken by the children are saved in the tablet photo album, and can be used as a base for a presentation, discussion and reflection session held by the teacher in a larger group of children after the quest has been completed.

4. METHOD

In order to gain insight into how well CamQuest is received by children and to what extent the application is appropriate for educational use, three encounters with preschool children aged four to five were conducted during the development of the application. Each encounter was limited to one hour, and ten children were participating at a time. The children worked in pairs and each couple shared one Ipad. A teacher was continuously involved in the execution of the different activities. After each visit an interview was held with the teacher in order to gain important insights and feedback.

CamQuest was developed, tested and evaluated in an iterative process where the children were involved as testers and informants, in accordance with the different roles children can have in design of new technologies defined by Druin [2]. During the first encounter, the children were observed as testers of a low-tech prototype of CamQuest. Handling of tablet, need of guidance and level of collaboration are examples of important aspects that were taken under consideration during the observation. The second encounter involved the children as co-designers in a sketch workshop, where they were asked to make drawings of cameras, buttons and possible quests. They were also asked to design their own interface. For the last encounter a digital prototype was developed, which was tested by the children. Here, the children were given the role as informants, since they were asked questions about their experience of using CamQuest.

5. RESULTS

The participating children in the studies had very little previous experience in using a tablet for any other activity than playing games. Most of them had never used the camera application before. The children had previously been introduced to basic geometrical shapes, but they were not confident in using the correct terms and were unable to distinguish the different shapes from each other.

5.1 First Encounter: Testing and Observation

During the first encounter the children were initially gathered for a short introduction to the quest. Each couple was given a low-tech prototype to share. The prototype consisted of the Ipad camera application, with a geometrical shape printed on overhead paper, which was taped onto the screen of the Ipad (see figure 1).

After the children had completed the quests of photographing the different shapes, they were gathered again to look at and reflect on all the photos as a group activity led by the teacher. Both the introductory and finishing group discussion were very valuable for the learning outcome, but also for the sake of the children's motivation and amusement.

Figure 1. The low-tech prototype used for early testing.

The following conclusions could be made when analyzing the results from the first encounter:

- Using CamQuest made the children joyful, curious, eager and proud.
- The children appreciated getting to know the tablet better, and embraced the responsibility of it.
- The children managed to successfully collaborate with each other during the quests, and took turns.
- Most children held the tablet horizontally with both hands and pushed the trigger button with their right thumb.
- The different geometrical shapes varied in difficulty for the children. It was obvious from the amounts of photos taken of each shape that the circle was the easiest, followed by the square and the rectangle, while the triangle was the hardest shape to find (see figure 2).
- The children had difficulties in separating squares and rectangles from each other.

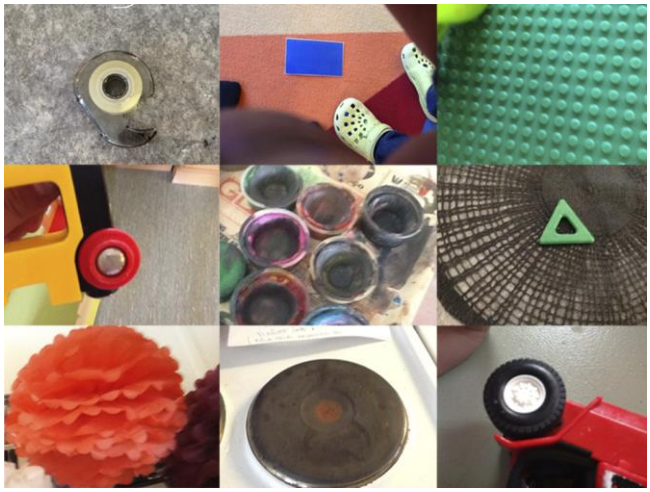

Figure 2. A majority of the photos produced by the children are taken of circular objects.

5.2 Second Encounter: Co-Design

During the second study a sketching workshop was held, where the children were asked to make drawings of cameras, buttons and possible quests. They also got to color the interface of the application according to their own preference. This provided us with an insight on how the children perceive cameras, and what they think the interface of the application should look like. The children mostly drew conventional cameras; a rectangular shape with a circular lens. Some children on the other hand, drew cameras similar to tablets. According to the drawings of buttons, those can vary a lot in both shape and function. When the children were asked what else they would like to search for in future quests, some of the things mentioned are: flags, letters, numbers, fruit, clothes, colors, and poo.

When designing the interface, each child was given a template printed in black and white. All children colored the interface template in different colors, with the results ranging from very bright and colorful to completely black and grey (see figure 4). Many children also gave different colors to the trigger button and the buttons for selecting geometrical shape.

Figure 4. Some of the interfaces designed by the children.

When observing the children play with their creations we realized the importance of the shutter sound, since they added that sound themselves when taking imaginary photographs. This indicates that auditory feedback is of high significance regarding the children's perception and experience of using the tablet, and also the learning outcome from using the application. Therefore, sound clips of the name of each shape were added to the digital prototype tested during the third encounter described below.

5.3 Third Encounter: Evaluation

During the third encounter a first digital prototype of CamQuest was tested and evaluated, followed by short interviews with the children. When designing the graphical user interface of the prototype, the input from previous observations and workshops were taken under consideration. We strived to obtain simplicity both graphically and interactively, as simplicity is a significant parameter when designing successful technologies for children [7]. The application is made up of one single interface, which consists of the camera and a panel with buttons (see figure 5). The use of text has been totally excluded in favor of an icon based interface, since the amount of text in applications aimed at preschool children should be minimized. The buttons are given a generous size to make sure they are age appropriate [3]. When a geometrical shape is selected, an integrated image of the shape appears in the camera. The photo album can be accessed by tapping an image of the last taken picture, and by double-tapping the i-button on the bottom right the information for teachers and parents can be opened.

With the results from the first encounter in mind, we increased the size of the integrated shape in the camera. The color was also changed from green to bright yellow to make it more distinguishable from the background (see figure 5). Since the children's color choices for the interface varied a lot, we decided to use a limited amount of gender neutral colors for the panel and the buttons: green and purple.

Figure 5. The CamQuest interface.

During the third encounter, it was obvious that the children's handling of the Ipad had improved compared to the observations made during the first encounter. On the contrary, one problem we noticed when the children were using the digital prototype was that some of the children felt uncomfortable with letting go of their two-handed grip (see figure 6). This made it difficult for them to reach the geometrical shapes at the top of the screen with their thumbs. This implies that the placement of the selectable shapes should be reconsidered.

Figure 6. A child using the digital prototype.

6. DISCUSSION

We found that observation was very useful as a method for understanding how the children interacted with, understood, and experienced CamQuest. Observing children in their natural environment and analyzing their behavior turned out to be more useful than interviewing them. We think asking children in this age to reflect on their own behavior yields less useful results, since their responses often contradicted our observations. This was also true when evaluating the digital prototype.

The main advantage with co-design as a design method is that the designers can gain greater understanding and important insights about a user group that is very different from themselves. It makes the children feel more secure and confident in the presence of the designers, which in our case lead to a more natural and unaffected behavior in both ways. There were however not many direct design decisions based on the results from the co-design workshop.

One important design decision we had to make when designing an application for collaboration was whether or not to force this on the users. Since the application is intended for educational purposes, it automatically relies on involvement of the teacher. We do not believe in forcing a specific way of using the app, since the advantage of an open-ended application is that it is unrestricted and versatile. In an educational context where children are at different stages of development and are learning things in different ways, it is more suitable with an open-ended application that can be used in several ways. An application with a more predefined method of use could in this case limit the educational potential.

During the evaluation of the digital prototype, it was noticeable that some children had problems with reaching and selecting the different shapes placed at the top of the screen, since they had a hard time holding the Ipad with one hand. Seeing this, a more user-friendly design of the graphical user interface could be to place the shapes vertically on the left side instead.

Regarding the learning outcome from using CamQuest, we found that the children gained both confidence and knowledge, not only from being involved in the design process but also when it comes to their accomplishments with the application and the Ipad. From using the application together with other activities related to geometry, the children were able to transfer the knowledge about geometrical shapes to other contexts separated from the tablet. For example, the children started to ask the teachers for "rectangle papers" to draw on. Being able to distinguish between the names and the shapes provides the children with a vocabulary to use when discussing basic mathematical concepts. We believe that the transfer was successful because the fact that the combination *reality-tablet* provided the children with a relatable context that is meaningful to them, something that is also comparable to Druin's findings on mobile technologies and learning [1]. This adds to the children's motivation and understanding of the concept of geometrical shapes.

According to the teacher, the children continued to work with CamQuest for a longer time compared to when they are given the Ipad to play a game by themselves. We think that one reason to this could be that the activity is diverse and therefore motivates the children. We found that the children enjoyed each part of it; the introduction, performing the quest together with a fellow preschooler, and reflecting on the photos with the teacher afterwards in a concluding group gathering. When CamQuest is used in this way; in pairs and as a group activity; the children practice collaboration, communication and problem solving. They are also given the opportunity to develop skills in presentation, discussion and reflection during the final gathering. The variation in these different activities enables the children to experience through different senses and to learn by varied subtasks.

7. CONCLUSION

CamQuest has potential to change the common attitudes towards the use of tablets in preschools, and to promote the advantages of using the tablet as a pedagogical tool. The application enables preschool children to recognize and explore geometrical shapes in their environment through using digital media. The application also supports group activity led by the teacher, and social interaction and collaboration among the children.

There are many reasons to why we find CamQuest highly suitable for educational use in preschools. The simplicity of CamQuest not only appeals to the children, but also provides pedagogical benefits. Teachers can set their own educational goals adapted to children's specific needs. Thanks to its open-endedness, the application also provides good opportunities for varied use, for example both indoors and outdoors. When tablets and applications are used in this manner, we are convinced that tablets can provide a useful and valuable complement to the educational tools in preschools.

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