In Class Adoption of Multimedia Mobile Phones by Gender - Results from a Field Study

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Abstract. In this paper we share our findings from a field study conducted in Panama, focusing on adoption of mobile phones in classroom settings. Our initial findings reveal that during the initial phase of use, boys adopt mobile phone usage faster and explore more functionality; while girls take more time to familiarize themselves with the phones. Girls seem to maintain a better focus on the learning activities using the mobile phones across all tasks. When the task implies an active role then boys also showed high concentration. The videos recorded by the children as part of the learning activities showed a remarkable difference in roles between girls and boys. These findings suggest that it is important to consider the different adoption and exploration strategies of girls and boys with new technologies when designing tools for mobile learning.

Keywords: Mobile phones, children, technology adoption, rural schools, developing countries, novelty effect, learning, boys, girls

1 Introduction

There is a great potential of using mobile phones for learning in both developed and developing countries. For most people living in developing countries, mobile phones are the only computing technology they know and have access to. This makes mobile phones a potential alternative for computer supported learning. Additionally, it is known that children are very fast in taking on new technologies, such as mobile phones. Nonetheless, using them for learning in formal classroom settings is still not common and little is known how to do this in a successful way. Most of the approaches found in the literature have focused on the development of dedicated learning games or applications to cover one specific learning subject or content. Understanding children's practices of learning to use new technology could support the creation of better learning applications and teaching practices.

We conducted an explorative field study to learn how pupils in developing regions take up the multimedia features of mobile phones in classroom settings to support their learning activities. Our study took place in Panama, a small country in Latin America with a population of 3.5 million [1], and where approximately 40% of the population lives in poverty [9]. The experiment was run in two schools in rural areas.

2 Related Work

Although mobile phone assisted learning is an emerging field, there exists some earlier research in the area. The interaction between children and multimedia phones has been investigated in developed regions e.g. in [5, 6], where Jarkevich et al. [6] studied the adoption of mobile phones by small children in the kindergarten, and Puikkonen et al. [5] analyzed short videos created by girls with their mobile phones. However, our research focuses on the use of multimedia phones in developing countries. Here, pioneering work has been done for example by Kumar et al. [4], who studied the utilization of mobile phones in unsupervised learning environments in rural India; and Kam et al. [7], who explore the adoption of local game practices for learning games with mobile phones in schools, also in India. Hollow and Masperi [8] explored the use of video learning tutorials for handheld devices in primary schools in Malawi. In contrast to this work, our research looks at the opportunities that arise from using general multimedia mobile phones as generic learning tools – much like paper and pencil. Qualitative findings of how teachers adopt the use of multimedia for their own teaching style; and needs and strengths of their pupils in a similar setting as used in the research presented in this paper have been reported in [3].

3 Method

The starting point for our research reported in the paper was based on the results from a set of interviews, discussion and surveys to teachers and children realized previously in Panama [2,3]. The surveys and interviews were conducted to get an overview of the use of technology in schools, the acceptance of using mobile phones for learning, how teachers and children imagine mobile phones could be used for learning, and the learning needs that could be supported by mobile phones in Panama. The main findings revealed that teachers and pupils have a high access to mobile phones [2], and they would welcome support especially for Math, Language arts and Nature [2,3]. It was desired that any learning application should include multimedia features. Teachers were open to use mobile phones in their classes, and they considered the school the most suitable place for using a mobile phones for learning [2,3]. Based on these findings we decided to conduct an explorative field study to understand how children and teachers adopt the use of the mobile phones in class and how phones could support learning in class in the context of rural areas in developing countries.

3.1 Setup of the Field of Study

The field study was realized in two schools in Cocle, a province located in the west of Panama City. The first study was conducted in a rural multigrade school in the village El Retiro. The participants attended 4th, 5th and 6th grade; pupils from the 4th and the 5th grade worked together in the same classroom under the supervision of the same teacher (multigrade). We have described the learning activities and general findings from the field study realized in this school in [3]. The second school was Maria de

Tirones, an urban school located in the village of Rio Hato. There we worked with 2 classes of the 5th grade. Although only one of the schools was classified as rural, most of the pupils in both schools came from families with low or very low income. In total, 78 children participated in the study, 36 from the first school and 42 from the second one. Additionally, we worked with 6 teachers, including the two respective grade-teachers and the English teacher. The gender distribution was 41 girls and 37 boys, and the mean age was 10.5 years. As the learning activities using the mobile phones were planned by teachers to target the specific grade and learning goals, some activities were analyzed from a subset of all participants. The study ran for two working-weeks in each school, between September and October 2010.

As we want to explore the use of multimedia in class and to avoid any bias if children used their own phones, we provided each child and teacher with a Nokia 5530 Music Xpress equipped with an SD card of 4 GB. With this model we were also able to explore touch screen interaction, as touch-screen phones are currently the trend in the market. In both schools we gave a brief introduction to the teachers showing the multimedia features and applications of the mobile phones. Teachers were free to decide which multimedia features and applications they used during their classes. The learning tasks were designed exclusively by teachers and respected the planned lessons scheduled previously by them for the school term.

Only three of the children had never used a mobile phone before, but none of them had prior experience with touch-screen interaction on mobile phones. Mobile phone features and applications were introduced to children when needed for a learning task. After the first week all the children knew well how to use the phone. The mobile phones were used only during the school; teachers delivered them to children when starting the class and collected them once the class was finished. On average, children used the phones between 2 and 4 hours daily. In addition to the instructed tasks designed by teachers, children had a chance to explore the mobile phones freely. The mobile phones were used only as portable computers, thus the ability to do phone calls was not available during the field study. To monitor the usage of the mobile phones, we installed a logger application in all the phones. The logger run on the background and recorded the applications that had been opened by the pupils. The logger application created a daily text file with the phone IMEI, timestamp and name of the application launched. In addition, the logger took a screenshot of the active application every 20 seconds. The first author of this paper was present during the field study doing observations and giving support in case of any technical problems.

4 Adoption of the Use of Multimedia Phones during the Learning Activities

One of the goals of this research was to explore gender differences in using multimedia features of the mobile phone in class. From our observations made during the field study, apparently, boys seemed to be more distracted than their female peers while working with an assignment on the phone. For example, they explored other applications during an instructed task. Also, our observations suggest that boys are faster to adopt the mobile phones than girls. As initial point, we analyzed two learning

tasks: watching a video, and filming a video. The choice of these two tasks was based on the opportunity of analyzing different roles of the children: one as active role (filming video) and the other as passive role (observing a video).

Watching videos. Overall, there were six learning tasks involved watching videos, and the videos varied in terms of topic and duration. We restricted our population to two 5th grades groups who observed the same Math video (introduction of the multiplication of fractions), to ensure comparability. The video has duration of 5.7 minutes and was watched by 21 girls and 18 boys. In our first analysis, see fig. 1 (left), we found a gender difference in how many times the pupils observed the same video. In general, boys watched the video 1.2 times less than their female peers. To confirm this difference statistically, we conducted 2x2 between-subjects ANOVA to analyze the net time used for watching the video. The analysis revealed a significant difference between the groups 1 and 2 ($F_{1,35} = 6.65$, $p < 0.05$). However, the difference between genders was only marginally significant ($F_{1,35} = 3.77$, $p = 0.060$). As illustrated by fig. 1 (left), group 2 observed the video less times than group 1, while maintaining the trend between girls and boys.

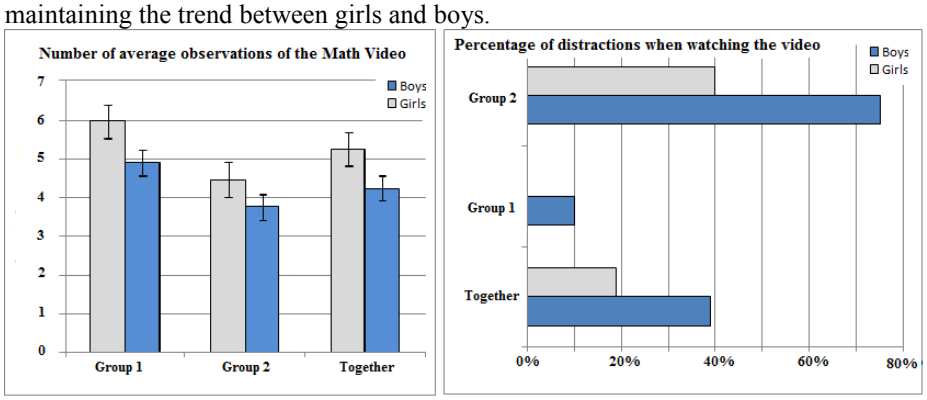

Fig. 1. Number of repeated observations of the Math video by gender and by class group *(left)*, and the percentage of interruptions in the video watching task *(right)*. Group 1 and 2 represent the pupils of 5th A and 5th B respectively. Together refers to both groups.

Fig. 1 (right) shows the number of distractions while watching the Math video by gender. We define distractions as the occasions when the pupils pause/stop playing the video and open another application on the mobile phone instead. Fig. 1 (right) illustrates that the number of distractions by boys (39%) is approximately double in comparison to their female peers (19%).This also explains the shorter time used by boys for watching the video. We notice also that in group 1 girls show no distractions, and the number of distractions by boys is considerably lower in group 1.

An explanation of the variation between the two groups showed in both graphs is that in the first group teacher used the video to introduce the concept (multiplication of fractions), while in the second group the topic was already introduced and the video was used to reinforce the learning. Another explanation is the learning effect. The group 1 observed the video during the first day of the field study and group 2 during the fourth day. This means that pupils in group 2 were already familiar with the mobile device. For both groups, however, this was the first time they were introduced to playing videos using the phone.

Filming videos. Although there were around 7 tasks involving filming video, most of them were realized in a team - every child had to film a video in one learning activity only. We analyzed the children's behavior during this task. In this activity, pupils had to go out to the school garden to film and describe a part of a flower. Children were free to choose the flower(s). This task was performed by children from the 5th grade of the first school, including 8 girls and 4 boys. The task was conducted during the third day of the trial, but it was the first task involving video recording. In general, we noticed two major gender differences: (1) All the girls worked in pairs – one filming while other presenting and vice versa; in contrast all the boys worked alone and filmed their own videos; (2) boys had no technical problems when filming, while two girls had difficulties with the task.

Fig. 2. Screenshot of the video recorded by the children for Nature Science class

Boys maintained focused in the flower as the main subject (fig. 2 right), while girls were more concerned about acting in front of the camera (fig. 2: left and center). All the girls cut off the flowers and held it in the hand in front of the camera; in contrast all boys completed the tasks without cutting it. As the boys created their own videos, they did not appear on the film in person. Six girls presented in front of the camera (full view), while two only partially (hand and lower body). The zoom option was neither taught nor explored by the participants.

5 Learning/adoption during explorative use

In addition to instructed learning activities, children were allowed to explore other functions of the mobile phone. Teachers reserved specific time slots (between 10 and 15 minutes) for free exploration, but unscheduled explorative usage also occurred during and between the instructed learning activities. We analyzed the explorative use of the phones mainly from log files containing active application history data. Findings from the quantitative log data were then contrasted by qualitative observations.

5.1 Log File Analysis

We did not have any a priori hypotheses, as the original focus of the study was in the learning activities. Due to lack of control in the field trial method, the results are affected by unknown random and potentially confounding factors. Therefore, the following results should be interpreted merely as hypotheses for future experiments unless strongly supported by qualitative findings. To avoid bias in selecting metrics

and comparisons, the log files were analyzed by a researcher who was not involved in the field trial.

Log files contained a time-stamped history of active applications. We analyzed the usage during the first 4 days, and excluded 3 users who participated less than 4 days. First, the applications were categorized in system applications (e.g., home screen, application menu), learning applications (e.g., Camera, Paint Pad) and explored applications. A subset of the last category was further classified as game applications. Second, a set of metrics were extracted from the log files. We analyzed the results using mixed-models ANOVA with *gender* and *school* as between-subjects factors and *day* as a within-subjects factor.

Time used for learning applications varied between the schools and days, but there were no systematic differences. Overall, the mean time used for learning applications was 60.8% (sd = 21.3%). For explored applications, there were significant main effects for *gender* ($F_{1,53} = 5.98$, $p < 0.05$) and *school* ($F_{1,53} = 6.86$, $p < 0.05$). In the first school, the mean exploration time by boys was 8.5% (sd = 13.4%) and by girls 3.6% (sd = 3.7%). In the second school, the corresponding results were 14.8 % (sd = 15.1%) for boys and 8.9% (sd = 8.9%) for girls. The remaining time was used in system applications. Idle time was excluded from the analysis using a threshold of 1 hour without an application switch.

By analyzing the explorative usage further, we found a significant *gender* difference for game applications ($F_{1,53} = 5.99$, $p < 0.05$). There were also significant *school-day* and *gender-school-day* interaction effects. A post-hoc analysis with Bonferroni correction revealed a significant *day* effect for the second school ($F_{3,132} = 10.91$, uncorrected $p < 0.000005$). This reveals that time used for games increased day by day, as illustrated by Fig. 4. Overall, the time used for games was more significant for boys ($\mu = 4.1\%$, sd = 9.6%) than for girls ($\mu = 0.3\%$, sd = 0.9%).

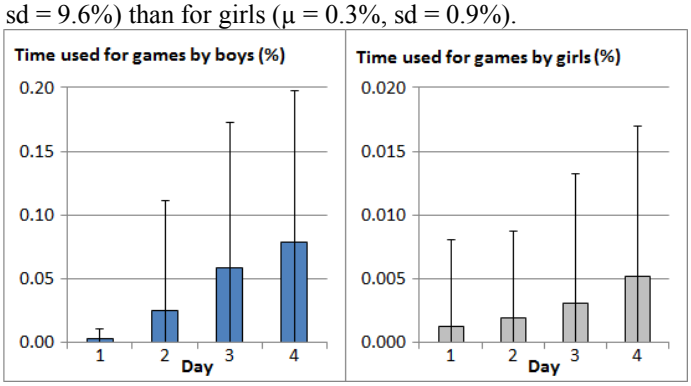

Fig. 3: Mean percentage time used for game applications.

Similarly to these findings, during the field study we observed that girls played games notably less than their male peers. One girl commented to us *"I find this game [car racing] very boring and difficult"*, while a boy stated *"I like this game [car racing] … is easy but I have to be concentrated"*. The most played game was the Global Race- Raging Thunder® where the player drives a car in a racing competition. Most of the boys played alone, but four boys discover that turning on Bluetooth allowed them to play against each other.

In order to analyze the scope of explored applications, we calculated the amount of new applications discovered daily by each user. System and learning applications were excluded from this analysis. We found significant main effects for *gender* $F_{1,53}$ = 12.28, $p < 0.001$ () and *day* ($F_{3,159} = 5.28$, $p < 0.005$). The mean amount of discovered applications was higher for boys ($\mu = 3.5$, sd = 3.0) than for girls ($\mu = 2.6$, sd = 2.2). The discovery rate decreased moderately with time. Cumulative amounts of discovered applications are illustrated in Fig. 5 (left).

We also analyzed exploration activity by calculating the frequency of switching the active application per hour. This metric includes learning and system applications, such as the application menu. We found a significant main effect on activity by *day* ($F_{3,159} = 5.28$, $p < 0.005$). Further analysis shows that there is an increasing trend in the activity during the first 3 days. Interestingly, the activity seems to decrease after the third day, as illustrated in Fig. 5 (right). Decreasing activity and slightly decreasing discovery rate may indicate that users found the most interesting applications during the first three days.

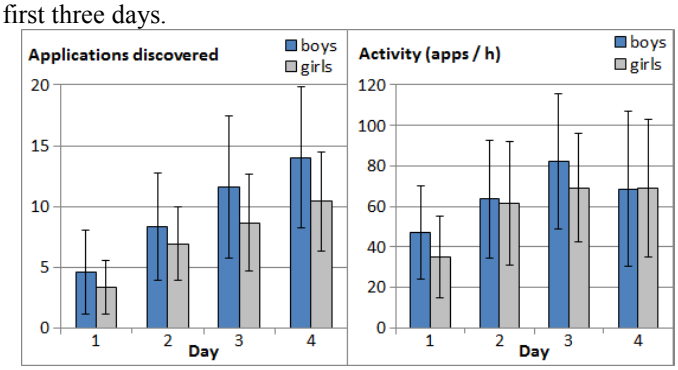

Fig. 5. Cumulative amount of discovered applications (left), and application switch frequency (right).

5. Discussion and Conclusion

Mobile phones have a great potential as learning tools. In the learning process children need to learn to use the basic functions and a variety of applications of the mobile phone to utilize the tool. Children are fast to adopt these skills, especially if they find the device interesting. Games and media applications can have an important role in maintaining interest and introducing new functions. On the other hand, such applications can distract the actual learning process.

A design challenge for future mobile learning devices is to balance pragmatic learning activities and free exploration. Our results indicate that there is a notable gender difference in how much children weight these activities. Boys are more active in free exploration and learning new applications, games in particular. Therefore, boys discover the basic functions of the phone faster. Girls are typically more focused on the learning task, but may be accidentally interrupted by problems in operating the device. One possible reason discouraging girls from exploration is that the existing games are more targeted towards boys.

The initial surveys and interviews [2,3], as well as the post-interviews after the field study indicate that teachers in Panama would welcome the use of technology in classroom. In particular, they welcome the use of mobile phones, as they are more commonly available and widely used than computers in Panama. Teachers with no prior experience of these technologies, react more skeptically to the use of technology for learning.

Because of the explorative and uncontrolled nature of our study, where each teacher designed their own learning activities, we received a variety of results and insights. As the learning tasks varied in content and form from grade to grade, the results are difficult to compare directly. The focus of this study was to capture the initial adoption of the mobile phones, a new technology for the children, thus the paper is limited to findings in this area. Nonetheless, we believe that our findings contribute in better understanding how children in unprivileged areas adopt the use of multimedia phones for learning with no preinstalled learning applications. Our future work will focus on longer term usage trends and gender differences in both in and out classroom settings. Also, we plan to conduct a controlled experiment to evaluate how using mobile phones actually affects the learning performance.

Finally, as touch-screen phones are a growing trend in the market, it is expected that in the near future the technology will become a commodity in low-end devices and reachable to people living in developing regions. This will enable the use of touch-screen technologies and widen the spectrum of potential mobile applications also for learning purposes.

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