# MOBILE APPLICATION FOR MOBILE LEARNING

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**ABSTRACT**

The paper presents a pilot case study intended to examine how socio-cultural and situated learning aspects are reflected in learning experiences within a novel mobile learning environment, Math4Mobile, a cellular application for mathematics learning. The case study focused on four students in a mathematics methods course who were engaged in a mathematics project based on the cellular applications. We found that use of the cellular environment enhanced the participants' engagement in the modeling of real life scenarios and contributed to collaboration between participants. These effects can be attributed to the mobility, flexibility, and availability of cellular tools, and they point to a possible contribution of mobile tools to mathematics education.

**KEYWORDS**

Mobile learning, cellular applications, collaboration, mathematics

## 1. INTRODUCTION

This paper presents a pilot case study involving learning processes within a mobile learning environment, Math4Mobile, a cellular application for mathematics learning.

Mobile phones are becoming a part of the daily culture of almost every student and teacher. They introduce new types of communication styles that remove spatial and temporal complexities (Alexander, 2004). Handheld devices can improve classroom dynamics owing to their computation and communication capabilities, which augment face-to-face interactions (Liu and Kao, 2007) and can support collaborative learning scenarios (Hoppe et al., 2003). In particular, Roschelle, Patton and Tatar (2007) noted that using handheld devices can enhance mathematics learning by providing a 1:1 student: device ratio and by enabling ready-at-hand access to technology throughout the school day and the learner's personal life.

Nevertheless, models for using and developing mobile applications for learning are somewhat lacking (Naismith et al., 2004). There is a need to formulate appropriate pedagogical models and to develop innovative strategies to integrate mobile applications in learning and teaching. Our project proposes to address this need by designing learning materials and applications that take advantage of the unique features of the cellular phone. In particular, our educational design takes into consideration the socio-cultural, situated learning paradigm. The data connectivity and communication aspects of mobile devices support social interaction, collaboration, and the construction of learning (Low and O'Connell, 2006), and may enhance interpersonal communication (Taylor et al., 2005). Being able to exchange work and applications through MMS and SMS, students and instructors can create a community in which they can work together, share knowledge, inspire each other, and interact socially (Tu and Corry, 2003; Reynolds et al., 2001). Mobile devices also offer opportunities to gain access to learning experiences while being immersed in a learning context –the real world (Low and O'Connell, 2006). Embedding the learner in a realistic context at the same time as offering access to supporting tools can enhance the active construction of personal knowledge (Naismith et al., 2004).

**The Math4Mobile environment** includes cellular applications designed to support mathematics learning. The applications can be installed in most cellular phones on the market. For example, the *Sketch2Go* application (Figure 1a) enables students to sketch graphs, using seven icons representing constant, increasing, and decreasing functions that change at constant, increasing, or decreasing rates. The application provides immediate feedback on the drawn graph by presenting a graph of the rate of change. Figure 1a shows a drawn graph (upward), the graph of the derivative, and the icons menu (downward). *Sketch2Go* encourages visual exploration of phenomena (e.g., physical temporal phenomena) by providing qualitative indication of the ways in which the sketch drawn by the user changes. The sketch motivates learners to experiment with a given situation, analyze it, and reflect upon it. Another application is *Graph2Go* (Figure 1b), a special-purpose graphing calculator that operates for given sets of function expressions. Its unique feature is enabling the dynamic transformation of functions. Figure 1b shows an algebraic expression which can be manipulated by changing its parameters, and the dynamic graphs of the function and its integral.

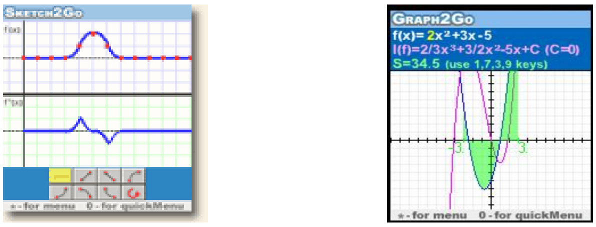


Figure 1. a. Sketch2Go; b. Graph2Go

These applications are an integral part of the learners' personal mobile phones, which they carry everywhere and at all times. The ability to use the devices to send graphs and formulas to other students as short text messages (SMS), the communication capabilities of the mobile phone, and the availability of cellular accessories such as cameras are expected to enhance the learners' engagement with mathematics learning.

## 2. RESEARCH DESIGN

The present research is designed as a pilot case study intended to examine how socio-cultural and situated learning aspects are reflected in learning experiences within the Math4Mobile environment.

**The learning setting:** We watched two pairs of students who studied in a mathematics methods course using the mobile applications. The course was focused on collaborative project activities supported by technological tools. Students were equipped with the necessary mobile phones and encouraged to use them for course-specific tasks as well as for their personal daily communication. The researchers met the participants face to face and introduced them to the cellular applications, then followed the students' work and guided them through cellular communication. At the end of the semester the participants presented their projects to the class.

**The participants** were four female mathematics major students studying for a teaching certificate. Participants were exposed to technological learning tools in a previous course.

**The project** included the use of the cellular video camera to record simple occurrences of temporal phenomena, the use of MMS massages to exchange video clips between participants, the use of the mathematical applets to construct graphs that represent the observed phenomena, and the use of SMS massages to exchange mathematical objects and verbal massages (explanation, justification, approval, or objection).

**Data collection and analysis:** The learning practices of the participants were fully documented and face-to-face activities were videotaped. Participants kept personal diaries to document their work. In addition, an interview summarizing the project was conducted with two of the participants. The analysis followed the grounded theory approach (Strauss & Corbin 1998), and the data were analyzed inductively to identify common patterns and norms.

## 3. ANALISIS OF THE LERNING EXPERIENCES

Although the experiment was short, we were able to identify some characteristics of the learning process within the mobile learning environment. The data collected from the participants' diaries show that the participants were actively engaged in mathematical modeling of real-life situations. Amman videotaped two kids walking: a boy walking forward and a girl walking forward to the middle of the path, then turning and walking backward. Ziva videotaped water pouring into two glasses of different shapes.

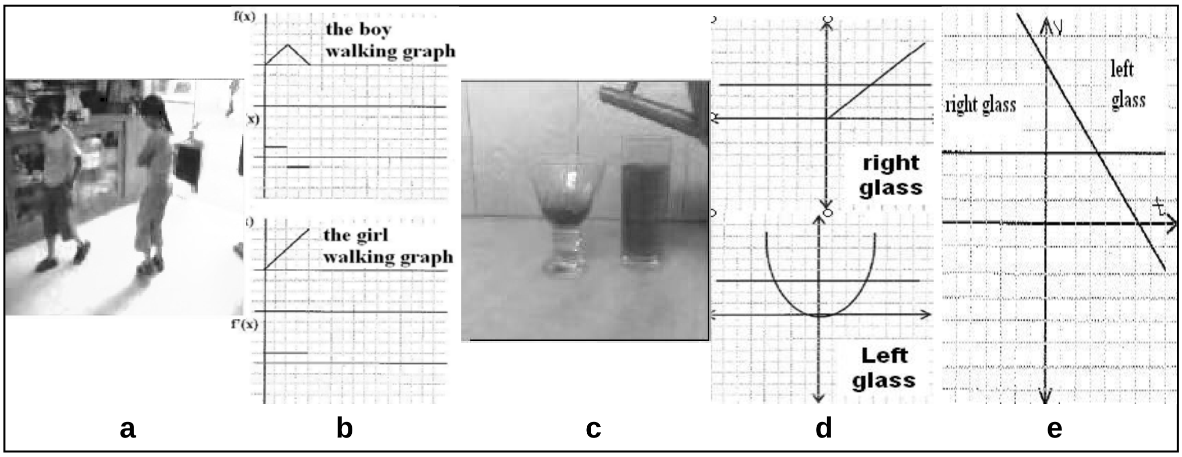


Figure 2. a. Videos of two kids walking .b. Position vs. time graph and its derivative. c. Videos of water being poured into glasses. d. Height of water vs. time. e. Rate of change of the height of water vs. time.

The participants exchanged their video clips and each pair used the mobile applications to constructed a graph representing the video captured by the other pair. Dana and Ziva used sketch2go to construct graphs showing the boy and the girl walking (Figure 2b). They added a verbal explanation and sent the graph to their colleagues. Ana confirmed that the graph was correct. Ana and Amman used the graph2go application to graph water height vs. time for each glass. The graph for the left glass was wrong (Figure 2d) because it shows an increasing rate of change rather than a decreasing rate change. Ziva asked her colleagues to review their graph but did not provide a mathematical justification for her request. Amman sent another graph representing rate of change vs. time created with the graph2go application (Figure 2e). Ziva confirmed that the graphs were correct and explained in her diary that using graph2go had the benefit of displaying the graph of the integral function alongside the graph of the function.

The active engagement in the modeling process can be attributed to the **mobility of the learning environment**: Participants used the cellular camera and the mathematical applications in a variety of contexts and sites. They indicated that the videotaping task and the graph construction tasks integrated well with their everyday lives and that mobile phones enabled them to use their time effectively (e.g., constructing a graph while traveling to the university). The participants' engagement in the modeling process can also be attributed to the **communication capabilities of cellular device**. Participants were able to share mathematical objects such as graphs through SMS massaging and to receive timely feedback from each other. The participants indicated that such interaction can strengthen student-teacher relationships and support informal communication between them. Another simple but important factor is the fact that applications were **handy and easy to use**. At the beginning of the project participants expressed doubts about using the cellular applications and wondered about the advantage of using them as opposed to solving problems with pencil and paper. By the end of the project they were proficient in using the mathematics tools, and when they presented their project and introduced the cellular applications to the class they persuaded most of their colleagues about the advantages of implementing this environment in schools.

## 4. CONCLUSION

The objective of this paper was to present learning experiences within a mobile learning setting and to examine how socio-cultural and situated learning aspects are reflected in these experiences.
Similarly to Sharples at al. (2005), we showed that not only the new technology was mobile but also the participants. Participants functioned as mobile learners in the sense that they used the mathematical application any time and anywhere, in informal settings, in the course of their everyday activities.

Socio-cultural aspects were reflected in the participants' learning practices and in their responses in the interview. Participants collaborated with each other and with the researchers in completing their project. In particular, their ability to send mathematical objects by SMS supported social interactions, the sharing of ideas, and the creation of new knowledge. We found that the contribution of the mobile environment lies not only in making dynamic mathematical application more available, but also in supporting the execution of mathematical tasks that are closer to the students' experiences and more relevant to them, which has the potential to enhance experiential learning (Lai et al., 2007). The results of this pilot experiment contribute to further investigation of the benefits of cellular applications in a wider range of student-centered learning and teaching situations.

## ACKNOWLEDGEMENT

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