Anytime, Anywhere Learning Supported by Smart Phones: Experiences and Results from the MUSIS Project

Marcelo Milrad and Daniel Spikol
Center for Learning and Knowledge Technologies (CeLeKT), Växjö University, Sweden
marcelo.milrad@msi.vxu.se // daniel.spikol@msi.vxu.se

ABSTRACT

In this paper we report the results of our on-going activities regarding the use of smart phones and mobile services in university classrooms. The purpose of these trials was to explore and identify which content and services could be delivered to the smart phones in order to support learning and communication in the context of university studies. The activities were conducted within the MUSIS (Multicasting Services and Information in Sweden) project where more than 60 students from different courses at Växjö University (VXU) and Blekinge Institute of Technology (BTH) participated during the course of their studies. Generally, the services integrated transparently into students' previous experience with mobile phones. Students generally perceived the services as useful to learning; interestingly, attitudes were more positive if the instructor adapted pedagogical style and instructional material to take advantage of the distinctive capabilities of multicasting. To illustrate, we describe a number of educational mobile services we have designed and implemented at VXU and BTH. We conclude with a discussion and recommendations for increasing the potential for successful implementation of multicasting mobile services in higher education, including the importance of usability, institutional support, and tailored educational content.

Keywords

Ubiquitous Learning, Educational Mobile Services, Smart Phones.

Introduction

In the past decade, the Internet has spawned many innovations and services that stem from its interactive character. The emergence of ubiquitous and inexpensive microprocessors and wireless networks has lead to the wide deployment of mobile devices that allow us to access and to handle information almost anytime and anywhere (Roussos et al., 2005). Diverse multimedia applications have flourished with recent advances in hardware and network technology with the proliferation of inexpensive video-capture devices and widespread adoption of the worldwide web via these mobile devices. All these forms of interactive multimedia and communication offer new possibilities for supporting innovative ways of learning, collaborating and communicating (Milrad, 2003; Thornton & Houser, 2004). These technologies and new forms of mobile communication and collaboration have been widely adopted by young people and integrated into their everyday lives. Clear indications of this trend can be found in sites such as www.youtube,com, www.flickr.com, and www.facebook.com. However, this transformation does not live up to the promises and expectations when it comes to the use of mobile technologies at schools and universities (Norris et al., 2002; Tatar et al., 2003).

Lankshear and Knoble (2006) claim that formal education ignores some of these trends and argue that mobile and wireless technologies and new media might be integrated into current school educational activities, as they are transforming and defining new literacies in teaching and learning. Thus, there are a number of challenging questions that deserve further exploration. What are the implications of using mobile computing and wireless communication for supporting learning and teaching? What new scenarios and applications will emerge? In order to understand the possible impact of using smart phones for facilitating learning and teaching, we will proceed by presenting the results of one of our on-going projects, MUSIS (MUlticasting Services and Information in Sweden).

This paper presents the results of two pilots studies conducted within the framework of the MUSIS project between the periods of 2005 and 2007. By presenting these two periods of the trials, we hope to gain new insights regarding how attitudes and expectations towards using mobile phones in educational settings may have changed over the last two years. The next section describes the MUSIS project and the technical infrastructure. The method section describes the implementation of the trials and the data collection techniques we have used. The results and discussion section describes the outcome of our trials and explain how students experienced the mobile services. Issues and

problems are discussed with regard to the technology and its use. Overall conclusions are provided in the final section of the paper.

A brief overview of the MUSIS project

The main objectives of the MUSIS projects are to explore, identify and develop a number of innovative multicast mobile services to support learning with multimedia information to be distributed over wireless networks using multicasting solutions at university. The project has had two pilot phases, the first one during 2005 and the second in 2007. MUSIS (http://www.musis.se) has brought together different partners. The key partners have been TeliaSonera (TS), Sweden's largest telecom operator, the City of Stockholm, Växjö University (VXU), and Bamboo MediaCasting, a company pioneering in the field of cellular multicasting. Also, Luleå Technology University (LTU), the Royal Institute of Technology (KTH) in Stockholm and the Blekinge Institute of Technology (BTH) have been actively involved in the project.

Multicasting mobile services developed in the MUSIS projects are organized as a range of content channels to which users can subscribe. Each user can build a personal portfolio of channels that interest them. Multimedia content is sent, according to a predefined time schedule, to subscribers over the GPRS (General Packet Radio Service) network using wireless multicast technology (Varshney, 2002). It is also possible to program the MUSIS system in order to send content to the phones based on discrete events. The content sent to the phone is downloaded in the background and stored on the phone's memory card. Once the content has arrived, the phone beeps announcing a new message has been received, similar to standard message services. Users can then interact with the MUSIS client installed in the smart phone in order to view and save the content. This approach differs from the latest type mobile services offered by the telecom industries, which are using streaming technology. The digital content used in these trials included TV news, music, entertainment videos, general information related to student's activities, such as lecture notes (including video and audio), and specific information related to the different courses.

During the second phase of the project, we introduced additional content tools for the users allowing them to multicast video, audio, images, and text directly from the handset. We also expanded the web interface that controlled the subscriptions to include the ability to upload and convert content for multicast delivery. This fundamental change in this trial focused on shifting the traditional broadcast model we used in phase 1 of the project from a one to many model, to a many-to-many model, thus providing students with the ability to explore how these concepts could be used in an educational environment. The content in this phase was created by the students and the instructors and it included text, calendar events, photographs, and video. All these materials were sent between the students´ groups and back and forth between the instructors and the students.

Technical aspects

A complex technical infrastructure has been developed in order to deliver the different mobile services to the students. This task requires complex software solutions in order to connect and combine the content coming from different content providers. Figure 1 illustrates the generic technical architecture and the different hardware and software components used in the project.

Bamboo's equipment provides the multicasting feature in the GPRS network. The content management system (CMS) located at TS is responsible for scheduling the content transmissions. The MUSIS CCS (Collect, Convert and Send) developed and implemented at VXU is responsible for collecting, organizing, and converting the different digital material coming from all content providers (including educational material produced by the teachers) as described above. The MUSIS CCS system provides tools to manipulate content automatically and transmit it to Bamboo's router for distributing to the users. The CCS can get the content from the content's resources based on pre-defined rules, convert it to formats that are supported by the mobile handset and transmit it to Bamboo's server. These activities can be done automatically without human intervention.

The following illustration (see figure 2) describes the generic architecture of the MUSIS CCS system. As seen in the illustration below, the system is based on several different inputs and outputs. The system, which has been implemented using Java related technologies, is scaleable and it consists of modular, reusable and easily expandable

components to be able to deal with new types of content. This includes all features, i.e. the collecting, converting and the sending mechanisms. The system is programmed in Java using JSP and Java Beans on a Linux platform. It also uses open-source tools and applications.

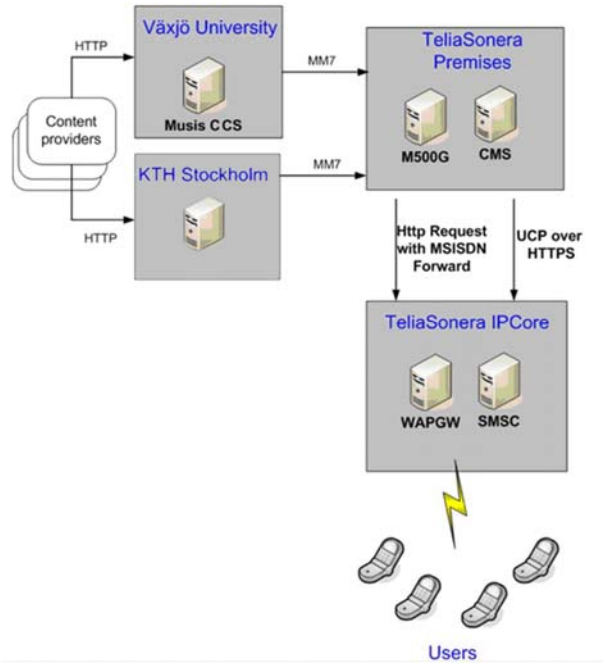

Figure 1. MUSIS generic architecture

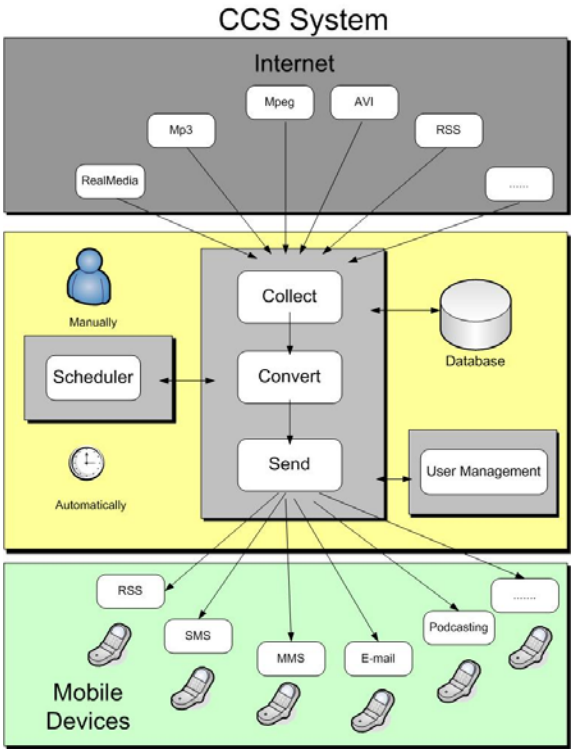

Figure 2. Generic illustration of the CCS system (Collect, Convert and Send)

In the next section we concentrate on those activities carried out at Växjö University and Blekinge Institute of Technology. We present the results of a couple of pilot studies conducted over a two years period, focusing specifically on the question of whether students would find a mobile phone useful for supporting their learning, and in particular whether multicasting mobile services would be suitable for supporting learning and other activities related to their academic life. These studies aimed to look at the patterns of use of the various mobile services and the impact on students' learning habits. We were also interested in determining what type of functionality is required for educational mobile services to be considered useful. Our results lead us to advocate a comprehensive approach regarding the introduction of smart phones and mobile services in university classes that considers not only technical features but also the individual, social and organizational aspects of technology adoption.

Method

Participants

For the first set of trials, we solicited volunteers from students enrolled in two courses offered at VXU during the spring term of 2005. One course was offered at the School of Humanities, and the other at the School of Mathematics and Systems Engineering. After a short presentation delivered by members of the research team at the beginning of the term, students from these two courses volunteered to participate in the pilot. Twenty-two students from the course in the School of Humanities and nineteen from the School of Mathematics and Systems Engineering volunteered. Each volunteer was given a "smart phone" for the duration of the school term (3 months). Although the number of smart phones available limited the number of participants, we were able to provide phones to all students who wanted to volunteer as participants. Each student signed a contract of use that specified their obligation to participate in the project in return for free use of the phone and a small amount of money they could use to make phone calls. The project also provided continuously available online and face-to-face support. The project began with a workshop session to familiarize the students with the smart phone and the software. Participants ranged from 19 to 40 years of age, with a mean age of 26. Nineteen were female and twenty-two male. All 41 students already owned at least one mobile phone at the start of project. With regard to the issue of how much they spent on their own phone services before joining the project, on average a student in this group paid 28 USD a month. Twenty per cent of the 41 students participating in this study spent more than 45 USD a month.

For the second trial, we worked with BTH students during the spring term of 2007 in a special project course in the Literature Culture and Digital Media in the Humanities program (END011). Twenty-one students and two instructors participated in the trial over a five weeks period. Participants ranged from 20 to 26 years of age, with a mean age of 24. Eleven were female and ten male. The students organized themselves into five groups consisting of 4 persons each. The expected outcome of the course for the students was to produce 5 pilot mobile applications that will help tourists to explore the history of the local city in novel ways using mobile phones and interactive storytelling techniques. The students in this trial all owned at least 1 mobile phone and spent a similar amount in phone costs compared to the 2005 trial.

Equipment and Services

The participants of the studies were each equipped with smart phones. For the first trail the students were supplied with NOKIA 6630 phones and for the second trial NOKIA N70 phones were used. Both phone models run on Symbian based operating systems and have mobile internet browsers, cameras with digital zoom, video, still, and audio recording, and RealOne's player for playback and streaming of 3GPP-compatible and RealMedia video clips. Additional applications include a personal information management (PIM), a calendar, and a contacts database. Users could synchronize contacts and calendar stored on the phone with data stored on a personal computer. Since the Symbian operating system is open we were able to develop a Python application that enables mobile multicasting from the handset. This particular feature was implemented during the second trial.

Technical development of MUSIS services took place concurrently in both studies, enabling refinements during the project cycles. For the first pilot phase that took place during the period March 1st- April 30th 2005, all participants accessed the same set of channels, receiving approximately 5 to 7 MUSIS messages (push technology) daily. One of these channels carried educational content related to their VXU course. Subscription to the educational channel was

compulsory throughout the project. However, beginning May 1, 2005 users were able to subscribe to up to 30 channels of their choice using a Web interface (both available via a PC or a mobile phone) specially developed for this project. During the second phase that took place during April 1 to May 24, 2007 all participants and two instructors accessed two public channels and then each of the five groups had a group channel for inter-group communication. In this paper, we focus specifically on our experience and results with the different educational channels only.

Figure 3. The MUSIS client interface (left) and the mobile multicast client interface (right).

Implementation of phase 1

For the first trial, educational materials delivered for this project include small ”micro lectures” in video format, voice based course information and assignments, and specific information related to the logistics (calendar information, cancellation of lectures and so on) of the different courses. In the case of the ”micro lectures” the audio based and text information, the contents were developed for (and sometimes tailored to) the phone by the course instructor. In order to send this material to the phones, the teacher used a special web interface we designed for this purpose. We also developed a number of solutions that allow internet-based educational resources used in the course to be sent automatically to the phones. Instructors were also given a smart phone of the same type given to the students.

FirstClass (FC) is a communication platform used at Växjö University mainly for distance education but also for campus based courses. There are two ways of accessing the FirstClass application. Students can use the FC client software or a web-based client directly from any browser. In the current version implemented at VXU, the only way to deliver FC content to mobile phones is by purchasing a very expensive SMS module. We developed an application using java and XML that it is used to convert the instructor’ contributions in the FC forum to an RSS (Real Simple Syndication, an XML format for syndicating web content) feed that it is then multicast to the phones. The java application was running in the background of the FC forum, so the instructor’s contributions to the forum were automatically transformed to a format suitable for the phone. The content from the FC forum arrives to the phones as a file in HTML format that can be viewed with the phone’s Internet browser.

Implementation of phase 2

In the second trial, the MUSIS system was used to foster collaboration and communication between the instructors and the students. Figure 4 below illustrates how communication and collaboration between the teachers and the student groups was envisioned. Instructors and students could multicast to group members, the entire class, specific groups and instructors using the mobile application we developed for the handset, as well as the development of the web-based interface to achieve the same goals. The system and the smart phones supported group and class interaction. This allowed the students to schedule group work and giving the instructors an additional way to give feedback using video, audio, and text messages to the class and the students´groups. This also provided ways to coordinate and organize the class work with calendar and text based messages sent to the phones.

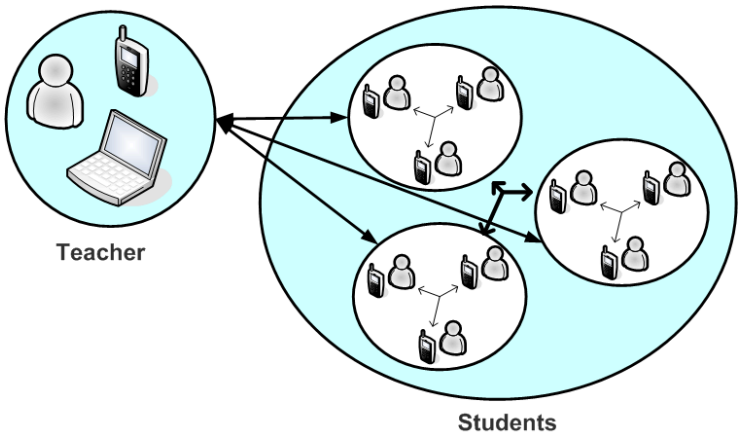

Figure 4. Communication and collaboration between instructors and student groups

In this second phase, we modified the multicast model to allow any user at anytime and from anywhere to multicast content from the smart phone. This fact opened up different ways to use the technology not only in educational contexts but also to support students´ daily activities. The key application that enabled this feature was a python application we developed enabling digital content generated with the smart phones (including video, still photographs, and audio) to be uploaded to the system and then multicast as an event to a particular channel. In addition, the application also provided plain text and calendar events that could be multicast.

Data collection across both projects

Given the exploratory nature of these studies, we used multiple methods to collect data for both phases of the MUSIS project. This allowed us to scan the patterns of uses and attitudes that could be investigated more specifically in future studies. For the first phase participants completed web based questionnaires in weeks 1, 5, and 10 of the project. The first survey included items that measured personal attitudes toward mobility, attitudes toward media formats, and how much different media formats were used. The second and third surveys included items regarding perceived effect of the phones on learning, preference for different media formats, preference for channels, and perceptions of telephone functionality and usability. Additionally, members of the research team facilitated four focus group interviews with 15 participants, which were videotaped.

The focus group ranged in size from 3 to 6 participants. The interview covered issues regarding the participants' perception of the project in connection to the services, the functionality and usefulness. Additionally, the participants were asked to suggest and discuss additional educational mobile services that could be developed. Finally, a 90 minutes workshop with the students was held at the end of the term, which was videotaped. The purpose of these sessions was to carry out an open discussion with most of the students in order get an overall view of how the students experienced the project. In the second phase of the project we continued using multiple methods to for data collection. Focus groups sessions with each of the groups were videotaped, covering perception and future uses of the technology. Additionally, the communication data was collected providing some additional insight on how collaboration and communication in each group and how the mobile application supported this. The main objectives of all these activities were to assess the usefulness and quality of the services, to identify problems experienced by the students and to explore how future MUSIS services could look like.

Results and discussion

General use and attitudes

The majority of the students participating in the two MUSIS pilots had mobile phones of their own before they joined the project. Therefore, delivering content directly to the smart phones is transparent for them, integrating not

only with their existing day-today practices, but also with their views of mobility and accessibility as central to their life-style. It is important to note that even if their personal handsets supported a variety of features such as e-mailing, surfing the Internet, calendar support, and so forth, most participants used their phones only for making ordinary voice calls or for receiving/sending SMS. During the course of the first trial, students' attitudes toward the services improved when they could for instance start choosing the channels of their preference and explore cost free the additional services. Through out both trials time periods the students perceived the MUSIS mobile services as something potentially useful, dynamic and as something that could be integrated in their every-day life.

Did students find mobile phones and multicasting useful for supporting their learning?

In the first set of trials, the participants were more likely to see the multicasting service as useful the more it was integrated into their course content. The cases presented in this paper differed substantially in how the instructors and the students used the technology. In the earlier trials, one instructor (for MEA708, in the School of Mathematics and Engineering) did not adapt his assignments or activities for the technology. The other instructor (for GIX 131, in the School of Humanities), actively produced content for this new medium. In addition to sending a relatively high number of MUSIS messages (41) to students, 7 were multimedia in form (video and audio).

Table 1. Perceived usefulness of the educational mobile services after 5 weeks (n=41) and 10 weeks (n=41)

Course	**Week**	*Very useful*	*Useful*	*Fairly Useful*	*Not Useful*
GIX131	5	27.3%	45.5%	18.2%	9 %
MEA708	5	10.5%	52.6%	21.1%	15.8 %
GIX131	10	40 %	26.7%	20%	13.3%
MEA708	10	5.9%	35.3%	41.2%	17.6%

The importance of integrating the service into the pedagogy or instructional style of the course is illustrated in Table 1, which reports results from the survey item, "How useful did you experience the course related information sent to the educational channel". In both classes, the majority of students saw the educational multicast services as useful or very useful in week 5. However, by week 10, that figure had dropped to less than 50% for MEA708. At the same time, the number of students in GIX131 viewing the services as "very useful" grew substantially.

In the most recent trial conducted at BTH (END011), the initial thoughts of how to use the system between the students and the instructors differed. The students expressed interest in using the system for communication and relevant school information while the instructors' concerns were on supplementing the student feedback with the technology. While the student groups sent 24 messages where 10 of them concerned specific project work scheduling and the remaining where more social. The instructors sent a high number of messages (25) where 12 were video feedback to the different groups about ongoing work and the remaining organizational about course times and deadlines. Table 2 illustrates how the perceptions changed as the system was used during the trial. Over the 5-weeks trial period, the students' perceptions changed, team communication was used and perceived as being helpful and very helpful. The instructor's feedback over the trial period was evaluated as being not helpful by more then a third of the students, while slightly less then a third felt more positive about the feedback and the remaining undecided. The analysis of these results gives us the opportunity to think about further research issues regarding how to best provide feedback with mobile devices in future trials.

Table 2. Perceived usefulness of the educational mobile services for the END 011 course after 5 weeks (n=21)

Initial Perceptions	**Week**	*No interest*	*Low interested*	*Interested*	*High Interested*
Team Communication	1	0.0%	19.0%	28.6%	52.4%
Instructor Feedback	1	19.0%	33.3%	28.6%	19.0%
Final Perceptions	**Week**	*Not helpful*	*Helpful*	*Very helpful*	*Undecided*
Team Communication	5	17.0%	21.0%	43.0%	19.0%
Instructor Feedback	5	38.0%	5.0%	24.0%	33.0%

With regard to usability and functionality of the phone itself, participants reported dissatisfaction with the small size of the mobile phone buttons, the quality of video, the small screen size, and the limited battery life of devices.

Discussion

These two trials clearly illustrate that both, students and teachers are open and intrigued while using everyday mobile communication and collaboration tools in education. What is still lacking is an understanding of how these tools provide new collaboration modes and how self-organizing environments can provide educational benefits (Dron, 2007). The perceived needs of the instructors and students remain unsynchronized with the instructors' desire to use the smart phones for providing feedback to the students while the students prefer more logistical and practical information to be delivered to the handsets. The creation of rich media like audio and video generated by the students requires more efforts than the traditional use of SMS and chat. From this perspective, having students working and communicating using these new media types may have some impact on the different educational activities (Lai & Wu, 2006).

An unexpected finding took place in both trials based on the outcomes generated from the assignments developed by the instructor in the earlier pilot, and then again in the most recent trial regarding the use of the mobile application for many-to-many multicasting. Contrary to email, SMS, chat and other type of more instantaneous communication, students and instructors spent significant time staging and composing their answers and feedback, often recording multiple "takes" before the final video or audio was sent in to be multicasted. This suggests that a common practice of "composing" text messages may extend to audio and video messaging as well. Indeed, preliminary analysis of these recordings shows that the users tried to compress information not by indistinct, fast talk (similar to the abbreviations of SMS), but by concentrated, effectively expressed sentences.

Conclusions and future development

These studies were designed to explore the patterns of use of a number of mobile services experienced by students at a couple of university campuses and other locations of their choice. In the second trial these patterns of use were extended to provide the individuals the ability to multicast to the channels of their choice and to explore new patterns of collaboration. Impact on learning itself was not measured, nor would it have been possible to measure it meaningfully when the devices were used for such diverse purposes. Phone-optimized content was heavily used, and there was a clear request from the students that more resources be made available in this format, including administrative information from the universities. It is also important to recognize the need to address the technical requirements of producing and sharing of content across multiple types of devices and networks. This clearly points towards a low barrier for adoption of these mobile services by students in the near future if the ease of use between smart phones and traditional e-learning materials can effectively harnessed in ways that make sense and provided that the cost is comparable to wireless broadband.

Ownership of the technology is clearly important. As long as the phones are loaned, students are reluctant to invest time and money in personalization. This will prevent better evaluation of the impact of technology on learning. Greater institutional support is needed in order for the smart phones to be used more fully. Regular updates of timetables and content, as well as adequate training and hardware provision are needed. As more students bring the technology with them to the university, change will most likely be driven by their demands as learners.

Our results confirm the importance of designing applications and services for learners that are easy to use "on the road" that could be completed in short bursts of time (Wuthrich et al., 2003). Multicasting is one way to support what Brodersen, et al. (2005) call ,"nomadic learners" who are more project oriented and who send much of their daily life, "transit between many physical places ("oasis") such as classrooms, labs, workshops, libraries, museums, the city, nature, clubs and at home" (p. 298). However, our results also suggest that in higher education, a challenge is on designing for social technologies that allow for bridging different pedagogic goals (control of learning) and ways of communication between the different actors in the learning environment. These latest aspects require more than designing just services to connect people and content (Dron, 2007), but also creating new didactic sequences and educational activities that can connect formal and informal learning settings.

As our work continues, we will try to enhance the educational aspects of the mobile services by developing and implementing various solutions to specific problems we have identified based on our observations and the data we have collected from the students. Our future efforts will continue to refine both the technology and activities for providing learners with more meaningful experiences with regard to the use of smart phones in educational settings by providing more tools for collaboration that take in consideration of the needs of both instructors and students. Coming research activities include the continuation of our efforts within the framework of a new international project exploring the use of mobile devices for game based learning and field studies in natural science, math, and physical fitness supported by mobile applications.

Acknowledgement

MUSIS is partially funded by governmental bodies – Sweden's VINNOVA and Israel 's MATIMOP - as part of the SIBED program, a joint Swedish-Israeli mobile technology research effort.

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