

Towards Mobile Tour Guides Supporting Collaborative Learning In Small Groups

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Abstract. Within this paper we address the problem of supporting small groups of museum visitors by means of museum tour guides based on mobile devices. Instead of forcing members of such groups into isolation, as today's personal museum guides do, we aim at supporting the potential of collaborative learning within such groups. In order to evaluate our approach, we propose a large scale user study evaluating the effectiveness of the group collaboration encouraged by the system.

1 Introduction

Starting with simple, audio-cassette based museum tour guides, the development of such guides over the past years has led to mobile museum tour guides capable of automatically reacting to the user context (i.e. user position and orientation) and automatic adaptation to users specific preferences and needs (e.g. [1]). Some of the systems are even capable of dynamic content adaptation, based on the user's interaction with the system (e.g. [2]). Furthermore, modern mobile museum tour guides are no longer limited to audio output. They feature mobile devices with high resolution colour screens, allowing for images and video-clips to be watched on the device. Even virtual characters, playing the role of a museum tour guide (see [3]), have been realised.

However, all of these different mobile tour guides share a common concept. They are designed to support an individual, single visitor in a museum setting. The original idea of the audio-cassette museum tour guides was to allow individual visitors of a museum to have a guided tour, since human tour guides are usually only available for groups. However, most of the visitors in museums nowadays do neither come as a large group (allowing them to have a human guide) nor as an individual. They visit the museum in small groups, like a family or a couple of friends (as discussed in [4]). Using any of the currently available personal, mobile tour guide systems will force the members of these small groups to separate and take a tour designed for individuals. Instead of sharing a common experience and benefiting from each others knowledge and understanding

of the material presented in the museum, the individual group members become isolated.

The work described in this paper will aim at the support of these small groups. We envision a situation where the following scenario becomes possible:

Charles, Julia and Ben are visiting a technically oriented museum. While Charles is interested in electronics, Julia and Ben are more into mechanics. Each of them is renting a mobile museum tour guide. The system, being aware of the individual user interests, automatically determines an optimal tour through the museum which will be of high interest to each of them. While visiting the individual exhibits suggested by the system, different content, focusing on the particular interests of each group member, is delivered to each of them. However, these presentations are not completely individual, since they share some common parts (i.e. general information) and even more, since the group members visit the same exhibits together. For example, when looking at a plane in the museum, Charles will receive detailed information on the navigation systems while Julia and Ben are informed about the mechanics of the under carriage. However, all of them will first get some introductory information, for example on the manufacturer of the plane, what it was used for and how it came to end up in the museum. After a presentation regarding a specific exhibit is over, the system calculates the potential knowledge gain in each group member and encourages them to share what they have learned with their friends. At the end of the visit, Charles, Julia and Ben have had a shared experience in the museum while their individual interests have been satisfied.

The basic idea behind our concept is to support the collaborative learning potential within small groups when visiting a museum. We plan to integrate virtual characters in order to facilitate the communication between group members, since literature suggests that these characters have a positive influence on the effectiveness in computer based learning scenarios [5]. We believe, that our approach based on mobile devices yields a high potential to support group collaboration [6].

We plan to conduct a large scale user study (~ 100 participating individuals) with children in the age group of 10-12 years. The goal of the user study is to evaluate the proposed mobile museum guide with respect to the task difficulty perception and knowledge gain of the participants as well as the effectiveness in supporting group collaboration within small groups.

In the following section, we will discuss the theoretical background of our approach, which is followed by a detailed overview on the set up and proposed evaluation method of the user study.

2 Theory and Background

2.1 Informal Mobile Learning in Museums

Mobile technologies have become very popular over the last 10 years. They emerged in a variety of different aspects of human life, e.g. mobile phones changed

the way we communicate. Since the late 1990s increasing interest has emerged in mobile technology usage within educational settings [7].

During the last five years mobile learning has been applied to a variety of educational settings, e.g. outdoor learning, learning in museums, classroom settings. Mobile learning incorporates two major advantages over other forms of technology-supported learning. First of all, mobile technology is not limited to one specific place, thus providing a greater integration into learning activities and the surrounding environment [8]. Learning used to be restrained to the place where the computer station was set up, now the learner is independent of location. Moreover increased mobility supports face-to-face collaboration among children [9]. Now children not only have to interact virtually with each other at another computer station but also can interact with each other directly, yet having digital tools at their disposal. Secondly, mobile technologies are context- as well as location-sensitive [10]. They are aware of their own location as well as that of other devices. Context sensitiveness is of interest for educational settings where learning itself is spread throughout space and specific collaboration is thought to take place among learners. This has proven especially valuable for places where learning takes place outdoors [11] like national parks. But it has also shown to have a great impact on learning that occurs indoors: in classroom settings, where it solved problems in settings without technological support [6], as well as in informal learning settings, like museums for instance.

Usually studies on mobile learning in museums involve a mobile device displaying a guided tour of the exhibitions in that particular museum. The guided tour in general is multimedia based, incorporating pictures, text, audio and/or video.

Still, there are some limiting aspects as well. The majority of studies are realised with PDAs and they do not allow for much content to be shown at once [8]. While evaluating learning scenarios, one should consider that tablet Pcs might be more difficult to handle but they also provide the required functionalities to engage in collaborative knowledge building like concept mapping. Moreover there are new emerging demands that ask for further technological and software developments like lower energy consumption for hardware or improved user interfaces [12]. Even though there still seems to be a need for further improvements, technological as well as pedagogical, quite a number of researchers are convinced of the future importance and impact of mobile technologies in education [13]. We share this belief, but would argue that in particular with catering to the needs of younger learners, more will need to be done with mobile devices than just making instructional content available to them. Virtual characters, we argue, are particularly well suited to support the segment of young and very young learners in informal settings.

2.2 Informal Mobile Learning with Virtual Characters

Research on virtual characters has been conducted primarily from a technological perspective [14]. A few studies started to consider the usage of virtual characters in educational settings [15].

One advantage of virtual characters is their social nature. Even though studies address the beneficial impact of virtual characters on learning [15], they have not been tied up with mobile learning environments on a larger scale. There is some evidence that the mere presence of a virtual character results in perceptions of reduced task difficulty [16]. This has been coined the persona effect. Since mobile learning fosters social interaction as well as mobility, it seems to be especially important to provide a guide or model that leads the learner through the learning process. Virtual characters can provide the support needed by learners during learning activities [17]. Some research has been done on the social effects of virtual characters in interactions with humans [18]. Relating those effects to human learning in informal mobile learning environments is yet to be done.

Providing the learner with a variety of perspectives on the learning content promotes knowledge construction [19]. The provision of learners with multiple perspectives is one of several principles stated in constructivist learning theories and is said to support and enhance the learning process. Some evidence can be found that the usage of virtual characters in constructivist learning environments results in greater knowledge acquisition [20].

In the current study we would like to address the above stated research lack through introducing virtual characters to an informal mobile learning environment that is based on constructivist principles. Thus combining advantages of mobile learning encouraging collaborative learning in museums with the implementation of social supportive aspects of virtual characters.

2.3 Group Modelling

As museums are more in tune with their social values and contemporary issues, they are increasingly recognised as social places. This is reflected in the work of Petrelli et al. [4], who observed that very few visitors went to the museum alone. It is conceivable that a group of people may have conflicting preferences and needs, and the generation of a recommendation which addresses the requirements of all the people in the group is much more complex than that of an individual. Moreover, they also observed that people act differently when visiting museums with companions, as opposed to visiting alone. People's behaviour typically depended on the group of people they were with (e.g. a person may be more motivated to learn about how a motor operates when he is with a knowledgeable friend).

Much work has been done in addressing groups in various domains. Masthoff [21] conducted two experiments on how a group of people select a series of TV programs for a group of viewers. She explored how people choose a sequence of programs to watch based on individuals' preferences from a third-person point of view. She also examined the satisfaction level people indicated with sequences of programs applied with different strategies. The results show that people (1) accounted for fairness and tried to avoid individual misery, (2) used normalisation (i.e. their satisfaction is based on both selected and non-selected items), and (3) used ratings in a non-linear way.

Another example of a group modelling system is MusicFX [22] used in a fitness centre to adjust the selection of background music to best suit the preferences of the people working out at any given time. One interesting facet of the system is that a group in the context is made up of people who happen to work out at the same time, unlike the sense of a group addressed in most other projects (e.g. [21], [23], [24]), who are non-strangers, such as friends or family members. Another distinctive aspect of the system is that it uses explicit preferences of all inhabitants to make a selection that will directly affect everyone who is present. The evaluation demonstrates that a good majority of users (71%) felt the music being played improved and that the people's musical preferences were better matched.

Group modelling is also attended in city tours. In the INTRIGUE project, the ranking of attractions are separately ranked by first considering the preferences of each *homogeneous subgroup* before combining them to obtain the overall ranking for the whole group [25]. In addition, some subgroups could be particularly influential either because it contains a majority of the members of the group or because it represents a relevant tourist class (e.g. children and disabled people).

Although a fair amount of literature has contributed to modelling heterogeneous groups in various domains, yet there is little work in the museum settings. Sotto Voce [24] is designed to accommodate a group of users, but does not include a personalisation component. The PEACH project also raised some interesting issues in how to personalise the information delivered, for example, following Kruppa [23] in providing some common information to the group on a large display and some personalised information on a hand-held display. Kay et al [26] also presented a scenario of how an adaptive museum guide may deliver personalised information to each individual in a group, which in turn stimulates after-visit group discussions.

3 Proposed Experiment

In order to evaluate the proposed system, we are designing a user experiment, which will be carried out in cooperation with the Nicholson Museum⁴, the first Australian archeological museum, located at the University of Sydney campus. The goal of the user study is to evaluate the effect of the proposed mobile museum guide in supporting group collaboration within small groups. By running this comparative experiment, we expect that the groups accompanied by a virtual character will prevail. In other words, participants with a virtual character are expected to have lower perception of task difficulty and higher knowledge gain than those without a virtual character.

⁴ The Nicholson Museum: <http://www.usyd.edu.au/nicholson/> (accessed 28 February 2005).

3.1 Settings and Methods

This study will take place during regular school-class visits in the Nicholson Museum. The museum provides a couple of programs⁵ designed to complement the Primary and Preliminary Syllabus⁶ in the New South Wales, Australia. We would like to target our subjects to primary children aged 10–12. We expect to have around 100 participants.

We envision the experiment to be of 2x2 research design, as shown in table 3.1. Each participant of the visit groups will belong to one of the four divisions, which will be around 25 participants in total for each of the conditions. To begin with, half of the participants in each visit group will be presented with a mobile tour guide system on a tablet PC (described in Section 4) with a virtual character to browse the museum, and the other half will have one without a virtual character. After the exploration phase, the system will automatically analyse the potential

	With Virtual Character	Without Virtual Character
Experts	25 subjects	25 subjects
Novices	25 subjects	25 subjects

Table 1. Research design

knowledge gain and implicitly partition each group into experts and novices. Before asking the participants to fulfill some collaborative tasks, the system will further organise the participants in groups of three or four with different expertise in certain areas. After completing the tasks, each participant is presented with a questionnaire inquiring aspects on learning effectiveness.

4 System Architecture

The system we plan to build consists of four main components - the user modelling server, the ontology, the virtual character interface, and the adaptive hypertext interface. The latter will effectively render the same museum content with and without the virtual character respectively. Fig. 1. shows a diagram of the system and how they interact with each other. Further descriptions of each component are described below.

4.1 Ontology

We propose to model the museum context with a light-weight ontology. An ontology describes not only the concepts but also the relationships between concepts

⁵ The program pamphlet can be downloaded at:

http://www.usyd.edu.au/nicholson/nichol_primary.pdf (accessed 05 March 2005).

⁶ The syllabi and relevant resources can be found at the Web site of the Board of Studies, New South Wales, Australia: <http://www.bosnsw-k6.nsw.edu.au/index.html> (accessed 05 March 2005).

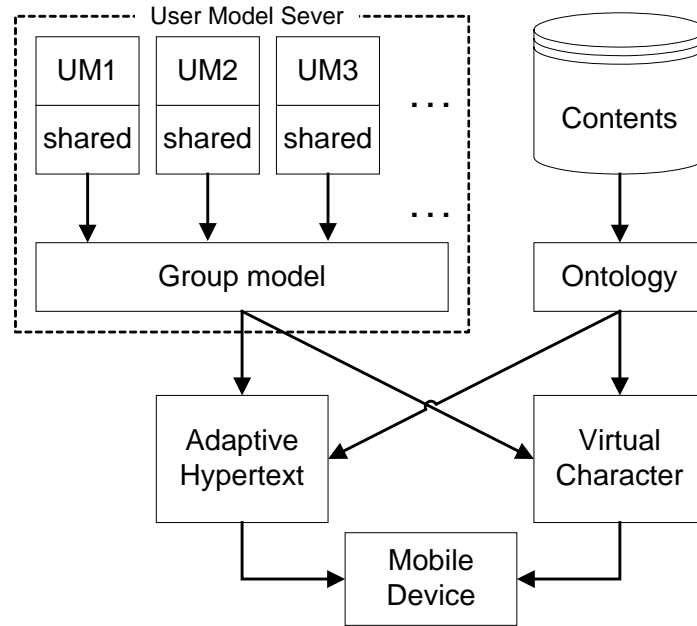


Fig. 1. Proposed system architecture showing the main components.

in a domain, and thus forms an ideal schema for semi-structured data. Museums commonly have small descriptions to accompany each exhibit. If all these exhibit descriptions were collated together, we would have, in effect, a specialised glossary of the museum contents. It would therefore be very useful to have an automated means to generate a light-weight ontology from these descriptions.

MECUREO [27] is one such tool to fit this task, designed to automatically construct ontologies from glossaries and dictionaries. MECUREO can not only create an ontology from these descriptions, but also one that is scrutable and understandable as every concept leads back to a description.

The vocabulary of the ontology forms the basis for the domain concepts in the user model, and the relationships can be exploited by the resolvers in user modelling systems to perform intelligent customisations. Through examining these ontological relationships, the resolvers can infer related concepts and provide recommendations to the users based on these inferences.

4.2 User Model Server

The personalised information delivered to museum visitors is powered through a user model. Actions by the user are stored in the user model as evidence to allow the system to create adaptations to enrich their experience of the visit. The evidence would range from the duration they have spent viewing or interacting with a particular exhibit to the history of exhibits they have visited.

In order to adapt information for a heterogeneous user group, a number of approaches is available. One is to build a group model from the individual models; an alternative approach is to interpret the individual models to take

account of the interactions between the people who constitute the group [28]; yet another approach is to model each *homogeneous subgroup* extracted from the group, as proposed in [25]. The relative merits of either approach need to be explored.

We plan to use the user modelling server Personis [29], which allows adaptive systems to easily manage evidence for user models. Personis provides a resolution system to perform customisations based on this evidence. The resolver API allows system designers to easily code in adaptation rules based on accreted evidence and can be accessed by different devices and applications and the results can be exported to various file formats such as XML.

4.3 Virtual Character

The virtual characters we will use throughout the experiment will be adopted from previous project work (described in [3]). These characters were developed in Macromedia Flash MX⁷ and are hence web based. This will allow for an easy integration of the html based content representation and the virtual character. The characters feature two different layouts (a minimal one for small screen devices like a PDA and a full sized one for large screen devices). The characters are capable of performing utterances by means of synchronised mp3 playback. The character engine is script driven and remotely controllable by a server over the network.

4.4 Adaptive Hypertext

We have been developing a version of the TUTOR system [30] that integrates the Personis user modelling server. The web-based interface renders content that is personalised for each individual user. Support for group modelling exists through the aforementioned Personis backend. The system has been developed in the domain of undergraduate computing courses, but recent work has seen it adapted to a museum context that we can build on for this user study.

5 Summary

In this paper we presented the concept and theoretical background of a proposed mobile museum tour guide which will support small groups of visitors in a museum. Even though small groups of visitors are very common in museums nowadays, they are seldom explicitly supported by mobile museum tour guides. In doing so, we hope to unleash the potential of collaborative learning within the group. The proposed initial experiment will evaluate the technological support of this collaborative learning potential by means of virtual characters on mobile devices. Based on the experiences gained during our experiment we hope to build a museum tour guide system which will improve the learning experience and enjoyment of each group member during their museum visit. Instead of breaking

⁷ <http://www.macromedia.com>

these groups apart, our system will encourage communication and collaboration among the single group members, resulting in a beneficial, shared experience for the whole group.

Acknowledgements

This project is partially funded by Smart Internet Technology CRC and Hewlett Packard.

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