A Mobile Sensor Activity for Ad-Hoc Groups

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Abstract. Designing mobile learning activities requires us to consider which key affordances of mobile devices can support the optimum learning experience. This short paper reports on the design and testing of a BYOD mobile learning activity that was based on an analysis of affordances and a survey of student preferences. It outlines the affordances and preferences that were identified and how these were included in a broader set of design requirements. It explains the choice of tools adopted for the activity, and how they were integrated into the overall learning experience based on using mobile devices to find locations and gather sensor data. Some interim observations are made around the experience and the collaborative data set gathered by the participants.

Keywords: *sensors, affordances, GPS*

1 Introduction

Mobile learning benefits from certain affordances that can be leveraged by a combination of mobile devices, mobile learners and environmental contexts. These affordances include portability (Naismith et al, 2004), data gathering (Orr, 2010), communication (Liang et al., 2005), interaction (Lai et al., 2007), contextual learning (So, Kim & Looi, 2008) and outdoor environments (Tan and So, 2015).

In a previous study (Parsons, Wishart & Thomas, 2016) we undertook an analysis of mobile learning affordances and embodied these into a survey of in-service teachers undertaking a part-time postgraduate course in an effort to identify which of these affordances should be included in a specific mobile learning activity aimed at these mature, professional students. The results of this survey indicated that the respondents would prefer an outdoor activity over an indoor one, would like to use device sensors, and would like to engage with QR codes rather than GPS location. Using these results as a guide, but also taking into account a number of other factors that influence the teaching and learning space, we analyzed the design context for the mobile learning activity. From the results of the survey, we aimed to develop a collaborative, outdoor, sensor based activity. This activity would be based on a Bring Your Own Device (BYOD) approach, since this was the normal policy of the course on which the teachers were enrolled. The activity also needed to fit into the curriculum and schedule constraints of the course delivery. Thus it needed to integrate into a 30-minute ‘station rotation’ blended learning class context (Staker & Horn 2013), where the activity would be combined with others happening at the same time. There was limited setup time so the software tools for the activity had to be easy to install and use. Another constraint on the tools was that they had to be free to use, so that the teachers enrolled on the course could use similar activities in their schools with their own students without additional cost. A further constraint was that the course runs over six different sites across the country, and local setup had to be kept to a minimum. As a result of this constraint, despite the results of the survey, we designed the activity to use GPS rather than QR codes, since these could be set up virtually and did not require someone at each physical site to locate printed QR codes outdoors.

2 Collaborative, Contextual, Outdoor, Data Gathering and Visualization

Given the mobile affordances that we wanted to take advantage of during the mobile learning activity, we had to find some way of enabling outdoor navigation that would include the gathering and sharing of data, communication, interaction with different devices, and learning related to context. We also had to identify the purpose of the activity in terms of its learning outcomes and how we might gather evidence of this. We decided to focus the activity on learning about sensors and how they might be used to measure environmental factors. The addition of multiple new sensor types has been one of the most significant changes to mobile device capability in recent years. Todays' mobile device is a powerful sensing platform that enables the user to distill meaningful views of their activities (Cardone et al, 2013). There are three generic types of sensor fitted to mobile devices; motion, environment and position (Android Developers, n.d.) Position sensors can be used to guide learners to different locations, while environmental sensors allow learners to explore and measure their environment, e.g. weather, noise pollution, light and shade, geography (orientation, elevation) etc. Motion sensors can be used for some types of measurement, and also for control of other devices, such as robots. For this learning activity we chose to focus on position and environmental sensors, and on enabling our students to explore the availability, reliability and potential uses of such sensors on their devices.

Collaborative Data Gathering and Analysis with BYOD

To integrate collaborative communication into the activity, students were divided into small groups, and each group was tasked with taking a set of environmental measures at three specified locations and sharing these on a single Google spreadsheet, thus allowing all learners to pool their data and be able to compare and contrast the results from multiple sites and locations on different days. From this, it was hoped that they would gain some insights into how sensors can be used to measure the environment, what types of measures are available, and what kinds of interpretations might be made of these measurements. We wanted them to realize that their own smart phones are not only communication devices, but also powerful computing units with rich sets of embedded sensors, introducing the concept of mobile decentralized sensing based on smartphone capabilities (Cardone et al, 2013).

Outdoor Navigation App - ARIS

Given the need for the activity to take place outside, some kind of navigation software was needed, preferably one designed specifically to support mobile learning activities. Key selection criteria were that it had to be free (so that it could easily be used by our students in their own schools), it had to be able to trigger geo-located events, it had to enable the same activity to be run in multiple locations and it should not be aimed at a particular age group, since the teachers enrolled on the course taught at all school levels. After an extensive review of the potential tools available for this purpose, the ARIS application was selected. There were a number of reasons for this choice. First, it is a rich environment for creating location-based mobile learning activities. Second, it was developed by a university (the University of Wisconsin) rather than a commercial organization, and, as such, is not only free to use but free from adverts or other commercial components. Third, it has an extremely useful facility of allowing mobile learning activities to be duplicated and modified very quickly. Given the multiple sites over which this activity was to take place this was a particularly useful feature. Since client applications are only able to run on iOS devices, it was clear that not all members of the group would be able to run this application on their BYOD devices. However, we turned this to our advantage by creating a collaborative mobile learning activity where only a minimum of one member of each group would need to have the ARIS app running on a device. Figure 1 shows some screen captures from the ARIS activity, showing its main features.

Sensor App - Sense-it

The other software component that was important to the activity was something that would enable device sensors to be used. The best tool that we identified for this purpose was Sense-it (Sharples *et al,* 2015). Unlike many of the alternatives, it can recognize and utilize every available sensor on the device. Sense-it runs only on Android devices, which had the advantage in our context of balancing out the fact that ARIS only works on iOS devices, thus members of each mobile learning group were likely to be able to run either ARIS or Sense-it, regardless of whether they had an iOS or Android device, emphasizing the benefits of collaboration in a BYOD environment.

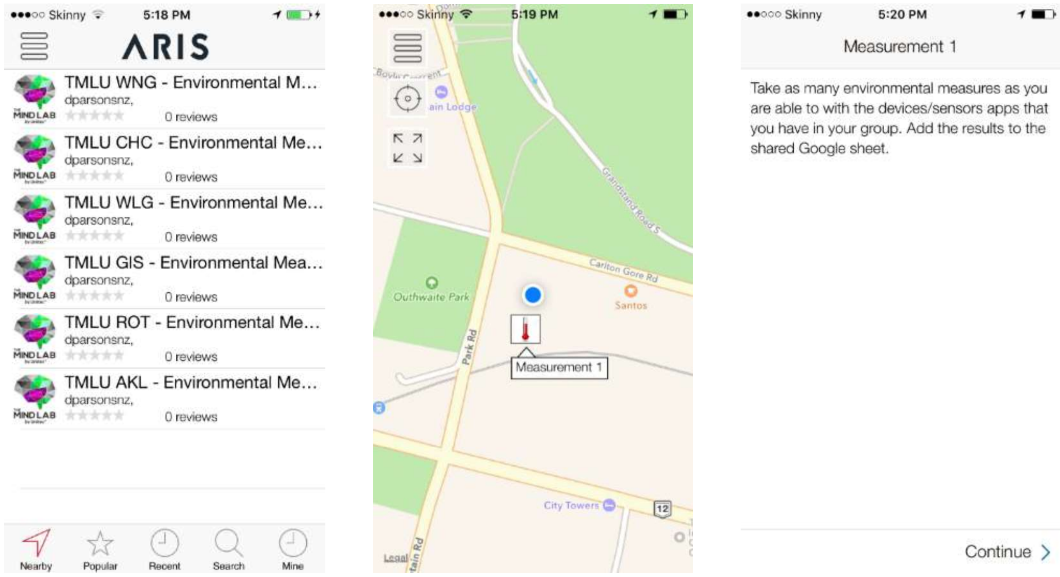

Figure 1. **Screen Captures from the ARIS Application, Showing (Left to Right) Multiple Versions of the App for Each Site, the GPS Guided Locations, and the Triggered Prompts to Take Sensor Measurements at a Specific Location**

3 Data Gathering and Analysis

During the activity, the participants explored their own devices and took whatever measurements they were able to. The number of different measurements that were taken, and the data ranges, fell under eight categories as shown in Table 1

Table 1. **Sensor Measurements**

Sensor Readings Taken	Units of measurement	Number of measurements taken	Range
Light	lux (lx) equal to one lumen per square metre	64	589.2 lx to 1977.7 lx
Sound	decibel (dB)	75	from 42 dB to 88.4 dB
Temperature	degrees Centigrade (oC)	63	15.2 oC to 30 oC.
Atmospheric pressure	hectopascal (1 hPa = 100 Pa) equal to one millibar	46	982 hPa to 1022 hPa
Humidity	percentage (%)	51	from 50% to 80%.
Compass	relative orientation	41	-10 meters above sea level to 298 meters above sea level.
Elevation	meters above sea level	36	N/A
Wind speed	Kilometers per hour (kph)	18	range 0.3 kph to 38.4 kph.

As might be expected, the affordances of different devices enabled the collection of different environmental measures, with the result that the range of measurements recorded varied considerably from one learner to the next. Over the course of the activity, 42 teams of 101 learners participated across six sites, so they were able to compare their combined results across multiple readings from three locations locally and across sites.

4 Outcomes

As a result of the mobile activity and post-hoc discussion, the participants gained increased awareness of different sensors on smartphones, their potential for mobile learning activities, and various limitations on accuracy (Rana et al, 2015). They also saw the opportunities using different devices in a collaborative BYOD approach provides for problem solving and data gathering. They also gained some experience of elements of the uses of smartphones for crowdsourcing data (D'Hondt, Stevens & Jacobs, 2013), by pooling their resources for shared analysis, and the role of affordances in contemporary mobile learning.

Our experience in running this first pilot activity has given us insights into new directions that we can take this type of sensor-based learning experience with future cohorts.

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