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WHAT DO CONTEXT AWARE ELECTRONIC ALERTS FROM VIRTUAL LEARNING ENVIRONMENTS TELL US ABOUT USER TIME & LOCATION?

Laura Crane and Phillip Benachour
School of Computing & Communication Systems
InfoLab21, Lancaster University
Lancaster, UK

ABSTRACT

The paper describes the analysis of user location and time stamp information automatically logged when students receive and interact with electronic updates from the University's virtual learning environment. The electronic updates are sent to students' mobile devices using RSS feeds. The mobile reception of such information can be received in three dimensions of context: time, location and activity. Fifteen students took part in this study with the three dimensions of context evenly distributed. The study aims to identify how users can engage with electronic updates related to teaching material, course work feedback, and general announcements from teaching staff across the University's academic departments. As well as user profiling when reading the updates under these three dimensions of context, early investigations show that there exists peak times when users read these updates. All three dimensions exhibited a similar trend with activity being the highest. Initial results indicate that interactions occurred generally during office hours and within the confines of the campus environment, although uses of the activity based application were recorded also in informal locations outside of the working hours.

KEYWORDS

Context Aware, Mobile Information Delivery, Virtual Learning Environments, Ubiquitous Learning.

1. INTRODUCTION

Virtual Learning Environments (VLE's) have existed long before the digital revolution and continue to develop from the original mail based systems to the modern online structures which are now an integral part of course delivery. The majority of higher education universities have adopted VLE's to enhance the face-to face learning experience to instigate a blended learning approach. Higher and further education institutions now understand learning is no longer restricted by the physical boundaries of their retrospective campuses, as learning interactions occur throughout the entire student experience. In addition to the formal and traditional learning spaces, the informal physical and virtual areas may now encompass a wider range of distributed learning areas and possess an importance which requires further understanding. Investigating the ubiquity of spaces in order to enhance the learning and teaching experience is not only important for students but also for faculty who value the potential benefits which are available with the adoption of mobile technologies when delivering information to students. This heightened awareness of learning transpiring within different contexts has given rise to concepts such as 'ubiquitous' or 'flexible learning' as defined by Moran and Myringer; in which mobile devices have been seen to both provide and promote.

The evolution and progression of mobile technologies such as wireless networks and handheld devices provide ubiquitous access for both information delivery and retrieval, as stated by Muhammad and Soraya. At the same time the penetration and popularity of 'smart phones' have provided a platform for users to receive updates for information such as news, shopping and social media in a concise and convenient method. Traxler identified that mobile devices allow for portability, connectivity, convenience, expediency, immediacy, accessibility, individuality as well as Song arguing 'interactivity'. These attributes are the reasoning behind the popularity and penetration of mobile technologies within general society as well as their impact within educational environments.

Although mobile applications are used for a wide range of purposes, their functionality often relies on executing functions or services based upon a frequency of time. Although these are effective in their activity, they have been proven to generate issues with users, as demonstrated by Crane et al. However with the integration of both global positioning systems (GPS) or assisted GPS functionality in most smart phones; location awareness can now be integrated into information systems as update points, mostly referred to as 'Location Based Services'. It is these schedule based services and location based services which are deemed the two fundamental points for context aware applications as stated by Smailagic. It is this integration of location based services into mobile applications which has created a plethora of application fields such as shopping, advertising, travel information and entertainment. Although location based services have been utilized successfully for many domains, their use in the organization and supporting of learning has not been fully exploited. With technology now available to provide a higher level of context adaptability within higher education course delivery, information which students receive has new possibilities in the way in which it is retrieved and delivered. Given the individual characteristics that can define circumstances and subsequently, the ambient information which can be gathered by mobile devices, Yau & Joy argue there may be benefits to the learner if their mobile application were to be aware of these dimensions of context. As well as the requirement for context to be integrated into the VLE; the technology enhanced learning research group'; the STELLAR network has identified 'contextualizing virtual learning environments' as one of its three grand challenges which need to be addressed for the future of technology enhanced learning .

Within recent literature there are numerous studies such as Sohn et al as well as Marmasse and Schmandt, which exemplify how location based services can be integrated to support the organization of a mobile user. This study demonstrated the principle that reminders can be created and executed on specific GPS co-ordinates rather than at a defined time of the day. It is this concept of using other forms of context to deliver information to a user's device while on campus which is of significance. In order to provide a ubiquitous information environment, understanding the context of the user must be of paramount importance for the appropriate information retrieval and delivery. Therefore the inclusion and integration of other dimensions of context are now possible by the technology; it is the understanding the usage and impact on the user within an educational setting which is of importance. Previous work centered on comparing both time and location as methods of delivering information, but further work to evaluate a third dimension of context has provided data on the context in which the users interacts with their device.

This paper is structured in the following format, it firstly defines which aspects or dimensions of context can be utilized for delivering information to student's devices from virtual learning environments. From here, the investigation into mobile virtual learning environments is explored before the implementation is provided in detail.

2. DEFINING & DEDUCING CONTEXT

The understanding and definition of context has been a research field spanning decades, but has its potential realized with the arrival of mobile devices. Since Barwise described situations over three decades ago, the importance of other contextual aspects such as the individual and the relationships to other objects were understood. More recent work by Dey investigated and promoted the concept of context being more multi-faceted than that of location awareness.

Most contemporary context-aware mobile learning applications operate with what are recognized as 'learning contexts' in order to appropriately adapt or organise information to users in a learning environment. Learning contexts has been defined by Baseed et al as "*the circumstances in which, or conditions that surrounds the learning*. It is this classification of context which has created much discussion and research. The most recognized model for context dimension is that of a pentagonal form consisting of time, location, activity, identity and relationships as demonstrated by Zimmerman, Lorenz and Oppermann. Table 1 below provides a definition of each dimension used within this study of context, as suggested by Zimmerman et al.

Table 1. Defining the five contextual dimensions by Zimmerman et al

Dimension of Context	***Definition***
Identity	This category gives access to contextual information about the entity the context is bound to. This information comprises anything that can be observed about an entity, typically its state.
Time	This category of context subsumes time information like the time zone of the client, the current time or any virtual time.
Location	A location may be described as an absolute location, meaning the exact location of something, or as a relative location, meaning the location of something relative to something else.
Activity	The activity dimension of context covers the activities the entity is currently and in future involved within. It described by means of explicit goals, tasks, and actions. In most situations when interacting with a context-aware system, an entity is engaged in a task that determines the goals of the performed activities.
Relationship to n	This dimension of context information captures the relations an entity has established to other entities. Such surrounding entities can be persons, things, devices, services, or information (e.g. text, images).

Although defining context is crucial when understanding context's position in the delivering of course materials to students; it is far too simplistic of a concept. Understanding if one dimension of context outweighs another for a student in a particular context becomes of interest to the research as it is important in deciding the best mechanism for context-aware delivery. The precedence of each of the dimensions needs to be addressed in order to deliver information and course materials appropriately in context. Dey stated that "*We cannot enumerate which aspects of all situations are important, as this will change from situation to situation"*. Evidently, this proved true by Crane et al, although there were slight differences between the responses within the different context-situations; a general theme emerged from the results. Only activity, time and location were deemed important in each context in their current definition. Of course this is was a theoretical evaluation and therefore future conclusions must be formed upon implementing time, location and activity based information retrieval as real and user tested mobile applications.

The sensing and deducing the context of the device in its operating environment requires direct access to the phone's sensors, and therefore using the application programming interfaces (API). Most smartphones have a range of integrated sensors which allow an application to exploit these into forming conditional statements for which information can be delivered upon their execution. Figure 1 demonstrates how each of the five dimensions of technology can be sensed using the sensors within a mobile device. Of course, by utilizing these sensors, user permissions must be accepted during the installation process; if the user doesn't grant these permissions the application will not function as the functionality is dependent upon accessing API data. The Android application installation method means no further checks with the user are done while an application is running: it had to be granted a particular permission when installed, and can use that feature as and when desired.

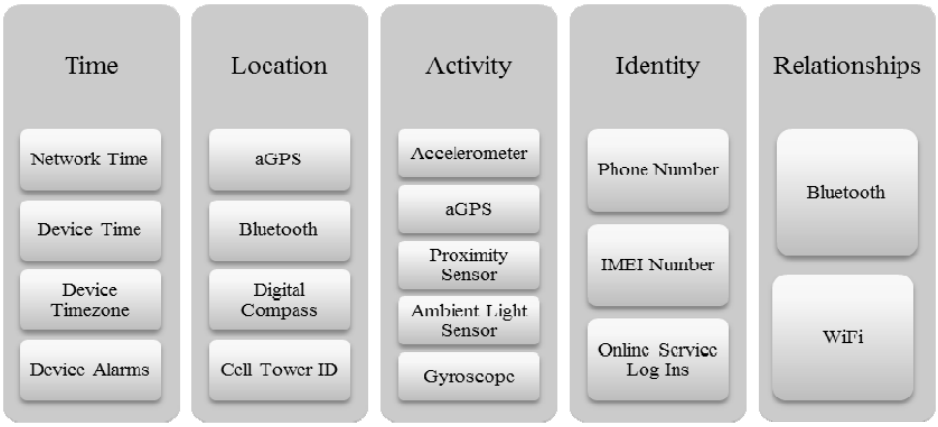

Figure 1. Demonstration of the sensors available in smart phones which could be used to sense or determine user context.

3. DISSEMINATING INFORMATION FOR FLEXIBLE LEARNING

Disseminating information to students from the central VLE is imperative to support the notion of flexible learning to be 'anytime, anywhere'. There are a plethora of technologies which can be used to deliver information to mobile devices; including channels such as SMS or E-mail, RSS has been proven by Lan & Sie**,** to perform superior to both SMS and Email on content accuracy and adaptability; therefore rendering RSS as more appropriate for supporting various front-end mobile devices to access and present the content in a mobile learning environment. It is this RSS channel usage which not of question, but how in which it can be delivered in accordance with the user's context to add to the learners experience.

Mobile technologies afford flexibility to the student experience in higher education and subsequently, they will become increasingly significant as students and academics pass through physical, blended and virtual learning environments. The Horizon Report argues there is a shift in the method that users are connecting to the internet directly caused by *"..the growing number of internet-capable mobile devices, increasingly flexible web content, and continued development of the networks that support connectivity*." It is the importance of the context which is debated by many; as when using mobile technology, the learning occurs within context and this context constantly changes. Yet, others such as Keppell and Riddle argue that context becomes almost irrelevant and of no particular no value as mobile technologies can transform any space into a 'learning space'. It is this importance of the dimension of context which is of question, for example is location actually important when receiving information based upon that context itself.

Again, this same concept applies to the context dimension of time; does time become more fluid and adaptable when mobile devices provide a variable to their respective context. This hypothesis which is stated by Jones and Jo amongst others, believes any setting in which students can become totally immersed in the learning process can be seen as a ubiquitous learning environment. Therefore if context awareness was integrated into mobile alert delivery; would the traditional and physical boundaries of time and location still be valid for learning or alternatively subjected to new patterns of mobile stimulated ubiquity.

4. IMPLEMENTATION

Although like many other VLE's or Learning Management Systems (LMS); Moodle provides RSS channels which are available for such items as announcements and discussions. With careful discussion with the universities Information Systems Services, a method of including other updates such as changes or updates to uploaded files could also be implemented using PHP to create one stream or RSS channel which aggregated more information surrounding a certain course of module.

The software for each of the applications was built in native Android using the Eclipse development environment. All three of the mobile applications used Java for the majority of the functionality, such as notifications, menu creation and the parsing the XML format of the RSS alert feed. In order to ascertain the context of the user, the Alohar API was integrated into the applications. The programmable interface provides battery optimized, ambient sensing & location awareness platform which enable developers to build a whole new class of mobile applications that understand a user's behavior automatically and provide highly customized services to the user at the right time and right place. For this study this included the automatic detection of walking, sleeping and commuting as well as understanding the place type of where the device is, in correlation to Google Places data.

The automatic logging system developed parallel to the application was a combination of Java and AJAX to push data including the latitude, longitude, device id, and timestamp to an online SQL server for further analysis. This function was intentionally concealed from the user when using the applications in order to provide ethnographic data to observe the user's behavior with the technology.

The three separate native Android applications were developed which delivered information based upon either the user's specified time, location on campus or their current activity. The applications were installed randomly on the student's Android devices in order for them to receive notifications when a new item has been posted within a given module on Moodle.

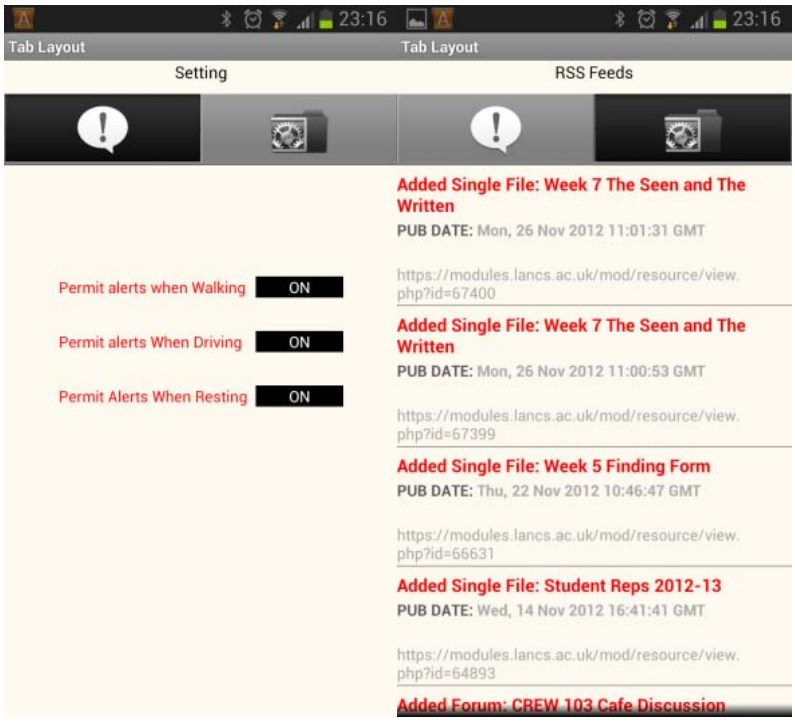

Figure 2. Screenshots of the Activity based RSS Alert Application, showing both the settings page and course alert list parsed from the XML channel.

The applications were installed upon 15 students own handsets, from a range of six different modules which included Environmental Sciences, English, History and Computer Science disciplines. Altogether time, location and activity dimensions each had 5 separate students who all ran the applications which looked identical to one another, apart from the settings properties. The demographics of the mobile users were of 10 males and 5 female participants, with first year, second year and final year students being amongst the testing group. Once deployed the applications were left to run for the remainder of the term which spans ten weeks from October 5th to December 21st 2012, delivering information and logging the locations and times when the application was used by the students.

5. RESULTS & ANALYSIS

Once the applications had been installed and were active, data collected from the devices was aggregated. The distribution of user interactions with the context aware alerts on a daily basis is shown in Figure 3. Upon initial analysis, it can be seen that there are four peaks across the three dimensions with a highest and dominant peak between the hours of 2-3pm. One obvious point to note from the figure below is that the three dimensions (activity, time and location) exhibit similar trends across the day. Further, given that the profile of users spans a number of academic subjects, the results show that course alerts tend to be read during the hours deemed as ‘office’ and ‘learning hours’. The results of interactions at peak times could be correlated with students using their mobile devise for other activities too such as checking their emails and social networking. It would be premature, as a study, to assume that electronic alerts are read when students are using their mobile devices primarily for social networking. But social networking is a big part of a student’s social life.

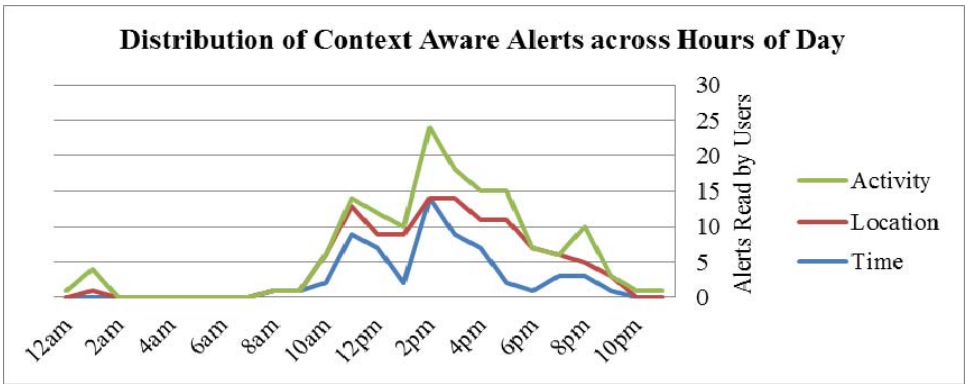

Figure 3. Distribution of user interactions with the context aware alerts across each of the hours of the day.

Figure 4 provides a density map of the locations on campus in which students used the application to interact with an alert. The y axis title being 'alerts read by users' is the aggregated amount of occurrences when an alert from VLE has been read by a user on the mobile. The time based application provided the highest density across the whole of the campus, with all areas covered including residential, informal and formal areas across the entire university. Alternatively, both location and activity alerts were only interacted with in certain areas across campus, mostly central in the heart of campus. It does have to be noted that activity was the only dimension which recorded interactions off the campus environment, demonstrating the dimensions ability to provide the true concept of flexible learning.

Figure 4. Choropleth of Alert Interactions across the campus

Further, it does appear feasible to argue context aware alerts do provide information ubiquitously for keeping students up to date with their courses. Yet the majority of locations where the mobile interactions were situated fall within the typical boundaries of campus perimeters. This confinement of 'learning spaces' is even more apparent for the locative and activity aware applications.

6. CONCLUSION & FUTURE WORK

This study focuses on answering what context aware alerts can inform us about the time and location of users when 'flexible learning occurs'. Although the study has created an insight into user behavior with context aware alerts, a longitudinal study would be necessary to validate the user patterns which have been found so far. Such issues as the seasons could be an important factor as activities and location frequencies may change when the weather improves. For further research the same case study must be carried out in warmer, milder weather to ensure a balanced perspective of user behavior with the alerts. Another issue affecting the mobile interaction areas may be cultural with students possessing a belief or biased towards 'formal learning' areas being the only learning spaces they perceive in a campus environment. Future work should address the reasoning as to why the usage trends as seen in the results occur in all three types of mobile application, this would provide students own perceptions as to why their usage does not fully exploit the concept of flexible, anytime - anywhere learning.

Context aware alert applications have the potential to sustain student engagement with their modules, and provide an innovative method for accessing VLE information away from conventional learning spaces. This study has shown context awareness, especially location and activity can be utilized as information delivery mechanisms; although to what extent needs to be investigated in regards to both pedagogical theory and underlying user reasoning.

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