INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
3 & 4 SEPTEMBER 2015, LOUGHBOROUGH UNIVERSITY, DESIGN SCHOOL, LOUGHBOROUGH, UK

UTILIZING SMARTPHONES TO IMPROVE THE EFFECTIVENESS OF UNIVERSITY STUDENTS' COLLABORATIVE WORK

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ABSTRACT
With the rapid improvement of technology, the screen size of smartphones is becoming bigger, battery life is increasing and more processing power is available. Smart phones have been regarded as a complement-learning tool beside formal classroom-based pedagogy. Compared with traditional personal computers, the portability of smart phones enable groups of students to work on a common project while not tied to a fixed location. Previous studies have shown that mobile learning provides opportunities for students to learn from within real contexts/situations not tied to a specific location. Mobile learning can also aid in multimedia authoring and sharing. Few articles discuss whether these new features improve the effectiveness of students' collaborative work. The goal of this paper is analyzing the use cases of personal computers and smart phones, identifying suitable tasks for smart phone use, and conducting usability tests that can lead to improving the effectiveness of mobile collaboration. The task performance of college students' collaborative work on smart phone and on laptop will be measured, and students' preferences will also be collected in this study.

Keywords: Mobile learning, collaborative work.

1 INTRODUCTION
As the technology advances, smartphones are increasingly used in students' daily life. Students use their phones not only for making phone calls and sending/receiving messages. They are able to browse Internet, record videos, and entertain themselves. Due to their widespread use, great attention has been paid to utilizing smartphones as a way to improve students' academic performance. Previous research has found that mobile learning seemed to be a good complement-learning tool alongside formal classroom–based pedagogy. It provides students with the ability to learn outside the classroom, to access rich digital resources and to communicate with others ubiquitously [1]. Mobile learning provides great flexibility but is limited by its relatively small screen compared to a laptop. Little study has focused on mobile learning compared to laptop-based learning with respect to group collaboration. This paper focuses on identifying unique use cases for collaborative mobile learning, designing a new mobile application that facilitate collaborative work, and evaluating the impact on collaborative performance.

2 BACKGROUND
Mobile learning has three main advantages: portability, context sensitivity, and instant connectivity [1]. It provides the students opportunities to study at their own speed, the possibility of learning within a real context, working with others on projects, and learning outside the classroom. Mobile learning is defined as more than just learning supported by a mobile device but learning that is both formal and informal as well as context aware and authentic for the learner [3].

Previous investigations have found that fast access to information is an important feature to enable mobile learning. The results of one focus group among college students [3] suggested four main advantages provided by mobile learning: Quick access to information, better communication, an increased variety of ways to learn, and situated learning. Quick access to information included advantages such as receiving emails from instructors, referencing course content online, or the ability to easily search searching for useful information. Communication with instructors or other students was improved as using a mobile device as often more convenient than logging onto a website from a laptop. Avenues for learning were increased through the ease of access to information (such as external media, interactive messaging/chat, and other resources) that allows the student to engage material in a format/situation that is most comfortable. Finally situated learning is enabled by allowing engagement with material within a particular context or environment. Material can be experienced in either real world or classroom type situations that are more authentic to the learner. A different investigation [1] found similar results. In this study three main features of mobile learning were identified. They were ability to access course information, ability to communicate with instructors and the ability to discuss course content with other students.

Technical limitations of devices such as slow processor, network connectivity, relatively small display and awkward input [2] [5] have been cited as issues for mobile learning in the past. Advancements in technology have to some extent addressed these, though some are still cited. Poor input methods such as small touch screen keyboards still pose problems for anything more than small/quick responses. Technology integration, such as applications that do not work as they are supposed to or not working properly with the device hardware also get in the way of effective collaboration and learning. Finally the devices themselves can at times be a distraction, particularly when other applications compete with the learner for their concentration (i.e. incoming text messages, emails, Tweets, etc).

Liaw [6] identified four design principles for mobile learning systems that broadly address these technical and user needs. Mobil learning systems should be: simple, adaptive, individual and communicative. They should be simple because mobile devices have a relatively slow central processing unit (CPU) and a small amount of memory. To encourage students to utilize it in their spare time, in terms of user experience, the system should be easy to operate. Learning activities should be meaningful and customized for individual learners and take advantage of the fact that handheld devices are personal tools. A mobile learning system should also provide adaptively communicative and collaborative functions to facilitate easy communication of digital content to others.

3 DESIGN

The aim of this project was to begin to develop a mobile application to improve student's academic collaboration. The application is based on a social network platform that enables students to join groups, follow people, create, share, and collaborate on contents. It is focused on providing students with the opportunity to explore academic groups (related to specific topics, classes, etc). Once a group is joined students can get updates on group activities, participate in group discussions, follow other members of the group, and build connections. The application will be a mobile interface to an existing browser-based collaboration tool called the Open Academic Environment (OAE). OAE is used for enhancing teaching and learning via social media. It allows users to follow scholars, upload media files, create discussions, and work on collaborative documentation. The goal of OAE is to create a new way for students and faculty to create knowledge, collaborate and connect with the world [8].

The design, development and investigation of this mobile application mock-up was conducted within a Vertically Integrated Projects (VIP) course at the Georgia Institute of Technology. The VIP Program integrates undergraduate students, graduate students and faculty research within a team-based context in order to benefit from the design/discovery efforts of collaborative teamwork [7]. The initial design of the new OAE mobile application consisted defining use cases, gathering user needs and low-fidelity prototyping.

3.1 Use Case

Two specific use cases of the application focused on joining, and following were generated. Joining refers to a user interacting within a group, uploading media files, joining discussions and collaborative writing, such as a study group. Following is passive. Users receive various updates about the group but do not directly interact. These use cases were selected because users need to be able to actively interact with groups (especially if they are strongly interested in it) and also need to be kept up to date on all groups which they have joined whether or not they have a high or low level of interaction with them.

3.2 User Needs

Based on the background information and several group brainstorming sessions, potential features needed to support mobile group collaborative work were defined and grouped in an affinity diagram.

These included features such as group statistics, group information and recent activity (Figure 1). In order to gather more specifics about what users look for when deciding to join a group, an interview was conducted among students at the Georgia Institute of Technology. A convenience sample of 14 subjects (5 male, 9 female) participated. All were industrial design students were offered the incentive of an extra course credit if they participated.

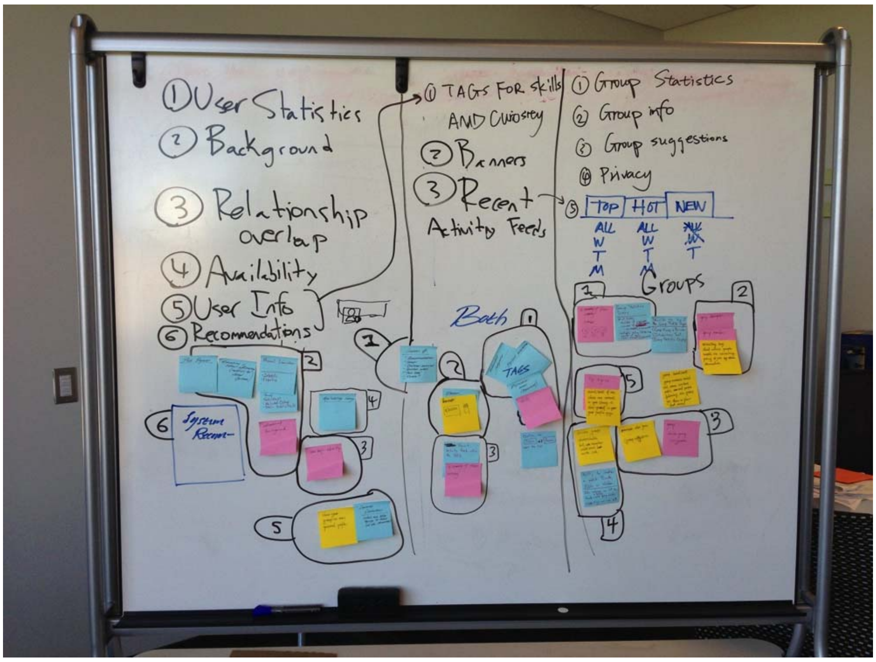
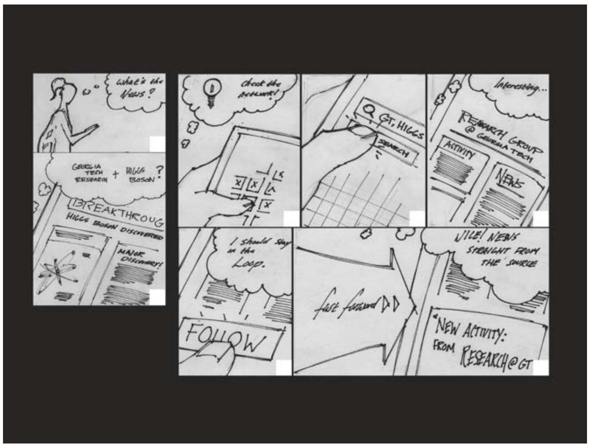


Figure 1. It shows how the function/feature for a group and for an individual user were defined

The interview was composed of three parts. First was a round of interview questions about online group activities. For instance, “Why did you join each group?”, “What were you trying to achieve by joining each group?”, and “What information helped you decide to join each group?” These questions were meant to gather relevant qualitative information that could be used to help make sense of later data from the test, such as, which information users paid most attention to when they decided to join a group.

The next section of the test was a storyboard depicting the following situation: a student notices a group of interest, uses the mobile app to find the group and examine the profile, and then either joins or follows the group. The storyboard was based on the two use cases (Join and Follow) generated before. Two separate storyboards were used, one presenting a scenario where the student follows a group, and the other where the student joins a group (Figure 2).

The final section was used to measure users’ preferences about different features when they consider joining a group. It consisted of a ranking activity. The subject was given multiple cards, each labelled with a different possible feature that a group profile page could display. The subject was then instructed to arrange the cards into three groups listed as ‘Very Important’, ‘Good to have’, and ‘Not needed’. The frequency of each feature was calculated for analysis.



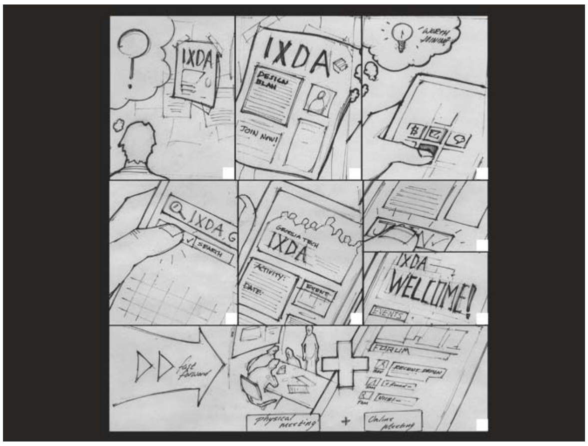


Figure 2. Storyboards showing Joining (left) and Following (right).

The top six most essential features for a mobile app were the “Group Description”, “Activity Feed Ranked by Recency”, “Activity Feed Ranked by Popularity”, “Number of Members”, “Number of Active Members” and “Relevant tags” (Table 1). The least essential features were the “Number of Posts”, “Average response time to discussion posts”, “Number of posts in the past 7 days”, “List of people you have followed who are in the group”, and “Number of files contained in your library”.

Table 1. Users’ Preferences

Feature	Number	Percentage
Group description	14	100.00%
Activity feed ranked by recency	10	71.43%
Activity feed ranked by post's popularity	9	64.29%
Number of active members	9	64.29%
Number of members	6	42.86%
Relevant tags	6	42.86%
Number of posts	3	21.43%
List of groups commonly joined by people	2	14.29%
Number of files contained in Library	2	14.29%
Number of posts in the past 7 days	2	14.29%
Average response time to discussion posts	1	7.14%
List of people you have Followed	1	7.14%

3.3 Prototype

Based on the interview, a low-fidelity linear prototype was created in Axure, a software program that helps designers quickly create wireframes for user testing [9]. The prototype (Figure 3) focused on testing a) browsing and joining a group and b) following an individual person.

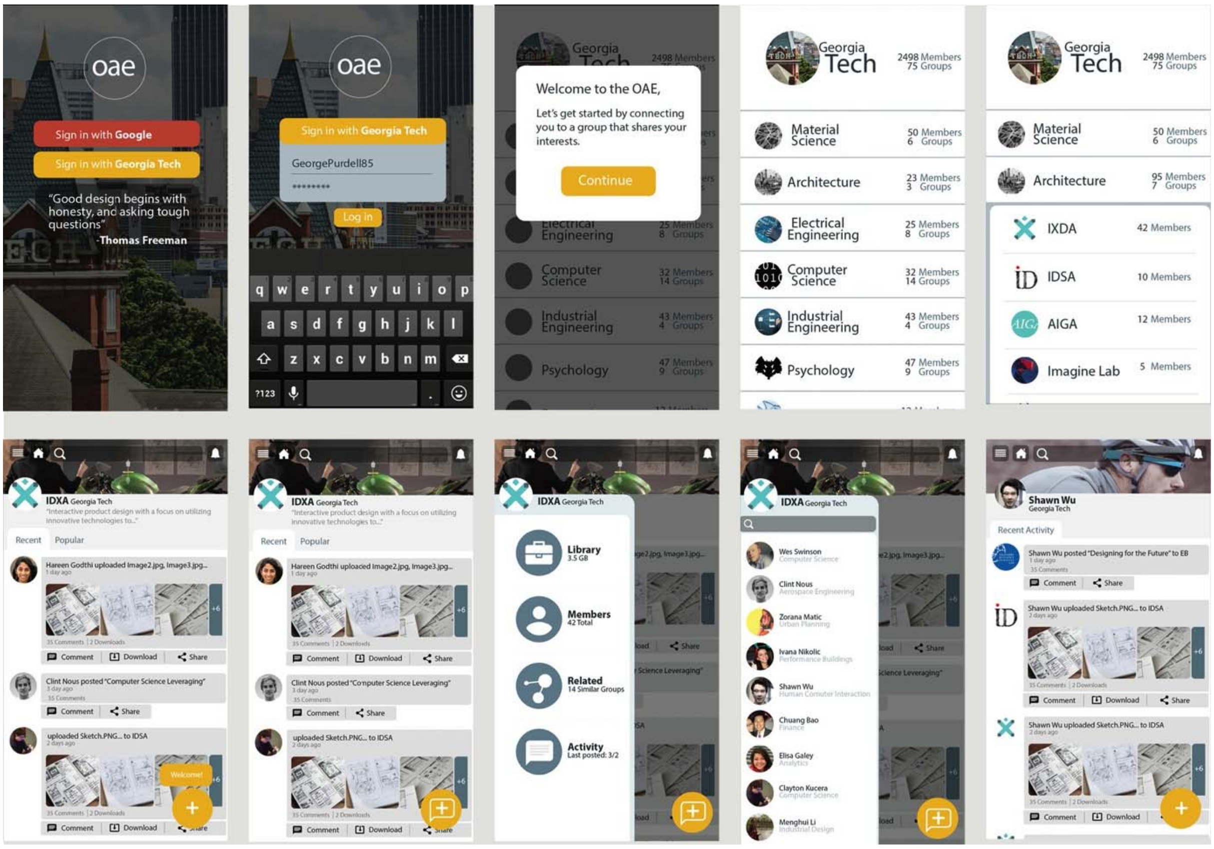


Figure 3. Linear prototype showing the workflow of the mobile application.

4 DISCUSSION

The interviews indicated that students pay a lot of attention to the group description and recent activity of a group when they are deciding whether or not to join. The Group Description is necessary to provide a general idea of what the group is about and its focus. The "recent activity" and "number of active numbers" give an idea about the vibrancy of the group and suggests that students are most interested in being a part of active communities (whether or not their own level of active participation is high).

Some other important attributes of the application were also raised from the interviews. User satisfaction is a key factor that will determine whether or not the application will ultimately be accepted and actually used. A couple of the main contributing factors to acceptance is the functionality of the system and also the level of user autonomy. It is important from the user perspective that the required functionality is present. Missing functionality would obviously add to frustration with the system but it is critical to ensure that the functions actually work well (both with the mobile hardware and the underlying OAE system). Users must also feel like they are in control (have autonomy) and have the freedom to engage with the system in a way that fits their individual needs.

At the time of this writing, the application is still under development and testing. The factors for acceptance will be important factors in evaluating the mobile application as additional functions are added and tested.

There are several limitations to the results presented. The sample size is obviously limited. The students interviewed were all from a single department so a broader range of students from different schools and disciplines will be needed to identify additional needs and issues. In addition, during the interviews, the order in which the information was presented/requested (interview questions, storyboards and the feature card activity) may have lead to subjects giving different answers. For example, when asked what mobile service they used most the majority of the subjects answered Facebook. From that point on, many of the questions were framed using Facebook as a context. Steps may need to be taken in future interviews to avoid this kind of framing.

5 FUTURE WORK

Usability test will be conducted with the high fidelity prototype which is still under development by the VIP team. This testing will focus on examining the intuitiveness of the application workflow, the size and location of the buttons, and overall acceptability and usability of the prototype. Based on the result, the group will further refine the prototype in order to ultimately implement a fully functional application for both Android and iOS based mobile devices.

REFERENCES

[1] Cheon, J., Lee, S., Crooks, S. M., & Song, J. (2012). An investigation of mobile learning readiness in higher education based on the theory of planned behavior. *Computers & Education*, *59*(3), 1054-1064.

[2] Taleb, Z., & Sohrabi, A. (2012). Learning on the move: The use of mobile technology to support learning for university students. *Procedia-Social and Behavioral Sciences*, *69*, 1102-1109.

[3] Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, *19*, 18-26.

[4] Fails, J. A., Druin, A., & Guha, M. L. (2010, June). Mobile collaboration: collaboratively reading and creating children's stories on mobile devices. In *Proceedings of the 9th International Conference on Interaction Design and Children* (pp. 20-29).

[5] Elias, T. (2011). Universal instructional design principles for mobile learning. *The International Review of Research in Open and Distributed Learning*, *12*(2), 143-156.

[6] Liaw, S. S., Hatala, M., & Huang, H. M. (2010). Investigating acceptance toward mobile learning to assist individual knowledge management: Based on activity theory approach. *Computers & Education*, *54*(2), 446-454.

[7] Vertically Integrated Projects (VIP) Program Retrieved from http://vip.gatech.edu/new/.

[8] Open Academic Environment Retrieved from http://www.oaeproject.org/.

[9] Axure RP7 Retrieved from http://www.axure.com.