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Using Mobile Technology in a Construction Management "Hands-On" Laboratory

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Abstract
This study discusses the introduction and use of the iPad mobile device in a freshman level construction management "hands-on" materials and methods laboratory. The devices are incorporated into the course in four ways: (1) for plan reading; (2) for RFI documentation, including the development of the RFI, highlighting of plans, and attachment of photos; (3) for presentation and documentation of "Tool Box" safety meetings; and (4) for documenting Daily Reports. This paper discusses the use of mobile technologies in a "hands-on" laboratory setting, the challenges of the incorporation, lessons learned, and student reactions to the use of the mobile device.

Key Words: Mobile Technologies, Education, Learning, Mobile Learning

Introduction

Companies in the U.S. construction industry are increasingly using mobile technology devices, such as iPads and smart phones, to assist in the management of construction projects. Companies often assume that university students own and use these technologies, and are familiar with the latest technological innovation, and thus look to their younger, newer employees to drive the adoption of technological change. In reality, currently only about one third of US college students own such devices and incorporate them into their daily routine. Thus, as the construction industry moves to mobile technologies, so too should university construction management programs move to mobile education and learning applications to intensify student awareness of how mobile technologies can impact their academic productivity and performance, and to ensure that students are prepared for a mobile construction industry[1].

Mobile Technologies

Mobile technologies include mobile devices, wireless protocols, wireless language, and wireless applications, and together these items allow access to web sites and web portals[2]. Mobile devices are electronic devices that can store, access, create, modify, organize, or otherwise manipulate data in various forms without being tethered to any particular location[3]. Mobile devices include handheld and mobile devices such as cell phones, personal digital assistants (PDAs), smartphones, tablet Personal Computers (PCs), personal media players or wireless laptop PCs[4].

Mobile technologies are becoming increasingly more common on the construction site as companies become aware of how mobile technologies can simplify and automate the capturing of information in the field and communicate that information back to company management systems. Mobile technologies reduce inefficiencies, raise productivity, reduce costs, and positively impact a companies "bottom line[5]." Through the use of a Virtual Private Network (VPN) or other web-based document sharing applications, construction personnel can remotely access construction estimating, project management, and accounting software. Mobile technologies also allow site supervisors the ability to manage digital time cards for pay role and project cost coding, quickly develop RFIs to reduce construction delays, develop daily field reports in real time, as well as access project plans[6].

Mobile Technologies and Learning

The history of computers and education has largely been confined to the introduction of personal computers, internet access, and the use of educational software to classroom settings[7]. Definitions of mobile learning historically focused on technology and mobility, however, mobile learning is certainly not merely the conjunction of "mobile" and "learning"[8]. Mobile learning, should not be interpreted purely in terms of the technologies and hardware used for learning delivery[4], rather the use of mobile technologies in the educational process should be viewed as a tool that allows for more efficient education and improved learning results. Mobile learning enables learning in formal and informal settings, decreases the dependence on fixed locations for work and study, and changes the way individuals work and learn[9].

The benefits of mobile learning are far from being a theoretical possibility. Mobile learning is an on-the-ground reality allowing learners to access educational content, communicate and share information with other learners, and elicit support from peers and instructors. While mobile technology is not an educational panacea, it is a powerful tool that can support education in ways not previously possible[10]. The use of mobile technologies in education can be used to re-enact approaches and solutions already used in 'conventional' e-Learning by using mobile technologies as flexible replacements for desktop technologies[11], aiding in the acquisition of knowledge regardless of location and time[12].

Materials and Methods Laboratory

Bolstered by andragogical studies on adult learning theory and research literature on experiential learning, the authors developed experiential learning applications to effectively facilitate a student's mastery of knowledge, skills, and competencies necessary for success in the construction management field. The learning applications, consisting of both lecture and lab sections, have evolved over several years through trial and error, employing multiple experiential learning theory processes[13]. The freshman level lab sections vary in size from semester to semester but usually each section contains between 15 and 25 construction management students. Students attending the lab vary in age an industry experience thus the goal and learning objectives of the class are more general in nature. The stated learning objectives of the course are:

1) Goal 1: Gain a working knowledge of current construction methods and materials used on building projects.
    a) Learning Objectives:
        i) Demonstrate knowledge of the methods and equipment commonly used to construct buildings including the foundation and framing systems.
        ii) Utilize correct terminology and nomenclature associated with the materials, methods, equipment and building components found on building construction projects.
2) Goal 2: Gain a working knowledge of construction safety.
    a) Learning Objectives:
        i) Apply OSHA standards during assigned laboratory tasks.
        ii) Complete the Occupational Safety and Health Administration (OSHA) 10-hour course.
3) Goal 3: Strengthen team building, communication, and problem solving skills.

a) Learning Objectives:
    i) Demonstrate an ability to work as a productive team member in the completion of assigned laboratory tasks.
    ii) Demonstrate leadership and problem solving skills.
    iii) Identify, evaluate, and determine appropriate solutions to problems before and during construction.

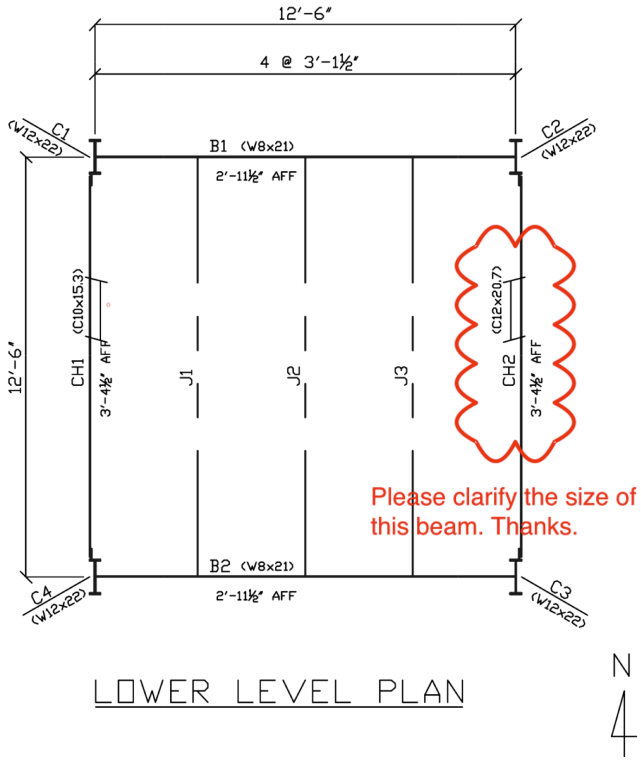
In the Fall of the 2012 semester the authors developed learning application using mobile technology devices, specifically Apple iPads and added those application to the course curricula. The mobile devices were attained through a mobile learning initiative grant at Boise State University, and were provided to the students free of charge for the duration of the semester. Students were given an orientation that included how to set up the device, how to connect to their university email account, and how to download mobile device applications. Students were encouraged to consider the iPad as their personal device, fostering familiarity and comfort of use. Providing the mobile devices to the students bypassed individual student financial issues. Further, an additional benefit to providing the devices was that all students in the course had the same device, eliminating issues of having different versions of a similar device, or having devices that use a different platform (iOS versus Android) where the same mobile application may not be available.

The iPad devices were used in the laboratory in several ways. All course documentation was provided to students in electronic format, and though the documentation could be attained using desktop technologies, the availability of information using mobile technologies made the documentation available at all times.

Students were required to conduct Tool Box Safety Meetings using the iPads. The meeting presentations were made with iPads using prepared tool box safety forms. Attendance forms were in hard copy format to ensure proper documentation. In addition to the Tool Box Safety Meetings, students would use the iPads to follow safety presentations made by the class instructor during the class. This use of the iPad greatly reduced the amount of paper and photocopying for the class and facilitated the learning process.

Plans and specifications used for the construction of lab construction activities were provided to the students using the iPad. Drop Box, a cloud storage, file hosting and synchronization service, was used to deliver construction documents to all students at one time. The use of this service allowed files to be placed in a folder that was assessable through a website using a mobile application. Plan Grid, an application that allows for the viewing, annotating, and communicating of project information from a mobile device was used by the students during the construction of lab projects. The use of the mobile devices allowed students to not only view the project plans, but also to view details, zoom in and out as needed, and migrate from drawing to drawing as needed. The application allowed students to annotate plans, develop Requests for Information (RFI) using a text feature contained within the application, and attach photos of the item needing clarification. Further, using the Plan Grid mobile application, RFI documents can be sent directly to instructors who can rapidly respond to the RFI by uploading revised drawings or providing written clarification.

Item 1. Annotated drawing with RFI.



Daily Reports developed using the iPad devices required students to reflect on Construction Methods Learned, Leadership Skills and Management Methods Learned, and Safety Methods and Requirements Learned. The reports could be filled out during the lab activities to allow students to document learning lessons in real time. Further, students were required to use their iPad mobile device to take photos of the days activities and attach them to the daily reports.

Concerns in the implementation of the use of mobile technologies included the technical ability of the students and the durability of the iPad in a construction environment. From a technical ability standpoint, most of the students were able to use the iPad and applications without significant problems. It was found that some students were more proficient at using the applications than others but it is believed that this may be due to prior use of mobile technologies or time spent using the applications. No iPad durability issues were encountered during the course and all of the devices were returned in working order.

One issue encountered was that many of the students were apathetic about receiving their mobile device and/or failed to bring the device to the lab course. Students claimed that they did not like to carry the device or felt that they could use the device of other students rather than use their own.

Conclusions

While formal education has historically been confined to a classroom where students interact with their instructors directly, mobile technology moves learning to new settings that maximize

understanding by doing away with one-size-fits-all models of education[1]. Mobile technologies allow education to be tailored to the individual learner allowing for varying learning styles and allow for immediate help or feedback from the instructor to the students. The implementation of the use of Mobile Technologies in the "Hands-On" Construction Materials and Methods Laboratory facilitated the communications between the learner and the instructor, increased understanding of construction safety, and increased communication and problem solving skills. Further, the use of mobile technologies gave students a greater understanding of technologies that they will be required to use in the construction industry.

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