Key Words

Spatial context, mobile learning, maps, soils, vegetation, landscape.

Abstract

Understanding geospatial concepts and using mapping tools are essential abilities for professionals working on natural resources management. Universities are expected to build these mapping foundations. Our students need to learn to associate where and how resources such as soils, water and vegetation fit in the landscape. However, existing approaches to landscape interpretation using paper maps can be considered pedagogically inflexible and disengaging for contemporary students. Therefore, we propose to develop a mobile learning tool to address this need. Our *DigiMapping* pilot project will compile and integrate relevant digital maps, and use an existing application (App) software to deliver contents and exercises. Students will use portable devices to enable educational activities conducted in small groups in field locations. This project will impact several University courses attended by an average of 344 students per year, and it has the potential to be extended to many audiences across and beyond campus.

PROJECT DESCRIPTION

Mobile Learning – *An on-going Revolution in Education*

Mobile devices have shown to enhance behaviorist learning processes and thereby provide a positive contribution to knowledge development. The use of mobile devices to present teaching content with specific motivations and questions (stimulus), obtain answers from learners (response), and provide appropriate feedback (reinforcement) provides opportunity for 'drill and feedback' activities and fits well within the behaviorist learning paradigm.

Mobile devices provide a unique opportunity to have learners embedded in a realistic context while accessing supporting tools simultaneously. Each learner or small groups can carry a device which allows them to become part of the dynamic system they are learning about. Some researchers describe mobile learning as the use of mobile devices for the purpose of learning while on the move (Park, 2011), and hence, it becomes an ideal solution to implement during educational field trips. In general, Ally (2012) suggests that mobile learning can overcome barriers to learning such as distance and by making education more accessible and inclusive. Park (2011) also supports these advantages of mobile learning because technology can make learning ubiquitous by freeing learning from any particular location, device, or setting. Mobile learning can also decrease isolation amongst learners and help them to create personal learning environments by facilitating users to share knowledge and interact with each other (Attwell et al., 2009). Thus, mobile learning has the advantages of delivering learning in a flexible, individualized manner, where and when students want and need it. This form of delivery includes a wide range of flexibilities in the kind of device used, the platform used to deliver learning, and the learning context, reducing barriers of time, cost, and technical expertise. When combined with instructional design techniques, mobile learning can provide an engaging experience, and it effectively contributes to achieve educational goals by incorporating digital contents, interactive monitors, portability, collaborative exercises, and rapid delivery.

DigiMapping – *A Novel Mobile Learning Tool*

The current and future generations of professionals working on agriculture and natural resources are expected to learn and be able to apply geospatial skills. Specifically, they are expected to discern where and how key biophysical features such as soils, hydrology and vegetation fit in the landscape. These contextual abilities also involve interpreting how the spatial relationships interplay. This knowledge is one of the essential foundations for effective assessment and management of our land resources as well as for devising future developments and preservation of our natural assets depending in part on how they are distributed in the landscape. Although this conceptual knowledge and practical skills are critical for future professional, engaging our current students in active learning of geospatial context using the traditional approach based on paper maps is challenging and inherently limited. Therefore, using digital maps on mobile devices is an exceptional opportunity to enhance experiential learning of our students.

Mobile delivery can be applied in remote fields where students participate in learning activities relevant to gaining hands on expertise in the spatial context of land resources. This will place students at the center of the learning process as they will operate mobile devices to access, select, query and interpret multiple digital maps on the device monitors while following prescribed educational guides, exercises and evaluation. This mobile learning tool – *DigiMapping* – will enable and engage students to follow their own curiosity and inquiries, and will help to develop in our students the conceptual foundations and abilities for analysis, interpretation and mapping of landscape features and processes through the correlation of their own field observations with multiple georeferenced spatial data layers.

The **Objective** of this pilot project is to develop a mobile learning tool that will improve teaching of the spatial context of land resources using digital maps of soils, hydrology, and vegetation. More specifically, for this pilot project, we will compile and reformat digital maps of soil classification in polygon scale, geology, terrain elevation, and land vegetation cover for Alberta. These teaching contents will be uploaded into iPad devices via an existing application software. We will test the use of this prototype by students in field exercises in early Spring 2017.

This novel teaching tool will be an exceptional and transformative educational experience for courses focusing on land resources inventory, planning, management and conservation. Implementation of this mobile learning system will shape the new generations of professionals educated in these subjects at the University of Alberta. The proposed DigiMapping fits perfectly in the ***University of Alberta For the Public Good*** and ***Comprehensive Institutional Plan*** within which a top priority is developing robust, versatile, efficient digital learning environments. The development and dissemination of DigiMapping will effectively establish and improve our leadership in mobile learning. Beyond our campus and degree programs, DigiMapping also has the potential to impact and benefit the broader society as it can attract, capture and benefit users across Alberta.

In subsequent phases, the large project will involve the design, development, and delivery of two learning modes: mobile learning (using a new Application software on portable devices to enable offline operation) and online modules. The curriculum content will include tutorials, guides, asynchronous sessions, and assessments as deemed by the instructional design and delivered by various media (visuals, audio, video). These educational contents will be available on the mobile devices for offline use and on eClass for online access. Potential mobile devices will include iPad, iPhone, Tablet or Android. The design approach for the new DigiMapping App will aim at

providing the student with resources (map layers), learning activities, and collaborative opportunities with cohort members.

Compared to using traditional paper maps, this DigiMapping project will enhance by many times the visualization, resolution and interpretation of data layers available on the device monitor. It will benefit students as they will be able to switch across multiple map layers instantly. The map contents will integrate topography, terrain elevation, imagery, land use & cover, town & roads, watershed, ecodistricts, parent material – geology, climate, edaphic polygons and soil properties.

Innovation

For this pilot project phase, we will be using an existing App software to deliver the digital map contents to small groups of student in field exercises (spring 2017). This existing App is entitled: Integrating Spatial Educational Experiences (ISEE, 2016) which is available for free via Apple App Store - https://appsto.re/us/nbdy7.I. This ISEE App is an earlier attempt to develop portable interfaces with spatial information about land resources which has been successfully demonstrated and tested by Mitzman et al. (2011). This ISEE App runs offline, and at the present this ISEE App is only compatible for installation with Apple iPads. Another earlier effort is SoilInfo App by ISRIC (SoilInfo, 2016). These two Apps have limited mobile learning capacity as they do not include interactive exercises in their digital contents (only maps). Also, SoilInfo can only run using cellular signal (this is a restriction for both large data layers and remote locations). In the future, when we eventually undertake the development of a new App (during this pilot project we will conduct an early prototyping and development), we will learn from these two previous App experiences to deliver much more effective, user friendly, practical and interactive digital contents and curriculum for the benefit of our students.

Collaboration

Because the students using DigiMapping will be engaged working and collaborating in small groups (two to four individuals), DigiMapping will implicitly lead to effective synergistic learning amongst our students. They will need to deliberate with each other as they develop and resolve the exercises and evaluations both in indoor settings and in remote field locations.

DigiMapping will enhance synergy within the Faculty of Agriculture, Life, and Environmental Sciences (ALES) and the Department of Renewable Resources (REN R) as the development and implementation of DigiMapping will involve the instructors (PI & co-applicants) for several university courses (Table 1). The PI is deeply involved in research projects focusing on quantification and mapping of ecosystem services in grasslands and croplands in Alberta, and hence, DigiMapping will be intimately connected to the PI's research interests and expertise. It is natural and genuine for the PI and co-applicants to branch out from their research on spatial heterogeneity and landscape processes into undergraduate teaching activities via DigiMapping.

In addition to collaborations on campus, DigiMapping will be strong in connections outside campus. For example, collaborator institutions will include Alberta Agriculture and Forestry (David Spiess, Tom Goddard and Barry White), and Alberta Biodiversity Monitoring Institute (ABMI – Geospatial Center; Jahan Kariyeva and Majid Iravani). Likewise, other collaborators are Darrell Schulze at Purdue University, Indiana who has been involved in the ISEE App project (ISEE, 2016), and also Robert MacMillan (Scientist & Consultant, Edmonton) who has participated in the ISRIC SoilInfo App project (SoilInfo, 2016). All these relationships have been already established. These collaborators will provide insights from previous projects, expertise,

and access to valuable spatial data layers. The data layers are available on a public domain, and therefore, no financial exchange or funding allocation will be transferred to the collaborators.

Evaluation

To assess the pedagogical effectiveness of teaching spatial context of land resources to students using DigiMapping (e.g., REN R 299 as a pilot in the spring 2017; Tables 1 and 2), we will use a design in this sequence: pre-test, treatment and post-test. In the tests, we will ask a series of questions designed to assess the abilities to understand spatial concepts and resolve geospatial applications and inquiries using maps. Test scores will be contrasted with paired t-tests (before versus after) as Mitzman et al. (2011). As the proposed teaching is learner-centered, we will apply surveys to collect feedback from the students using multiple choice and open questions. Evaluation activities with students are planned for the spring 2017 (Table 2 - Timeline). Eventually, upon completion of other future phases of this project, insights from the evaluation will be shared with the wider public as part of the ***dissemination***.

Sustainability

As mentioned in the ***Budget Justification***, the purchase of any iPad devices will have warranty for repairs and loss as well as protective cases. Likewise, the iPads will have high memory capacity (128 gigabytes) and true GPS built-in. This implies that GPS signal and location can be acquired outdoors in real time without the need for any cellular or data plans, so these expenses are unnecessary. These key characteristics will provide autonomy, operation in remote fields and practical sustainability of DigiMapping in the long term. Following project completion, the courses adopting DigiMapping will assume the basic operation and maintenance of this mobile learning platform.

Impact on Students

For the pilot project, we will undertake testing activities with students in REN R 299 (Spring 2017 with about 100 individuals in small groups). Eventually, upon completion of subsequent phases of this project, several courses will be impacted by DigiMapping (Table 1). After pilot completion, this project will create activities and exercises modules in REN R 210 including field visits focusing on spatial distribution of soils in the landscape (two weeks of content delivery); also, REN R 450 focusing on watershed planning (one week); REN R 441 including field visits focusing on soil formation factors as a function of meso-topography (four weeks); and also two full days in ecosite hand-on exercises in REN R 299 in field locations.

Table 1. University courses to be impacted by DigiMapping. Typical annual student enrollments are indicated. The four instructors listed below act as the PI and co-applicants on this proposal.

Course code Course name	REN R 299 Field School – Ecosite	REN R 441 Soil and Landscape	REN R 450 Sustainable Agriculture	REN R 210 Intro to Soil Science	REN R 443 Soil Physics
Enrollment	106	40	18	150	30
Instructors	G. Hernandez, M. Dyck, D. MacKenzie	S. Quideau, M. Dyck	G. Hernandez	D. MacKenzie	M. Dyck

The population of university students to benefit from DigiMapping is approximately **344 students per year** (Table 1). This is a significant student population to be impacted from this

project. Students will work together in small groups during field trips using the mobile devices. Each course involves teaching assistants who will be facilitating DigiMapping delivery and use.

Dissemination

Eventually, after completion of this DigiMapping pilot phase and during the implementation other future phases of this project (for which we will be seeking and applying for additional funding), we will conduct DigiMapping workshops to share our evaluation results and insights as well as to engage and train other instructors on this novel mobile learning tool. For example, two workshops will be offered at the Faculty of ALES and one at the Faculty of Science (aiming at Biosciences and Earth & Atmospheric Sciences departments). We anticipate that the outcomes of this project will be communicated in journal publications and several presentations in scientific meetings (i.e., European Geosciences Union, and American Society of Agronomy and Soil Science Society of America). Participation in these meeting will enhance the visibility of DigiMapping and showcase its contributions to experiential and mobile learning. Collectively, these future efforts will document and communicate the project results. This will further promote and enable the use of DigiMapping by other educators and students. Our dissemination plan will take place in year 3 (Table 2 Timeline; A17-A20 & M3).

References

Ally, M. 2012. Mobile learning: The equalizer in education. La Educ@ción Digital Magazine 147.

Attwell, G., Cook, J., Ravenscroft, A. 2009. Appropriating technologies for contextual knowledge: Mobile personal learning environments. *In* Lytras et al. (Eds.) Best Practices for the Knowledge Society: Knowledge, Learning, Development and Technology for All. Springer. Pages 15–25.

ISEE. 2016. Integrating Spatial Educational Experiences by Purdue University. https://itunes.apple.com/us/app/isee-integrating-spatial-educational/id996159565?mt=8 Verified on 1 May 2016.

Mitzman, S., Snyder, L.U., Schulze, D.G., Owens, P.R., Stowell, M. 2011. The Pilot Study of Integrating Spatial Educational Experiences (Isee) in an Undergraduate Crop Production Course. J. Nat. Resour. Life Sci. Educ. 40:91–101

Park, Y. 2011. A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. The International Review of Research in Open and Distance Learning 12:78–102.

SoilInfo. 2016. World Soil Information Center (ISRIC). http://www.soilgrids.org/ and http://soilinfo.isric.org/ Verified on 10 Jan 2016.