DEVELOPING AUTHENTIC AND VIRTUAL E-LEARNING ENVIRONMENTS

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ABSTRACT:

As part of their learning process, students often need to understand and interact with real world processes. Traditional learning activities such as field trips, site visits, videos, visiting speakers and live interviews have been used to achieve this. Because of various practical, legal and political issues, such activities can be difficult or even impossible to organise.

E-learning can play a vital role in providing suitable and effective learning environments to enhance the knowledge and skills of students. Such an environment can provide a virtual interface to a real-world scenario or process. Students need to make decisions and receive responses in a highly interactive exchange. An e-learning environment must also be authentic, providing the student with meaningful and realistic information and scenarios that represent real world processes in a practical manner.

The work being presented in this paper describes the virtual e-learning developments, experiences and evaluations that have been undertaken by the Department of Spatial Sciences at Curtin University across a number of projects. The Virtual Online Learning (VOL) project outcomes included a range of online and virtual modules in the spatial sciences – geographic information science (GISc), global positioning systems (GPS), cartography and surveying. The Virtual Industry Link Learning Environment (VILLE) project is developing interactive virtual site visits that interact with industry practitioners and emulate tours of processing facilities. The aim is to provide stimulating and interactive learning environments that adequately prepare a student for real world conditions.

1. INTRODUCTION

1.1 Introduction to e-learning

The world wide web is increasingly being used as a resource in the learning and teaching of students in higher education. The e-learning revolution has been largely technology driven with the Web enabling greater flexibility and access by students to learning resources (NBEET, 1996; Veenendaal, 2000; Koohang and du Plessis, 2004). The importance and potential of the web for e-learning has been recognised for providing education in the spatial sciences (Kemp and Unwin, 1997; Carver et al., 2004). However, e-learning is much more than simply a technological means of placing existing learning resources online and reaching a wider body of students; rather, it must be seen as a pedagogical means of enhancing the learning environment.

1.2 Beyond the classroom

E-learning is not just a replacement for classroom instruction and a means to facilitate distance learning. Instead, it can be seen as both a means to replace classroom activities for distance learners, as well as complementing face-to-face learning in classroom situations (Veenendaal et al., 2002b; Carver et al., 2004).

In fact, e-learning can go beyond the traditional means of instruction and learning by bringing student interaction and real-world scenarios directly into the learning environment. Authentic learning occurs where students can understand, relate to and interact with real-world situations and problems. Real-world scenarios can be brought into the classroom via virtual online environments where students can visualise and interact with the environment in a manner similar to real-world conditions.

E-learning is being utilised by both distance and on-campus educational programs in geographic information science (GIScience), cartography and surveying within the Department of Spatial Sciences at Curtin University of Technology. A number of projects have contributed to the development of e-learning resources. The Virtual Online Learning (VOL) project resulted in a number of highly interactive e-learning modules that involve learners in topics within GIScience, global positioning systems, cartography and surveying. The Virtual Industry Link Learning Environment (VILLE) project is developing interactive virtual field trips and site visits that simulate field work or emulate tours of industry sites and workplaces. Examples from these projects will be used in this paper to demonstrate the effectiveness of learner engagement in e-learning.

1.3 Dimensions of e-learning

In order for e-learning to be effective, three dimensions need to be considered: pedagogical, technological and organisational (Jochems et al., 2004). Although often driving the e-learning agenda, technology is but one consideration and provides the infrastructure to enable e-learning to take place. The more important aspect is pedagogical where the focus is on the learning process and how e-learning can be used to enhance that process and it outcomes. The organisational aspect concerns the roles and interactions among learners, educators and learning resources. All three dimensions need to be considered for authentic and virtual e-learning environments.

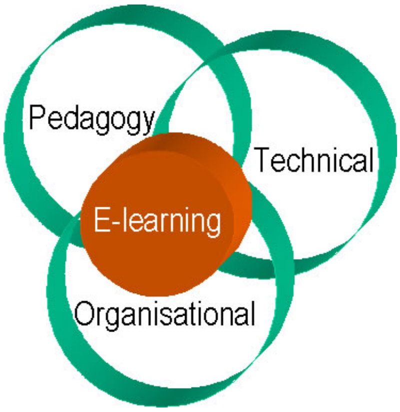

Figure 1. The three dimensions of e-learning

This paper focuses, in particular, on the pedagogical and organisational aspects as it relates to learner-content interaction.

2. THE ROLE OF AUTHENTIC AND VIRTUAL LEARNING

2.1 Improving learning by interaction

Many e-learning applications are of low pedagogical quality (Chou, 2004; van Merrienboer et al., 2004). In many cases, they simply use the technology as a repository of learning resources and as a facilitator of electronic communication between students.

Student learning needs to involve constructive activity (Jonassen et al., 1995; Chung et al., 2003; van Merrienboer et al., 2004). Just simply reading material from an online resource, interacting with classmates either directly or via email, or reading/copying other students' work is insufficient for learning. The frequency of interaction is not a good indicator of learning. Rather, the more students are directly engaged in their learning activities, the better they will learn.

In addition to asking questions and seeking help, students need to spend some time and effort in other constructive activities, such as interacting with the learning problem, seeking further explanations from different perspectives, and obtaining appropriate feedback and responses along the learning path. According to Chou (2004), learners achieve intellectual growth and changes in perspectives as a result of effective learner-content interaction.

E-learning provides a means to support such constructive activity. A study by Chung et al. (2003) showed that students who used online learning support tools reflected more on their learning than students who did not use such tools, resulting in improved interactions with classmates, better knowledge building and hence improved learning.

A small study was conducted by one of the authors (Gulland) in an introductory computer programming course. Three interactive online learning tools were developed for assisting students with control structures (FOR, WHILE and DO-WHILE loops). All students were subjected to a common face-to-face lecture, after which they were tested regarding their understanding of these concepts. The students were randomly divided into two groups, one group was given access to the interactive tools, and the other simply used their lecture notes. The group that used the tools scored 27% higher than the group without, and the standard deviation was 21% lower. The student feedback included the following comments:

- "*This would be VERY useful for each of the concepts that we learn in this unit. Not only does it explain the method behind the command but it gives the student the syntax, which is often what goes wrong in my programs (having a comma or whatever in the wrong place*)."
- "*It can be a good help, the last clip was very helpful and understandable , should use them in the lectures*"
- "*These little programs illustrate the concept well*"
- "*Easy to understand, useful*"

2.2 Utilising authentic learning experiences

Learners can become independent contributors by gaining first-hand knowledge and experiences from real-world situations (Carver et al., 2004; Jansen et al., 2004; Stein et al., 2004). Often, students are being taught concepts and applications in either a classroom or an online environment, where they cannot directly relate to the practical application or experience in the real-world setting. Such learning experiences are not authentic.

Authentic learning activities are designed to give students a sense of reality, of how the concepts and skills being taught are actually being used and applied in a real-world situation. Authentic learning needs to link classroom practices to industry practises that go beyond the classroom. Students need to experience the real world context within their learning environment by carrying out learning tasks as close as possible to the real world (Jonassen et al., 1995; Chou, 2004). Such authenticity can be gained by exposing students to real-world situations via field trips and site visits, to practitioners who can relate their experiences and practices in a real-world application, to concepts and processes that resemble real-world scenarios, to working collaboratively on industry projects and problem-solving situations, etc.

Virtual environments contribute to all such activities, placing the learning activity in a real-world context, providing further explanation evoking student responses, and enabling student discussion from a deeper learning perspective. For example, Jansen et al. (2004) describes a virtual business e-learning environment where students adopt roles and perform tasks in a simulated "real" business setting. The goal is to bridge the gap between the learning and working environments.

3. IMPLEMENTING AUTHENTIC AND VIRTUAL LEARNING

Within the context of a number of learning projects, a range of online learning resources have been developed at Curtin University for programs of study in the spatial sciences. Many of these resources involve a high level of interaction with learners and aim to provide authentic learning activities. This section will outline some of them, including a virtual field trip for vegetation sampling, a virtual industry learning link involving interviews with practitioners in live real-world industry settings, and virtual assembly of industry-based GPS equipment.

3.1 Virtual field trips

Field trips and excursions are learning activities that expose the student to real-world settings. Students are able to visualise the environment, understand the relationships, utilise their knowledge and skills in a real setting, interact with the environment, make "real" mistakes, and obtain responses and feedback to guide them in the correct direction.

One of the outcomes of the GIScience program at Curtin University is that students are able to perform spatial sampling. In addition to learning the principles and methods of sampling, students embark on an excursion to apply these principles and methods on, for instance, vegetation cover. In this example, students need to make decisions on how best to set up a sampling regime to cover the study area, to obtain the sample readings, to record the readings and to analyse them within a geographic information system (GIS) software package. The learning process is greatly enhanced by students viewing actual vegetation coverage, making decisions regarding sampling methods, observing the effects of their decisions, and working with the results obtained by their own efforts. The excursion helps students to more fully understand the concepts, take ownership of "live" data, and have a deeper understanding of the analysis process, knowing how the data relates to a real-world situation.

Such excursions, although very effective and crucial to the learning process, are often difficult if not impossible to organise and carry out. For example, the vegetation sampling activity is dependent on vegetation conditions, weather, etc., not to mention some of the organisational aspects including timetabling, transportation, liability and insurance risks. Inclement weather, the wrong season where vegetation coverage is inadequate, or timetabling clashes could constrain or prevent such an excursion from occurring, disrupting the entire learning program. In addition, such an activity is usually impossible for distance students.

The solution developed through the VOL project at Curtin University of Technology was to build a virtual field trip that provided a student with, as close as possible, the same experience by performing vegetation sampling via online and highly interactive learning activities (Veenendaal et al., 2002a). Figures 2 through 4 illustrate some screen shots of the vegetation sampling fieldwork module that was developed. Further information on the design and implementation of the virtual field trip is provided by Veenendaal and Corner (2001).

Some of the features of the virtual field trip learning resource involving a high degree of learner interaction include:

a) Panoramic view of the study region linked to an interactive map (Figure 2). Students can pan through the study area and view panoramic photographs of vegetation cover and topography. They can navigate from either the 2D map or the panoramic image which are linked and synchronised (that is, each image reflects mouse movements made in the other). The virtual study area, within the Canning River Regional Park, is also the place where the real field trip is held.

b) Choice of sampling methods and parameters (Figure 2). Students choose a site and set out the sampling frame utilising an appropriate sampling method of their choice (by determining origin, orientation, size, etc. of a sampling grid).

c) Measurement and recording of samples (Figure 4). Students utilise an appropriate measurement scale to observe and record vegetation coverage for each sampling unit. An interactive tool allows students to "practise" taking measurements and provides them with feedback regarding how well they fared. For example, in Figure 3, a green entry in the table of measurements indicates a correct value and red an incorrect one. When students have gained sufficient confidence in their ability to take measurements, they perform the "real" sampling. The results can then be recorded and uploaded via a spreadsheet directly into a GIS software package for analysis. In fact, since the results are obtained digitally, students performing the virtual sampling are spared the additional mundane effort of manually keying in the results onto computer.

Figure 2. Panoramic view linked to an interactive map

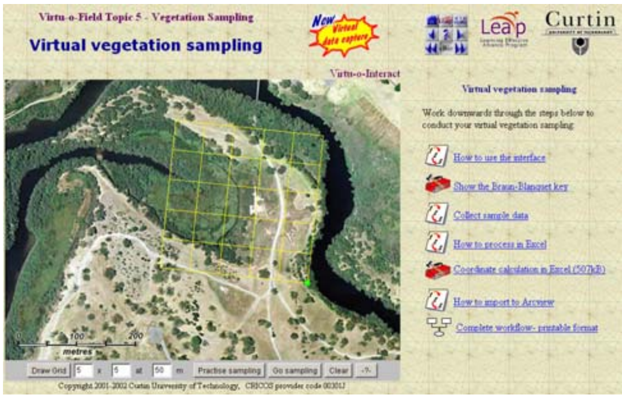

Figure 3. Choosing the sampling method and parameters

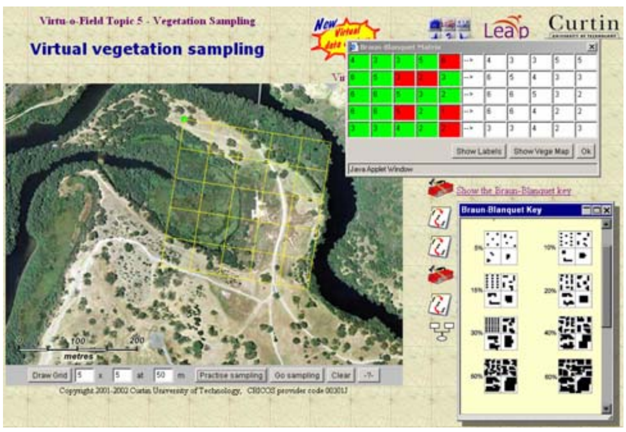

Figure 4. Feedback obtained from practise sampling

In fact, the virtual sampling field trip has additional benefits for the student. In addition to performing the sampling at any time and from any place, they can repeat the activity at a later stage if they so wish, and they can take as much time as is required to understand each step in the process without being constrained by the time limits imposed by an actual excursion. Further, the virtual field trip is used by on-campus students to prepare themselves for the actual excursion by orienting them to the study area and ensuring they understand the processes and procedures required to complete the vegetation sampling.

The students were evaluated on the basis of an assessment focussed on utilising the outcomes of the field trip. The same instructor, assessment and grading criteria were used across three years. In the first year, the virtual field trip was not yet utilised. In the second year, some components of the virtual field trip with some limited interaction were utilised. In the third year, the students were exposed to the full virtual field trip. The results are listed in Table 1. Note that the results include a combination of on-campus and distance students in the second and third years.

Year	Available to students	Student cohort	Assessment grade %	Change from Year 1
1	• No access to virtual field trip	40	60.6	--
2	Some virtual field trip components	43	64.6	6.6%
3	Complete virtual field trip	50	76.5	26.2%

Table 1. Results of virtual field trip implementation

There was a modest increase in assessment grades with the implementation of some components, but with the full implementation of the virtual field trip there was a substantial increase of 26.2% in grades compared to students who did not utilise it at all. Student comments included:

- "*for me, the virtual field trips were the only way to really understand and comprehend just what it takes to implement a complete GDA solution*",
- "*It felt like I was there*" (from a distance student),
- "*...added a strong element of reality to the unit that is often forgotten in lectures. The virtual field trip was good preparation for the real field trip*",
- "*it allows me to try and practice how to sample data of real world*"

Overall, student attitudes to field trips were very positive. Real trips were found to be more stimulating and virtual field trips were found to be more useful.

3.2 Virtual industry learning link

Students, toward the end of their study program, need to be prepared for a career in the real world of industry. Exposure to industry, perhaps by undertaking site visits or by listening to visiting lecturers from industry can be very helpful in this process. Both of these methods have been employed for many years and have been keenly sought after by students.

With the development of more flexible learning programs for both on-campus and distance students, new challenges have been presented to the educator. Students are often constrained to a specific time and place where the site visit or guest lecture is to be held. If they are unable to attend, which is most certainly the case for distance students, then they are not able to benefit from that particular learning activity. Even if present, they only have one chance to take in what is being said. Especially for site visits, students at the back of the group may not always follow what is being said, either because the speaker is somewhat soft-spoken or because of additional noise and interference in the on-site environment. A solution often utilised is to video the site tour or the visiting lecturer, and to stream it onto the Web for later access by learners. This is a very effective solution for making the learning activity accessible and reproducible beyond the constraints of the physical activity.

A further difficulty lies in the integration of such learning activities with the existing content and activities of the learning program. Adding the content of the visiting lectures into the study material can often appear as an add-on to the existing study materials and may not contextualise them well. Often, there are multiple learning outcomes that need to be addressed by site visits or guest lecturers, and they are then covered all at once when that activity takes place, rather than occurring at appropriate intervals within the study period as individual topics are covered and each learning outcome is achieved.

The GIS Management course within the Department of Spatial Sciences is a senior year unit delivered in both face-to-face and distance modes. There is a requirement in this course for students to understand and engage in business processes and procedures relevant to managing GIS projects. In the past, this course has relied on site visits and guest lecturers. However, the number of such activities needs to be minimised because of time and logistical constraints. Student feedback has indicated a greater desire to have more practical and real-life activities spread throughout the course, rather than focussing all on a limited number of such activities.

- "More examples of real-projects would be good. Examples from real-projects…"
- "…different case study each week would be better still, with different solutions to similar problems"

Curtin University has undertaken a novel approach to meeting this demand. Case studies from industry are embedded within the online learning resources. The case studies are presented in pop-up windows and are hyperlinked to appropriate locations in the e-learning resources (eg. study guide, work guide, etc.). The case studies are identified with an "industry interface" icon and include video clips, descriptions, examples, maps, images, documents, etc. as appropriate (Figure 5).

The videos are delivered by industry-based GIS practitioners and are recorded within the industrial workplace. Video footage including interviews and workplace scenes (and commentary) are segmented into short, easily-downloadable and manageable portions that are associated with particular learning topics and outcomes. These segments are then linked into the existing learning resources at contextualised and appropriate locations. Any supporting material, whether it be textual, graphic or other, are presented together with the video segment in the pop-up window.

The student, therefore, has access to the virtual industry link in the context of any supporting material, and at the point within the study program that is appropriate to that topic or discussion. The student is also able to progress through the e-learning resources in a flexible and self-paced manner, without being constrained by the time at which a physical site visit or guest lecture occurs. Further, because each individual "industry interface" is aligned to one specific topic or thought, and is contextualised, students are more focussed and can engage themselves more directly. The result is a deeper understanding and appreciation in working towards the learning outcomes.

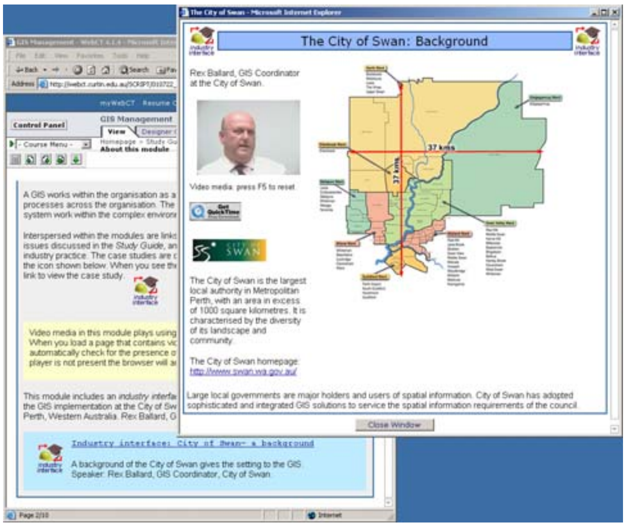

Figure 5. Let the practitioners give the real world view

A further benefit of this approach is that multiple industry links involving different organisations and case studies can be reached in a single study period, without encountering time constraints and logistical difficulties. This particular work, undertaken within the VILLE project, is ongoing. Although no formal evaluation results have yet been obtained, informal feedback suggests that students are very enthusiastic with the e-learning tools provided thus far, and that the video footage of the industry interviews and workplace add a sense of "realism" to their learning.

3.3 Virtual assembly of equipment

Frequently, students need to be familiar with equipment used in industry in order to get the maximum benefit from field trips and practical activities or applications. Usually such familiarisation takes place in a practical session with some hands-on experience preceded by a demonstration. Depending on the amount and availability of equipment as well as the duration of the practical session, students have a limited time to develop their knowledge and skills in using the equipment. Distance students don't even have this luxury. Further, there is the danger that learning how to set up equipment absorbs such a significant portion of a practical exercise that the underlying concepts and skills to be learned (for example, the use of the equipment in a field survey) are overlooked.

To overcome these problems, an interactive tool was developed to demonstrate how to assemble equipment for a GPS survey. On-campus students work with this tool in labs before operating the real equipment, leaving them with more time to understand how to assemble and operate the equipment. Distance students also use the online tool to become familiar with equipment commonly-used by industry.

An example of such a tool is the virtual assembly of Trimble Geodetic GPS equipment. Figure 6 illustrates the interactive tool where students need to identify appropriate components, and assemble them in the correct order by using the mouse pointer to move the component to its appropriate location. Red crosses immediately indicate incorrect locations and/or sequencing of components in the assembly. Pop-up messages indicating the type of error appear when rolling the mouse over a cross, and extra helpful tips are displayed after several unsuccessful attempts. When a correct decision is made, the tool immediately moves on to the next step. If students really get stuck, they can obtain hints that point them in the right direction.

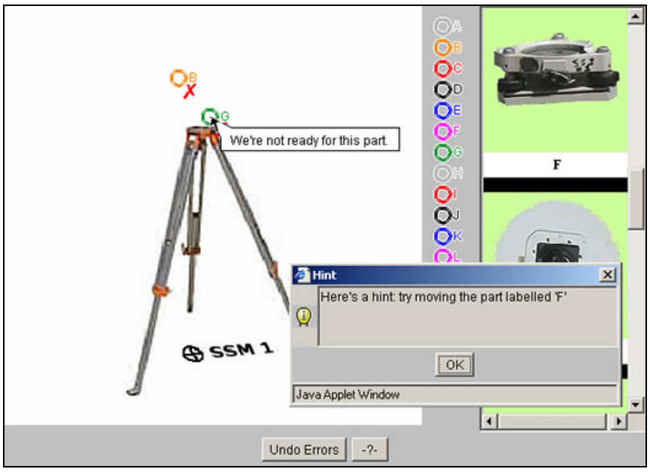

Figure 6. Virtual assembly of GPS equipment

The high interactivity engages the student directly in the activity of assembling equipment, and familiarises them with the individual components and order of assembly even before they ever touch the actual equipment itself.

Feedback from the instructors indicate that this particular e-learning resource saves up to 25% of valuable time in a 4-hour practical session. From the point of view of the tutors, there is less pressure on them, during the course of the practical session, to individually explain the assembly and operation process. In fact, they can focus more on the utility and application of the instrument which is directly related to the learning outcomes. Student feedback has indicated less frustration in seeking help from tutors and waiting for "their turn" when multiple groups of students simultaneously require attention.

4. CONCLUSIONS

An e-learning environment needs to extend beyond technical drivers to pedagogical and organisational dimensions that focus on the interaction between the learner and the learning environment. In fact, effective e-learning resources can not only be used to complement face-to-face education or replace the classroom for distance education, but can facilitate the integration of student interaction and real-world scenarios into the learning process. The use of highly interactive and virtual resources can support authentic learning where students can relate to and experience real world contexts in their learning.

A number of examples demonstrating the use of such virtual and authentic learning resources were outlined, in particular, a virtual field trip for vegetation sampling, a virtual industry learning link for introducing GIS management processes and decision-making via practitioners in industry, and the virtual assembly and handling of industry-based equipment.

By engaging with the knowledge, skills and real-world processes provided through the use of these highly interactive and virtual resources, students were able to gain a better understanding of the concepts, applications and relevance in relation to the real-world context. This was reflected in the student performance and feedback comments. They found their learning experiences to be useful and stimulating. The most effective tools tend to have a direct link to real-world applications. As interactive online tools allow students to proceed at their own pace, and repeat the process as necessary, more knowledge is gained from real-world applications that are preceded by use of related interactive tools.

The research and developments within the projects referred to in this paper are ongoing. For example, the authors are currently developing virtual and authentic learning resources for site visits or simulations involving processing plants, mining operations and geological processes.

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