2005

Integrating problem-solving strategies and fieldwork into an authentic online learning environment

Gwyn J. Brickell
University of Wollongong, gbrickel@uow.edu.au

Janice A. Herrington
University of Wollongong, janherrington@gmail.com

Barry M. Harper
University of Wollongong, bharper@uow.edu.au

Publication Details

Brickell, G. J., Herrington, J. A. & Harper, B. (2005). Integrating problem-solving strategies and fieldwork into an authentic online learning environment. International Conference on Education & Technology (pp. 38-43). Calgary: ACTA Press.

INTEGRATING PROBLEM-SOLVING STRATEGIES AND FIELDWORK INTO AN AUTHENTIC ONLINE LEARNING ENVIRONMENT

Gwyn Brickell, Jan Herrington & Barry Harper
Research Centre for Interactive Learning Environments
Faculty of Education
University of Wollongong, Australia
Email contact: gbrickel@uow.edu.au

ABSTRACT
In this project, a technology-supported learning challenge has been developed to replace a conventional visitation program at Sydney Olympic Park. The educational approach taken is based on a general social constructivist model of learning, challenging learners with a problem-based perspective directly linked to specific syllabus outcomes. Students engage in work on the web, in class, in the field and in technology 'pods' with an emphasis on student-centred tasks and field activities that will require them to explore data and information, construct and test hypotheses, and present conclusions and solutions in the form of artefacts. This paper describes the learning design of the challenge, and describes the results of formative evaluation in the form of user review and interviews with teachers of the program.

KEY WORDS
ill-structured problems, authentic environments, web-based learning, fieldwork, collaboration

1. Introduction

Both nationally and internationally, organisations are investigating ways in which technology can be used to provide a range of meaningful learning opportunities for students of all ages. This paper outlines one such application of the technology in the development of a prototype online learning environment involving an excursion to the Parklands of Sydney Olympic Park, that is based on a constructivist approach, specifically using characteristics of a situated learning model (e.g. Savery & Duffy, 1995; Herrington & Oliver, 2000) and engaging problem-solving strategies through learner collaboration (Katz & Lesgold, 1993).

Recent curriculum documents in Australia into the use of computer-based technologies emphasise the development of cognitive skills through the use of investigation, reflection and analysis, synthesis and evaluation to generate or refine knowledge:

> The study of Geography develops a wide range of skills such as gathering, organising and evaluating geographical information from a variety of sources, including fieldwork. Through the spatial dimension, geography enables students to identify and analyse the physical, social, economic, political, legal and technological factors that influence where things are and why they are there. The ecological dimension requires students to identify and analyse the ways humans interact with environments and in so doing develops students' skills in evaluating arguments and problem-solving (NSW Geography Year 7 to 10, Stage 4/5 syllabus, 2002, p.8)

In changing the focus of education the development and application of computer-based technologies, delivered to learners through WWW-based information systems, has become more common in recent years in an educational setting as a stimulus for both teaching and learning. In addressing this development, Jonassen (1997) maintains that the development of such 'higher order' cognitive skills can be achieved through problem solving in environments that present tasks in ill-structured domains.

2. Authentic environments

Traditionally, excursions or fieldwork have focussed on hands-on, immersive tasks where students are given the opportunity to engage in the 'real-world' albeit briefly, before they return to the 'theory' of the classroom. Learning on such excursions is at times engaging and effective, with students' making multiple and meaningful connections, to accomplish understandings that simply could not be achieved in the classroom environment. However, it is more likely that such outings involve meaningless measures and calculations, and the filling out of decontextualised worksheets that result in little more than disengagement and boredom on the part of the students.

While a substantial body of literature has emerged in recent years on the theoretical foundations of learning from museums and visitations, also known as 'informal' or 'free-choice' learning (cf. Falk, 2004; Anderson & Lucas, 1997), the theory of situated learning (Brown, Collins & Duguid, 1989; Herrington & Oliver, 2000) was the most appropriate theory to inform the whole design of the Sydney Olympic Park program. This theory provided the theoretical and practical constructs to inform an embedded, problem-based approach to investigating a complex issue. Rather than having an excursion as a one-off, isolated event, the visit to Sydney Olympic Park is seen as just one stage in a series of stages where students collect data to solve the problem. Nevertheless elements of 'informal learning' theory were used to inform the stage of the process that was conducted on site at the Park.

The challenge is comprised of pre-excursion, excursion and post excursion tasks that may take several weeks to complete. All stages lead to the resolution of a complex problem. The problem presented to students is realistic and compelling, and it is the first thing that students see when they enter the learning challenge environment online. A scenario is presented with cartoon-like graphics, visuals and a dynamic soundtrack, where the students are contracted, as 'expert geographers' by Sydney Olympic Park to investigate a serious problem that is causing a great many letters of complaint to be written by the people who use the park and the nearby residents. Issues of pests (mosquitoes, rats, gambusia), water management (low water levels) and human interaction are investigated by students as they seek to find a balance between the ecological and human needs of the area, and advise the keepers of the park on the most sustainable solutions.

As students investigate the problems of the park, they follow a syllabus-based research action plan. Figure 1 shows Step 5 in the plan, the data collection phase that is completed on site at the park. Within the context of seeking a solution to the problem scenario, and the pre-planning and preparation that has taken place at school, the students now have a realistic purpose for collecting data on the field trip. The data they collect has meaning, because they will analyse it after the excursion, compare it with historical data, and use it to prepare recommendations as 'expert geographers' on the future sustainability of the parklands.

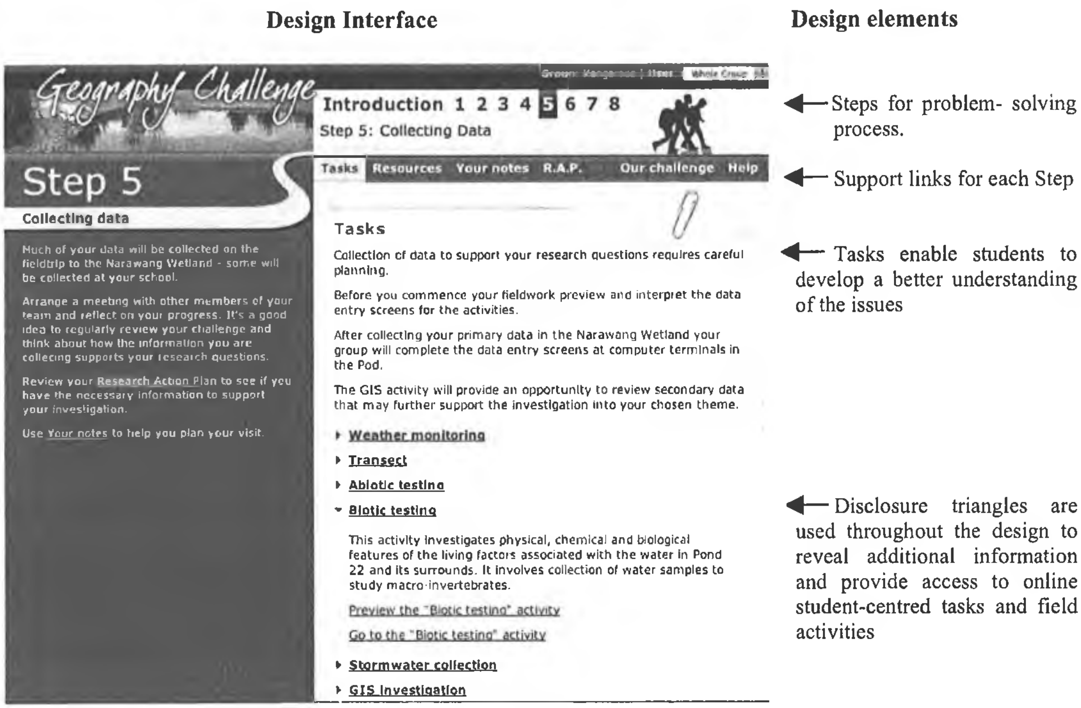

Figure 1: Interface of the 'Geography Challenge'

Moore et al. (1994) have pointed out that active involvement rather than passive observation or rote data collection is crucial for effective learning, and note that often, students observing an expert or performing various expert actions have little idea about what is happening and why. Only problem-solving activities, where students hypothesise, reflect and test, help them to acquire the necessary knowledge to understand expert performance. In this way, the situated nature of the problem and its solution—through a research action plan, data collection and analysis, and preparation of recommendations for the park authority—provides an authentic learning environment capable of enhancing the learning of complex geography processes and skills.

3. Problem solving

From a constructivist view of learning, effective learning situations are those in which the learner is immersed in the resolution of a problem where the learner's skills in informal reasoning, self-questioning, reflection and argumentation can be applied and developed. This view of learning asserts that knowledge is a constructed entity made by each and every learner. Such knowledge is internal and individually constructed through interpreting personal experiences of the external world (Jonassen, 1997).

A constructivist approach emphasises learners' ability to solve real-life, practical problems that involve identifying issues, researching the problem, planning the investigation and choosing a solution. By their very nature, real-life, practical problems involve unclear or ill-structured tasks that require reflective thinking and consideration of multiple perspectives. Difficulties arise for students because these problems have vaguely defined or unclear goals and possess alternative solutions that require some justification by the learner. Such difficulties stem from two essential areas:

1. the formation of a suitable mental model (Voss & Post, 1988), and
2. different learners often form different mental representations of the same problem (Wiley & Voss, 1999).

Both the representation phase and the actual problem-solving phase can be supported through the development of technology-supported learning environments (Jonassen & Grabinger, 1990).

4. Project description

In this prototype, the concept of a learning challenge has been developed to present a single complex and sustained situated case that supports the Stage 5 (Years 9/10) Geography syllabus of the NSW Department of Education and Training and is part of a larger plan to develop similar online learning environments across other K-12 syllabus areas. Initial engagement of the *Geography Challenge* by students is though an 'authentic' introduction that presents some of the difficulties associated with land and water management of the wetland and invites students to take up the challenge of investigating these issues. Working either individually or in groups students explore the *Challenge* and develop a Research Action Plan as part of the mandatory requirements of their course.

There are three distinct phases of engagement in the *Challenge* that are designed to stimulate student interest for a four to six-week period:

1. a pre-visit phase (Steps 1-4), where students develop a better understanding of the initial problems associated with the *Challenge* through interaction with a series of online tasks;
2. a fieldwork phase (Step 5), where students are engaged in a series of on-site activities involving the collection of primary data in the field. Students are then able to integrate direct observation and experience of the environment through Smartcard-enabled computer terminals at the excursion site;
3. a post-visit phase (Steps 6-8), where students have an opportunity to analyse, compare and discuss the data collected, collaborate and reflect on the outcome of their investigation(s) and articulate their argument through the production of a suitable artefact.

In each phase of the engagement, students are presented with a series of tasks that are linked to the appropriate step of the problem-solving process (Figure 2).

The *Geography Challenge* can be resolved through student interaction with a range of tasks and activities designed to focus on the characteristics of the wetland. It is envisaged that these interactions will allow students to: identify the problem(s) and refine the problem space; interrogate the content both in the associated fieldwork and in the web-based learning environment; analyse information and data; construct a mental representation of knowledge; and reflect on the knowledge construction process.

Scaffolding is provided through the use of cognitive support tools designed to facilitate the metacognitive learning strategies associated with these interactions. Such tools function as 'mindtools' (Jonassen, 1996) or 'mind-extension cognitive tools' (Derry & Lajoie, 1993, p.5). These tools provide support for the students in their search for and evaluation of the diverse range of information available, and in the collection of data, in developing their particular line of inquiry.

Problem-solving Process	Tasks	Engagement
Step 1: Understanding the Problem	What is a Wetland Mapping Climate Flora and Fauna History	Pre – visit (Context and Background Development)
Step 2: Asking Questions	GIS Investigation – Site infrastructure Pests Water Human Interaction	
Step 3: Deciding on the data required	Completion of data collection matrix for each of the on - site activities GIS Investigation – Fieldwork sites	
Step 4: Identifying Techniques	Completion of identifying techniques matrix for each of the on - site activities	
Step 5: Collecting Data	Weather Monitoring Transect Abiotic Testing Biotic Testing Stormwater collection GIS Investigation – Secondary Data	On - site Activities (Fieldwork and Data entry)
Step 6: Analysing Data	Investigating Secondary Data Comparing data with other groups	Post – visit (Artefact Development)
Step 7: Drawing Conclusions	Opinion of stakeholders	
Step 8: Reporting your Research	Complete Research Action Plan Propose individual or group action in response to research findings	

Figure 2: Tasks to assist the Problem-solving process

5. Context of the research

The learning challenge design draws on a broad base of research on computer supported collaborative learning to engage students in sustained challenges with their peers, at the small group, school and school visitors level.

The project offers a rich opportunity to examine the characteristics of learner interactions within authentic learning settings as well as learner experiences in collaborative learning processes that have been designed into the project. Specifically, the project team will examine learner joint decision-making and reflection on the tasks within the complex challenge and how this process supports the overall problem solving process and also the cognitive processes of the individual learners, within the theoretical underpinnings of the computer supported collaborative learning construct. Additionally, the designers have made assumptions about the problem solving process and scaffolding within the learning environment.

As part of the formative evaluation of the project, an investigation needed to be conducted on the learner experience in moving through this process, the relationship between the learners understanding of the embedded structured problem solving steps (based on the research plan model outlined in the geography curriculum) and the tasks and supports offered to learners.

6. User review

An initial formative evaluation of the website component of the excursion challenge was conducted with a group of 17 students from the target group, a class of Year 10 Geography students (reported in depth in Brickell, Herrington & Harper, 2005). The evaluation gave some insights into the links between the potential learner experiences and the theoretical underpinning of the design.

The analysis of data revealed that students generally perceived value in the authentic nature of the challenge giving some indication that the excursion program instantiated the underlying theory of the program. The collaborative opportunities of the environment were generally valued by the participants, both within and between groups. It was also found that the joint decision-making and reflection on the tasks appeared to assist students with the complex nature of the challenge. Nevertheless, the study revealed many practical problems, and suggested improvements that when implemented, will improve the usability of the program and increase its appeal to the target group.

7. Interviews with teachers

In addition to the formative evaluation conducted with the students, further research was conducted with the teachers of the target group. Two teachers of Year 10 Geography were interviewed to investigate the decisions that needed to be made to further refine the learning environment. Specifically, the following areas were explored with the teachers:

- Whether the intended benefits of the overall approach were realised.
- Whether the teacher introduction to the challenge needed to be adapted or redesigned for teachers.
- Whether the activities needed to be adapted or redesigned for the target group.
- Whether the interface and individual screens should be adapted or redesigned.
- Whether the underlying pedagogy was in their view instantiated in the learning environment.

Three major themes were explored in the interviews with teachers: the overall appearance and appeal of the site, usability issues from both the students' and the teachers', perspective, and the perceived effectiveness of the challenge.

In terms of the appearance and appeal of the challenge, both teachers confirmed the 'face validity' (Reeves & Hedberg, 2003) of the site for the target group. By this, they confirmed that the learning environment was appropriately pitched for its Year 10 audience, and that it was not over simplistic or ingratiating. In referring to the problem-based nature of the challenge, for example, one teacher pointed out: 'most students today like to be challenged by computers. They are less challenged by teachers in the classroom and like to have something different presented to them where they have to follow their own initiative'.

From a usability and ease of use perspective, both teachers suggested that the non-linear design would not be a problem for students. One of the teachers expressed this view: 'Students should be able to complete all of the Geography Challenge once familiar with the web site. Students can certainly work at their own pace and there is no lock-step progression to hold back the more talented students'. Similarly, from a teacher's perspective, both teachers concurred that it was important for them to 'do their homework' and that teachers should not 'come in cold'. One said: 'Prior to the visit, teachers should have a good idea about Sydney Olympic Park … and what can be investigated during the excursion', and suggested that perhaps in-service courses could be conducted for teachers. The other teacher observed that it was very important for teachers to adequately prepare for the excursion and to commit time to doing the necessary background work.

In terms of overall effectiveness, both teachers expressed the view that the learning environment adequately supported the Geography Syllabus and provided a valuable resource for the teaching of the sometimes difficult concepts implicit within the Research Action Plan.

Both teachers gave excellent feedback and suggestions for improvement of the site, including specific advice on clarifying confusing screens and instructions, advice on booking excursions, suggestions on storing and retrieving ideas and notes, and ideas on the nature of the final product or artefact produced by students.

Further effectiveness evaluations will be conducted when the challenge is fully operational within the Sydney Olympic Park excursion offerings.

8. Conclusion

Computer-based learning environments, if well designed, can support learner construction of knowledge through structured or ill-structured problem solving experiences. The assumption is that within these environments the learner is supported by visual metaphors constructed to represent the information structures available and how the 'real world' operates.

The unique nature of this project, which incorporates access to the real environment that is the basis of the investigative tasks, allows learners to access content and data beyond that included in the virtual environment represented by the website. The authentic concept of a learner challenge as representing the large scale task for learners to address is one that allows the project to be structured to suit its purpose in linking student-centred problem based tasks in the pre- and post-visit stages with the fieldwork activities in the natural setting of the wetlands.

References

[1] Anderson, D., & Lucas, K.B. (1997). The effectiveness of orienting students to the physical features of a science museum prior to visitation. *Research in Science Education, 27*(4), 485-494.

[2] Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

[3] Brickell, G., Herrington, J. & Harper, B. (2005). *Technology-supported collaboration on field-based authentic tasks.* Paper presented at the EdMedia 2005 World Conference on Educational Multimedia,

Hypermedia and Telecommunications Conference, Montreal, Canada.

[4] Derry, S. J. & Lajoie, S. (1993). A middle camp for (un)intelligent instructional computing: An introduction. In S. P. Lajoie & S. J. Derry (Eds), *Computers as cognitive tools.* Hillsdale, NJ: Lawrence Erlbaum Associates.

[5] Falk, J. (2004). The director's cut: Toward an improved understanding of learning from museums. *Science Education, 88*(1), 83-96.

[6] Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development, 48*(3), 23-48.

[7] Jonassen, D. H. (1996). *Mindtools for schools.* New York: Macmillan.

[8] Jonassen, D.H. (1997). Instructional design models for well-structured and ill-structured problem-solving learning outcomes. *Education Technology Research & Development, 45(1)*, 65-94

[9] Jonassen, D. H., & Grabinger, R. S. (1990). Problems and issues in designing hypertext/hypermedia for learning. In D.H. Jonassen & H. Mandl (Eds), *Designing Hypermedia for Learning*. (pp. 3-25), Berlin Heidelberg: Springer Verlag.

[10] Katz, S., & Lesgold, A. (1993). The role of the tutor in computer-based collaborative learning situations. In S.P. Lajoie & S.J. Derry (Eds.), *Computers as cognitive tools* (pp. 289-317). Hillsdale, NJ: Lawrence Erlbaum.

[11] Moore, J. L., Lin, X., Schwartz, D. L., Petrosino, A., Hickey, D. T., Campbell, O., et al. (1994). The relationship between situated cognition and anchored instruction: A response to Tripp. *Educational Technology, 34*(10), 28-32.

[12] Reeves, T.C., & Hedberg, J.G. (2003). *Interactive learning systems evaluation*. Englewood Cliffs, NJ: Educational Technology Publications.

[13] Savery, J. R. & Duffy, T.M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology*, 35(5), 31-38.

[14] Voss, J. F., & Post. T. A. (1988). On the solving of ill-structured problems. In Chi, M., Glaser. R., & Farr. M.J. (Eds), *The nature of expertise*. 261-285. Hillsdale, NJ: Lawrence Erlbaum Associates.

[15] Wiley, J. & Voss, J. F. (1999). Constructing arguments from multiple sources: tasks that promote understanding and not just memory for text. *Journal of Educational Psychology*.. 91,. 2, 301-311.