Scholarship in Teaching Project: Re-useable digital learning objects: what is their impact on learning outcomes?

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Introduction

This is the final report for the 2006 Scholarship in Teaching project, titled “Re-useable digital learning objects: what is their impact on learning outcomes?”. The original members of the project team were Amanda Davies (Chief Investigator) Lecturer, School of Policing Studies, Robert Parkes, (Mentor) Lecturer, School of Teacher Education, Glen Jacobsen, Academic Assessor, Centre for Investigative Studies and Crime Reduction and Ross Brogan, Academic Assessor and NSW Fire Brigade Officer. With the resignation of Robert Parkes from Charles Sturt University in 2006, Associate Professor Barney Dalgarno joined the project in the role of Supervisor. The CI has incorporated this research into study for the Master of Education (information Technology) at Charles Sturt University.

This report includes background information about the project, a summary of project outcomes, a description of dissemination strategies and a summary of expenditure.

Background

The primary intent within this project was to evaluate the application of a re-useable learning object to provide a vehicle for situated learning. The CI chose the Charles Sturt University subject JST415 Fire Investigation Cause and Origin Determination (referred to as JST415) in which to research, develop and evaluate the application of virtual reality learning materials.

For fire investigation students Charles Sturt University has traditionally offered both a mixed mode delivery of learning through the combination of a residential short course (5 day duration) with a component of distance education or a print based distance education course without a residential phase. The significance of this becomes apparent when traditionally, the inclusion in the residential phase of an investigation of a real time fire scene as an assessment element has been a pivotal concept. Here lies one of the problematic elements of teaching fire investigation, guaranteeing the availability of an uncontaminated fire scene for residential students to investigate, demonstrating the knowledge and skills acquired during the course of their study and provide the opportunity for aligned learning experiences which are time independent or asynchronous. This responsibility is founded on the notion proffered by Hodson et al (2001) that in the helter skelter of embracing technological advances for the delivery of learning that the same learning outcomes are retained for a given curriculum no matter who studies it.
Since the inception of the residential short course phase, this logistic, availability of uncontaminated fire scenes has been managed through combining the timing of the delivery of the residential course with the training needs and cooperation of the New South Wales Rural Fire Service. A building is identified (within reasonable proximity of the residential course) in need of demolition, a permit sought for destruction by fire, NSW Rural Fire Volunteer training day programmed to coincide with igniting the building and extinguishing the resultant fire and a date released to students for attendance at the residential course. With students travelling from their overseas bases to attend these courses, it is neither practical nor desirable to rely on a structural fire occurring naturally, within reasonable distance of the location of the course and coinciding with the timing of a residential course.

From 2005, the lecturers for the fire investigation short course identified that in addition to the difficulties associated with providing an uncontaminated fire scene as discussed above, a further obstacle was the restrictions imposed by the NSW Protection of the Environment Operations Act 1997. Regulations in regard to air pollution would result in permission to burn structures for residential courses becoming increasingly difficult to obtain.

Whilst incidents of accidental or deliberate fire damage continues to occur within communities, there continues a need for professional fire investigators. The resultant challenge was to provide a learning environment and experience which embraced the needs and expectations of the student fire investigator, the university, the community and associated professional organizations i.e. police, judiciary.

The development of a comprehensive fire investigation course which utilized previously filmed fire scenes converted into digital virtual reality imagery [re-useable digital learning objects] for assessment of the students investigation knowledge and skills was the product of this challenge.

The CI project managed the development of the JST415 learning materials into CDROM format with an embedded virtual reality component for learning and assessment purposes.

Objectives

The objectives of this project were to firstly identify any unique characteristics offered by the virtual environment in supporting the development of knowledge and skills for fire investigators. Secondly, to identify any perceived difference in the level of achievement of learning outcomes by fire investigation students when learning via face to face, distanced education or a combination of these two methods. Thirdly, through analysing the learning experiences of the fire investigation students identify the potential for reusable learning objects i.e.JST415CDROM for the study of associated investigation subjects.
In brief, four cohorts of students undertook the study of JST 415 Fire investigation Cause and Origin Determination within the time frame of this research project. Group 1 Short Course Real Time Burn (SCRTB), undertook face to face study with a real fire burn scene to investigate. Group 2 Short Course Virtual Assessment 1 (SCVA1), undertook face to face study and utilized a virtual fire scene on a CDROM for assessment purposes. Group 3, Short Course Virtual Assessment 2 (SCVA2) undertook face to face study and was equipped with a JST415CDROM containing the learning material from the short course and a virtual fire scene to investigate. Group 4 Distance Education (DEVA2) undertook the study by distance education mode via the JST415 CDROM with the same virtual fire scene to investigate as supplied to Group 3. As the context of this study encompassed an authentic learning situation which lent itself to the use of a virtual environment it was an ideal context in which to situate this research project.

As the purpose of this project was to develop an understanding of the impact on learning outcomes when virtual reality environments are embedded in the learning materials, the focus was therefore centered on gathering data which would inform on the lived experience of students undertaking study via the four alternate modes and provide the conduit to ‘give voice’ to their experiences.

The overarching research question for this project is founded on seeking an understanding of how participants view their experiences and the interpretivist approach allows the meanings and values of these experiences to be revealed through text which here is the account of meaningful experiences of the participants in the study.

Data Collection

The initial developmental work for the production of the JST415 CDROM began in June 2006, unforeseen difficulties outside of the researcher’s control created delays in the production of the final product until June 2007. The time lapse between the residential short course undertaken by Group 1 in June 2006 and the timing of their invitation to participate in the evaluation of the JST415 CDROM (August 2007) meant that some of the contact details for students were no longer current. At the outset of the research design application was made to Charles Sturt University Ethics in Human Research Committee seeking approval to conduct the study. Permission was granted under Protocol Number 2006/149.

The researcher endeavoured to contact personally all of the students in Groups 1, 2, 3 and 4 in preparation for sending a formal invitation to participate in the research project. Those students with whom contact was able to be established were forwarded the following in August 2007:
Three forms of data collection were employed in this project a Likert scaled survey, interviews and pre and post student assessment results for their study of JST415.

Survey

A combination of Likert scaled survey questions and open-ended questions were included in the survey for this project. The Likert scaled questions were placed at the beginning of the survey with clear instructions for their completion. The rationale for Likert scale questions aligns with the interpretivist methodology adopted for this project, the Likert Scale offers the opportunity to obtain people’s “position” on aspects of their learning experience and the use of the JST415 CDROM, (Alreck and Settle, 1985). As the researcher was relying on the goodwill of participants to complete the evaluation it was important that the task was not arduous or overly complex. Likert scaling allows for simple vocabulary, economy of words and method as one set of instructions applies to all questions.

Interviews

Interviews were conducted with randomly selected participants from each of the four groups, this aligns with conclusions proffered by Punch (2005) that the unstructured interview is a powerful research tool capable of producing rich and valuable data. Further, the unstructured interview as the non standardized, open ended in-depth interview provides an avenue for understanding lived experiences without imposing any a priori categorization which may set limitations on the inquiry. For this research project the unstructured interview offered the opportunity for the participant to provide rich and meaningful articulation of their learning experiences which they may not have been able to do in the Likert scaled questionnaire and the open ended questions.

Outcomes

Analysing the learning experience of students undertaking fire investigation studies, JST415, through one of the following process: via face to face with a real time burn; face to face and investigation of a virtual fire scene or through distance education with a virtual fire scene to investigate resulted in a number of unique findings. These findings have the capacity to make a contribution to the
emerging body of knowledge in the use of VLE in teaching and learning. The following presents a summation of the discussion of the data and findings and their contribution to and implications for research and teaching.

**Research question 1**

**How did the student’s preference for print vs. online impact on their use of the VLE?**

Pivotal to interpreting the learning experiences of the participants in this study, is understanding their familiarity and ease of use with the online and virtual environment as presented on the JST415CDROM. Youngblut (1998) cited in Chen (2006) suggests there has been little study of the human factor in the use of virtual reality whilst research by Akerlind & Trevitt 1999; Wan, Ismail & Chen, 2005; Dalgarno 2001; Hawryszkiewycz, 2002 would suggest the contrary. The emerging theme is that whilst the concept that the ‘human factor’ in terms of familiarity and ease of use with the online and virtual environment may influence the uptake of learning its effect is not specifically explored or reported. Research by Ahlberg, et. al. 2002. Arrowsmith, Counihan & McGreevy, 2005; Cochrane, 2004; Cramer, et. al. 2006; Paulsson & Naeve, 2006; Peat & Taylor, 2006; Stuckey-Mickell & Stuckey-Danner, 2007 for example, allude to the potential for this factor to influence research in the use of virtual reality in education however, it is not included in the scope of their studies. Generally, students do feel a sense of anxiety or stress when required to use a new or unfamiliar mode of learning delivery (Bonwell & Eison, 1991) and Akerlind and Trevitt (1999) suggest that this sense should be anticipated and students supported to ease the transition.

In this study, students were required to move from a print based learning environment to an online virtual reality environment. Through analysing the interview responses, open ended survey responses and the Likert scaled responses to questions designed to develop an understanding of how ‘comfortable’ students felt with using the JST415CDROM the following findings emerged.

**Finding 1:**
A student’s preference for learning materials in print mode did not indicate a limited familiarity and ease with the online environment.

**Finding Two (2)**
A student’s preference for learning materials in print mode did not indicate an inability to engage with virtual learning environments.
These findings provide insight for initiatives in learning delivery, where innovation seeks to replace the more traditional print based learning with technology rich environments. These findings are important in the context of this study as they indicate that a student’s preferred learning mode does not influence their potential to successfully complete the virtual reality assessment.

The following finding:

**Finding 3:**

The students accessed learning material of the JST415CDROM following the prescribed process which logically progressed their knowledge and skills.

emerged from the study as a result of the responses students supplied in relation to how they accessed the JST415CDROM learning material. In this study, students indicated that whilst the design of the JST415CDROM contained no restrictions in terms of order of accessing the materials, the students chose to work through the material in the prescribed manner in which it was presented. This methodical approach by the students supports the notion proffered by Bricken 1990, Chen & Teh, 2000 and Jonassen et. al. 2000, which suggests that the capabilities of virtual reality are found to be compatible with constructivist learning principles, learners actively construct knowledge and is influenced by the context in which the learning is situated.

**Research Question 2**

**Did the students find the learning content on the JST415CDROM as comprehensive as that provided in face to face learning delivery?**

The researcher acknowledges that with the rapid advancements in digital technology and its implications and applications for course design and delivery there is a vast array of published research available in this field including but not limited to: Dalgarno, 2001; Herrington & Oliver, 1995; Hawryszkiewycz, 2002; Schnotz & Rasch, 2005; Seung-Won & Doo Hun, 2007. The intrinsic design of the CDROM utilized in this research project is not presented for discussion at this point; the focus of this question was to develop an understanding of the capacity for online delivery of learning material to achieve comparable levels of thoroughness and completeness to that delivered in the traditional face to face mode.

The design of the study included surveying students who had undertaken the traditional face to face fire investigation course and subsequently evaluating the JST415CDROM, gathering their responses to a comparison of the presentation of the learning material through the two delivery modes. The results from this research project indicated that the materials presented on the JST415CDROM were comprehensive and replicated in quality and inclusiveness that delivered in
the traditional face to face teaching mode. All groups agreed that the learning material on the JST415CDROM was comprehensive and reflected the learning material delivered in the face to face classes. It is important to note that this question is specifically focused on the learning material; it does not take into account the comments from participants who indicated they considered it assisted with their learning to be able to ask questions and receive immediate responses from the teachers. Some also indicated they preferred to learn in a shared learning environment where they could interact with others. These participants acknowledged that online student forums or similar provide this interaction opportunity and would in part address the individual learner need for interaction.

Here the following finding:

**Finding 4**

JST415 learning material delivered via the JST415CDROM replicates in quality and inclusiveness as that delivered in the traditional face to face teaching mode.

has an implication for potential innovations in subject delivery design, in particular, the potential for subjects traditionally delivered in face to face mode to be delivered by the online medium.

**Research question 3**

What are the main aspects of a VLE that contribute to the development of knowledge and skills for fire investigators?

The exploration of this research question within the context of this study produced two distinct and important findings. The first of these findings:

**Finding 5**

A unique and valuable characteristic of presenting a virtual fire scene on CDROM is the unrestricted accessibility provided to the scene for investigation studies

is in part aligned to factors of value attributed to the use of virtual reality as an educational tool as identified in previous research, for example Haluck & Krummel, 2000; Bell & Fogler (1996), Turney et. al. (2004). This factor is the capacity for unrestricted access for students to revisit the virtual environment which it is not possible to replicate in real time. This is particularly attributable to the investigation of fire scenes. The facility to revisit virtual scenes offers the student the opportunity to reflect on and consolidate their learning uninterrupted by distractions beyond their control.
A further unique and valuable characteristic offered through the virtual environment on the JST415CDROM as identified in this study is:

Finding 6
The presentation of a virtual fire scene via CDROM allows continuous and unrestricted access to an uncontaminated scene for investigation providing a valuable learning tool for fire investigation studies.

The facility presented by the JSTCDROM to investigate a fire scene which remains unchanged offers the student a learning tool with which they can reflect on their learning and apply their knowledge to consolidate their understanding of key concepts. The intrinsic nature of real time fire scenes render it impractical to consider continuity of an uncontaminated fire scene in the real world.

These two characteristics the research participants identified as particularly significant to the learning experience. These characteristics negated the more challenging obstacles in the learning experiences of those research participants who in the course of their study undertook the investigation of a real time fire scene. Specifically, these students identified the lack of time available to investigate the real time burn, the inability to return to the scene and the inability to preserve the scene in an uncontaminated state.

A further characteristic of the JST415CDROM which emerged as pivotal to the learning experience of the student fire investigators was the capacity for the learner to maneuvers and navigate through the virtual fire scene. The following finding emerged from the data:

Finding 7
Embedded learner driven maneuverability and navigational characteristics in virtual fire scenes provides an authentic immersive learning environment for fire investigation studies.

Brown, Collins & Dugid (1989) suggest within the concept of situated cognition that meaningful learning will only take place if it is embedded in the social and physical context within which it will be used. Further that self navigation encourages engagement and hence exploration of the environment by the student. The responses from the research participants indicated that it is the ability to maneuver around the fire scene which provides the sense of ‘being there’. Students indicated the ability to navigate around the virtual fire scene, zoom in and out and re visiting as they required provided the opportunity to check their knowledge until they were satisfied. The consistent message which emerged was that these characteristics assisted the students to complete their assessment of the virtual fire scene successfully.
The final question explored in this study provided the opportunity to develop an understanding of the students’ perceptions of how the JST415CDROM supports the development of fire investigation knowledge and skills.

**Research question 4**

**How does the delivery of learning via the JST415CDROM support the development of knowledge and skills for fire scene investigation?**

In the analysis of the data the following themes emerged. Firstly, a comparison of the competency rankings and assignment marks identified in both categories, the students who studied fire investigation studies utilizing the JST415CDROM virtual fire scene for assessment purposes outperformed the students who undertook face to face instruction and investigation of the real time burn. It is important here to consider the students’ evaluation responses and interview comments which were addressed specifically to capture the students’ perception of the overall learning process via the four different delivery modes. The second theme which emerged indicated that the students considered unrestricted access to the learning material i.e. audio enhance presentations and graphics embedded in topic modules provided foundational knowledge and understanding of fire investigation. The following findings reflect these student perceptions and are validated by the assessment marks achieved and the competency rankings attributed to each student:

**Finding 8**

The study of fire investigation (cause and origin determination) via distance education with the JST415CDROM creates an authentic learning environment which supports the development of foundational knowledge and skills for application by fire investigators in the workplace.

**Finding 9**

The capacity for virtual fire scenarios to provide experiential learning experiences enhances the quality of fire investigation students’ learning outcomes.

**Implications of research findings**

In summation, the results of this study make a significant contribution to the immediate discipline of fire investigation studies. The methodological framework for this study being interpretivist in nature provided the mechanism through which the research participants ‘lived experience’ revealed the unique value and contribution of virtual reality in learning delivery for fire investigation studies. The unique characteristics of the virtual environment which contribute to a students, development of fire investigation knowledge has implications for subject delivery.
design within the wider body of investigation studies. Specifically, the value of utilising reusable digital objects, in the form of virtual reality scenarios embedded on CDROM within subject learning materials.

The study has endeavored to capture the experience from a comprehensive range of learning delivery modes and whilst the findings in this study have the potential to contribute to the wider body of knowledge, the limitation in the number of participants in this study, heralds a note of caution. These findings show that the use of ‘reusable learning objects’ in investigation studies shows promise in providing authentic learning experiences and providing foundational knowledge and skills transferable to real world situations. This potential indicates value in undertaking further research in this area of learning delivery.

In conclusion the project has been designed to align with the University Strategic Plan 2007 – 2011 through collaboration with the professions as well as continuing to lead in the quality provision of flexible delivery supported by well researched curriculum and teaching methodologies.

**Dissemination**

This research project was completed on the 27th February 2008 and currently
- a conference paper is in preparation for the ASCILITE conference in December 2008 leading into publication in the Australian Journal of Educational Technology.
- A paper is in preparation for The International Journal for Arson Investigation.
- It is anticipated that papers will also be submitted to journal/s producing maximum exposure in partnership organizations, specifically:
  - NSW Rural Fire Service Training Publication
  - Australian Journal of Emergency Management
  - Policing Issues and Practice Journal
  - E Learning and technology Journal
  - Journal of Interactive Learning Environments
  - The American Journal of Distance Education
  - British Journal of Education Technology

These dissemination strategies are stepping stones towards the development of an application under the Carrick Award Citation scheme in 2009, specifically for ‘Scholarly activities that have influenced and enhanced learning and teaching’.

**Expenditure**

As indicated in Table 1, of the allocated Teaching in Scholarship Grant of $6,961.88, total expenditure to date is
Initial Grant $6961.88
Total Expenditure $4,066.61
Funds Remaining $2,396.37

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Table 1