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The implementation and evaluation of an undergraduate virtual reality surveying application

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Abstract

Multi-media applications are increasingly being used to enhance the delivery of on-site and distance learning teaching material. However, production costs are often prohibitive, both in terms of capital investment and development time. Hence it is surprising that authors comment on the failure to adequately evaluate new educational software applications. This paper evaluates an interactive multi-media levelling resource, which comprises text-based guides, video instruction, photo-realistic panoramic scenes and multi-row object movies.

Students explore 360 degree images of building sites, using traditional computer input devices, and click on hot spots to gather detailed information about the position of the optical level and staff. Readings are taken directly from the staff and students record backsights and foresights as various change points are introduced. On completion of the levelling exercise, 192 first year undergraduate students completed an evaluation based upon a series of statements drawn from technology-based training literature. The findings suggest that the exercise complements traditional learning approaches, maintains student interest, and reinforces understanding. However, significant differences in student ratings for part-time and full-time cohorts emphasise the importance of designing resources that accommodate the needs of varying student profiles. Suggestions for enhanced interactivity are offered and new areas for development allied to construction technology are identified.

Keywords: multimedia; QuickTime VR; photo-realism; levelling surveys

1. Introduction

McNaught and Kennedy (2000) pose the question “What is the business of a university in the new millennium?” They conclude that universities need to provide staff with the physical and intellectual space to pursue research and provide teaching for growing student numbers in order to guarantee funding. Their solution, in part, calls for the adoption of flexible modes of delivery.

Flexible learning must allow for variations in study time and increasingly relies on the use of technology to enhance access to and the quality of learning. However, McNaught and Kennedy (*ibid*) caution that such reliance must not be at the expense of a sound pedagogic methodology. Hence flexible educational multimedia resources comprise a number of inter-related activities. Benyon *et al.* (1997), for example, identify a series of key stages in the creation of computer-aided learning (CAL) resources: courseware specification; instructional design; multimedia development; integration; implementation and evaluation. Whilst each of these components is important in the production of new learning materials, the perceived worth of these applications relies upon thorough evaluation. Many researchers have concluded that organisations frequently fail to evaluate training (Plant and Ryan, 1994; McClelland, 1994; Mann and Robertson, 1996; Athanasou, 1998) and the same appears to be true for CAL (Jacobs, 1998; McNaught, 1999). Few pieces of CAL, they believe, are subjected to rigorous evaluation during development.

The Higher Education Academy's (HEA) National Teaching Fellowship Scheme recognises and rewards individual excellence in teaching in higher education in England and Northern Ireland (HEA, 2006). The Scheme is in its sixth year and has allocated funds to support 180 assessment, teaching and learning-related projects. Virtualsite, a NTF project awarded in September 2003, is an on-line teaching and learning resource which comprises a database of construction-related images, text-based guides, video instruction, panoramic scenes and multi-row object movies. Whilst the principal aim of the resource was to create virtual tours of construction sites, an opportunity arose to develop a surveying application that replicated the tasks undertaken by undergraduate students in the School of the Built Environment at Leeds Metropolitan University.

In September 2005, a new virtual reality (VR) surveying learning resource was introduced to students. This paper reports on the evaluation findings and their impact upon future development.

2. Website Development

Virtualsite is a repository for construction-related learning resources, to which staff and students have access. The resources are categorised under four headings: Gallery; Site visit; Quiz; and Careers, and are accessed via a virtual room (see Fig. 1). Whilst the nature and scope of the website has been reported in earlier work (Dickinson *et al.*, 2004; Ellis *et al.*, 2006), it is germane in this paper to outline the nature only of the site visit and the surveying task.

The site visit

Created using QuickTime VR (QTVR) technology, users navigate through a series of inter-connected virtual panoramic scenes. Hot spots embedded within each scene enhance interactivity and provide access to a variety of learning resources. For example, clicking the optical level within the refurbishment site tour opens an object movie (see Fig. 2). Dragging the cursor over the image changes the position of the level and gives the illusion of being able to “handle” the equipment. Labels appear within the same movie to illustrate the purpose of the controls and provide links to guidance notes and video instruction (see Fig. 3).

The surveying task

The undergraduate curriculum for surveying-related courses at Leeds Met requires students to identify the principles of horizontal and vertical measurement and their application in the surveying of land and buildings. Students, working in small groups, complete a levelling survey using automatic levels and levelling staff. Level readings are booked following standard conventions and individual calculation sheets showing the calculation (reduction) of levels using either rise and fall or height of collimation methods. It is a practical exercise which requires considerable staff resource to



FIGURE 1: Virtualsite homepage



FIGURE 2: Optical level



FIGURE 3: Video instruction

manage – approximately 200 students complete a small plot survey in a three-week period early in the academic year.

The same VR technology (described above) was used to simulate the levelling exercise (see Fig.4). New QTVR panoramic movies are presented whenever the optical level or levelling staff is moved. Instructions embedded within the QTVR window provide feedback at each stage of the exercise. Students scroll around the scene to locate the position of the staff, take readings (see Fig. 5) and record the heights on a booking sheet downloaded from the website. On completion of the exercise, a model answer is provided together with questions to prompt a tutor-led discussion.



FIGURE 4: Levelling exercise

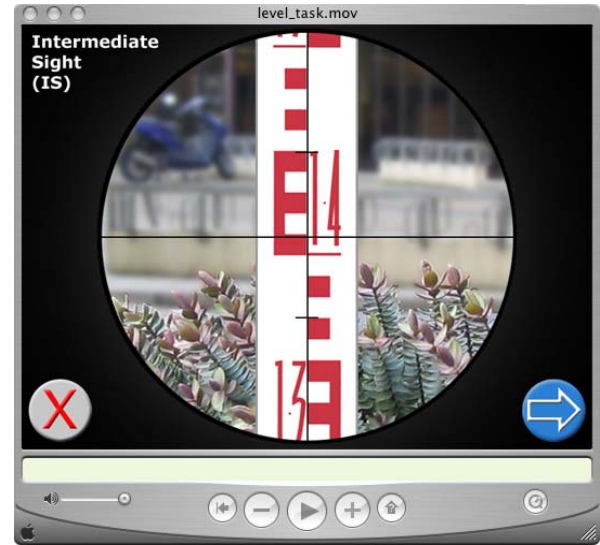


FIGURE 5: Levelling staff

3. Evaluation

Ellis *et al.* (2003) advocate the use of Kirkpatrick's early model for evaluation, which comprises four levels, namely, reaction, learning, application and results. Whilst application and results address issues of workplace performance and organisational improvement, undergraduate module evaluations most commonly collect student feedback in the form of end-of-course questionnaires. In addition, therefore, to the standard evaluation procedures operated within the School of the Built Environment, 17 statements (see Table 1), drawn in part from the proposed benefits of using technology-based training identified by Tucker (1997), were incorporated into a questionnaire in the form of a Likert scale.

In total 192 students were asked to rate attitude statements on a 5 point scale (1 = strongly disagree; 2 = agree; 3 = undecided; 4 = disagree; 5 = strongly agree). Recognising that current course delivery modes may affect attitudes, the data from respondents studying in part-time mode (71 Nr.) were distinguished from those studying on full-time equivalent courses (121 Nr.).

1	Enhanced the written guidance in the module guide
2	Readily accessible via the Web
3	Should be used after the introduction to the module
4	Should be used in preparation for the practical
5	Should be used after the practical exercise
6	Reinforced my understanding of the levelling procedure
7	Helped me understand how to use a booking sheet
8	Gave me confidence in using the optical level
9	Helped me visualise each stage in the exercise
10	Held my interest
11	The exercise is confusing
12	Helped me with my coursework
13	Enabled me to learn quickly
14	Enabled me to learn at my own pace
15	A useful revision aid
16	Enabled me to make mistakes in private
17	Provided useful feedback

TABLE 1: Evaluation statements (adapted from Tucker, 1997)

Caution must be exercised in the application of further quantitative techniques. Jacobs (1998) states that a judgemental scale is not necessarily a true linear scale and that whilst the results obtained may be mathematically valid, they may not mean what they appear to suggest. A similar view is expressed by Mogey (1998). Data collected using a Likert scale, he states, is ordinal i.e. there is an inherent order, but one cannot assume that the difference between “strongly agree” and “agree” is the same as “agree” and “undecided”. Accordingly a Mann-Whitney test - the non parametric alternative to the t-test - is used to determine whether Part-time (PT) and Full-time (FT) student responses were significantly different. Hence if the PT and FT responses are similar, then the sum of the pooled rankings for each group would be about the same (Fraenkel and Wallen, 1996).

Box-plots were considered to be the most useful tool to present and interpret the results since they provide a visual representation of the distribution of a variable. Each shaded box, created in SPSS, represents the responses between the 25th and the 75th percentile for one statement and the thick line across the box is the median. Whiskers indicate the lower and upper extremes of the range. For example, Statement 6: *The surveying-related materials reinforced my understanding of the levelling procedure*, has an inter-quartile range between 4 and 5, a median score of 4 and lower and upper extreme values of 3 and 5 respectively (see Fig.6).

Hence the box-plot clearly illustrates that the majority of respondents 'agree' or 'strongly agree' with majority of the statements allied to research and teaching. However, students generally were less keen regarding use of the resource after the practical exercise (median score = 3) and to assist them with their coursework (median score = 3). Moreover students disagreed with Statement 11 i.e. *The exercise is confusing* (median score = 2). The Mann-Whitney test revealed significant differences ($p < 0.05$) in the responses of PT and FT students regarding Statements 8 and 11. Namely, FT students gained greater confidence from and were less confused by the surveying exercise.

4. Discussion

The findings clearly show that students value the surveying exercise. Students could access the QTVR scenes, learned quickly and understood both the levelling process and booking procedures. However, there is some evidence to suggest that FT students gained greater confidence from using the resource and found it less confusing. Whilst further investigation is required to explain these differing responses, the evaluation reinforces the need for tutors to consider the student profile – issues such as IT literacy and industry experience may have a profound impact upon the effectiveness of the learning resource - and the timing of the intervention.

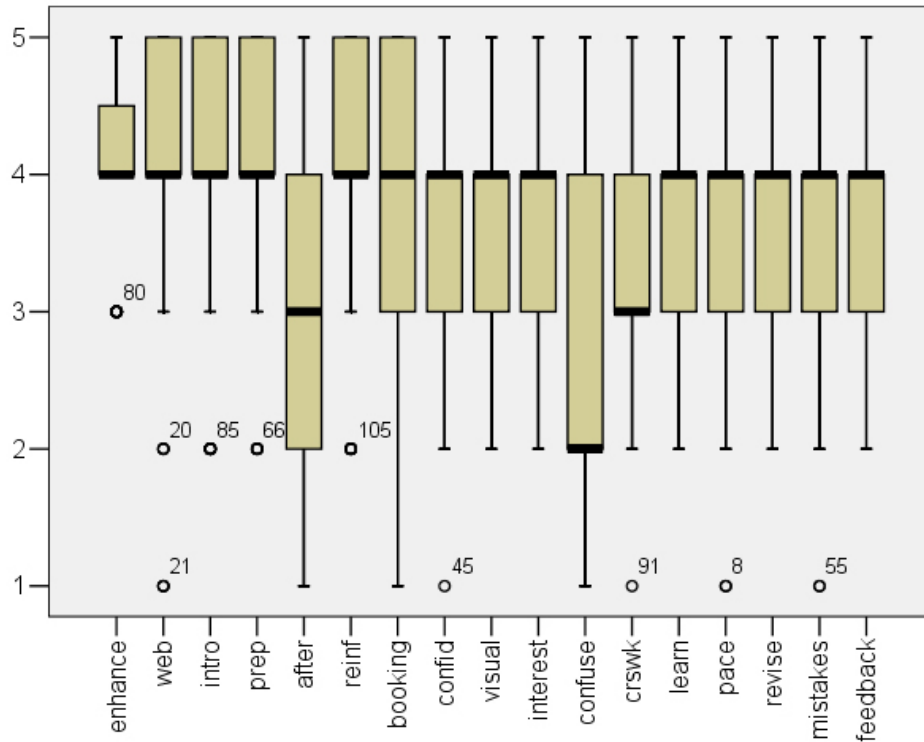


FIGURE 6: Boxplot (SPSS v13)

Tutors' reactions have also been favourable and it seems likely, following the pilot evaluation, that the resource will be embedded within the module timetable. In particular, tutors were keen that students gained practice in reading staff levels and that emphasis had been placed on photo-realism. However, one tutor had used the exercise in a group session, which he believed to be more beneficial:

Working at the PC can be very lonely for a student. It [the surveying exercise] seemed to work better in class, as it promoted a lively discussion. Whilst I have no evidence to back this up, I think that some of these students went back to the exercise after class and gained more from it.

The pilot also prompted tutors to request additional features. Suggestions included: interactive booking sheets, which provided feedback after each entry; greater flexibility in the positioning of the levelling staff; and the provision of more advanced exercises that provide differing levels of feedback to the student. This latter issue had raised some concern:

Yes, but it's too easy. Students know whether it's a backsight because it says so on the screen. It's good as an introduction, but there is much more scope to make the student think through the whole levelling process.

Much depends on the aim of the exercise e.g. to introduce the concept, to assess the student or to reinforce a student's understanding of theory, and its position within the module programme. And whilst these may appear trite observations, they further reinforce the value of Benyon *et al.*'s (*ibid*) development model – courseware specification and instructional design being of crucial to the success of any learning resource.

In this paper, the virtual surveying exercise was used to introduce students to the concept of levelling, prior to conducting a hands-on exercise. Accordingly, students were unable to gauge how useful the resource might be or how it related to the module assessment. Moreover, the size of the cohort also resulted, at times, in students sharing a computer. Consequently, some students either did not fully engage with the program or merely resorted to watching the main screen which the tutor had used to demonstrate the software. Computer-aided learning software, therefore has the potential to simulate practical exercises, but the evaluation also demonstrates the need for careful planning and monitoring of the resources necessary to support new delivery mechanisms.

5. Conclusion

Courseware design is an iterative process. Whilst pedagogically effective learning resources rely on clear initial briefing, evaluation *throughout* the development process will lead to a better end-product. From the evidence presented in this paper it can be concluded that VR applications are capable of enhancing paper-based guidance notes, that students welcome such innovation and that evaluation feedback can be used to inform future development and delivery.

VR must not be perceived as “bolt-on” activity. In order to derive maximum benefit, VR applications must be appropriately embedded within the curriculum. Moreover, the resource implications associated with their delivery should also be fully considered. This case study clearly demonstrates that investment in VR is not limited to the development stage as there may be significant IT infrastructure implications. Virtual the resources may be – but the costs involved in delivery are very real.

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