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2. Building Information Modelling Incorporating Technology Based Assessment

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Abstract

Building Information Modelling (BIM) is currently being developed as a virtual learning tool for construction and surveying students in the Dublin Institute of Technology. This advanced technology is also used to develop a technology based assessment practice for enhancing the learning environment of construction and surveying students. A theoretical design framework is presented in this paper, which combines advanced technology and assessment theory to create a virtual learning environment. This is based on the move from teacher-centered to student-centered learning, which attaches a higher degree of importance on what students know, understand, and can do as a result of their educational experiences. The design framework consists of three levels: the first incorporates student access for initial assessment, secondly student motivation is enhanced using self-assessment techniques and finally formative assessment through information sharing is introduced using student–teacher WEB-based interaction inside the virtual learning environment.

Keywords: assessment, building information modelling, curriculum development, e-learning, first year curriculum

Outline of Fellowship Project

Introduction

The aim of this project was to develop a technology based student assessment practice using Building Information Modelling (BIM). BIM is currently being developed as a virtual learning tool for construction and surveying students in the Dublin Institute of Technology (DIT). This aim was achieved through developing a theoretical design framework, which combined advanced technology and assessment theory to improve on the current BIM based virtual learning environment.

Throughout its development, evaluation was built into the process through testing the prototype with students and presenting the on-going work to seminars and conferences, in order to establish feedback, which could improve design. The outcome of the project is a prototype and a theoretical design framework for a technology based student assessment tool, which enables individual and group based student appraisal, that is student centred as opposed to being based on the traditional approach of exams.

Initial Step – Creating a Theoretical Design Framework

The outputs of two main pieces of research within the DIT's department of construction technology and management were used as the foundation for constructing a theoretical design framework for incorporating technology based assessment into building information modelling. The first is the outcome of an investigation of the assessment practices in undergraduate programmes in Built Environment. This research indicates that while the 'tide is starting to turn' there is still an over-reliance on the traditional summative examination at the end of a module or unit of learning. Secondly, new developments in the faculty using BIM as a virtual learning environment were incorporated into the design. Virtual learning offers a very different experience from classroom based learning; when interacting online individual students have their own perspective and experiences whereby they construct their own interpretations of the knowledge (Abrami & Bures, 1996). This was exploited in the design of learning software; students are encouraged to construct

their own interpretation from the simulation of realistic scenarios of the construction process thus improving the learning outcomes.

Defining the Technology

A study in the Civil and Environmental Department at Worcester Polytechnic Institute confirmed that the use of BIM facilitated effective learning mainly because it involves sharing, communicating, and group problem solving. It also helps students to actively engage in the process of planning, designing, and interpreting construction related data. Moreover, the concept represents an invaluable tool to teach students the notion of cooperative work, which is in line with the advancements of the construction industry (Salazar, Mokbel & Aboulezz, 2006).

As part of the initial design process a seminar was organised on BIM on Wednesday 25 November 2009; this attracted 150 participants and presenters from DIT, Industry and the University of Perdue. The recorded outcome of the seminar provided an understanding for the use of BIM in an educational setting. In particular there was a focus on the correct definition of BIM – where parametric objects are brought together as building components to create or form the entire building, this system is referred to as Building Information Modelling. The BIM can automatically create cut sections, details and schedules in addition to the orthographic projections and 3D models (wire frame or textured). The parametric building objects are not defined singularly but as systems using interaction with other objects and their own values (shape, texture etc.) within a BIM (Eastman, 2006). In building parametric objects, the problem of file format and exchange of data has been overcome within the ArchiCAD software platform by using a geometric descriptive language (GDL). The scripting in GDL allows for sharing and editing of the parametric objects at different levels. In Figure 2.1 below an example of a column with a capital and base is constructed using a GDL script (Graphisoft, 2006). Before placing a construction element, or GDL object, in a BIM, the default parameters can be edited by the software, changing parameters of shape, size or other properties as opposed to re-scripting in a GDL editor (Tse, Wong & Wong, 2005).
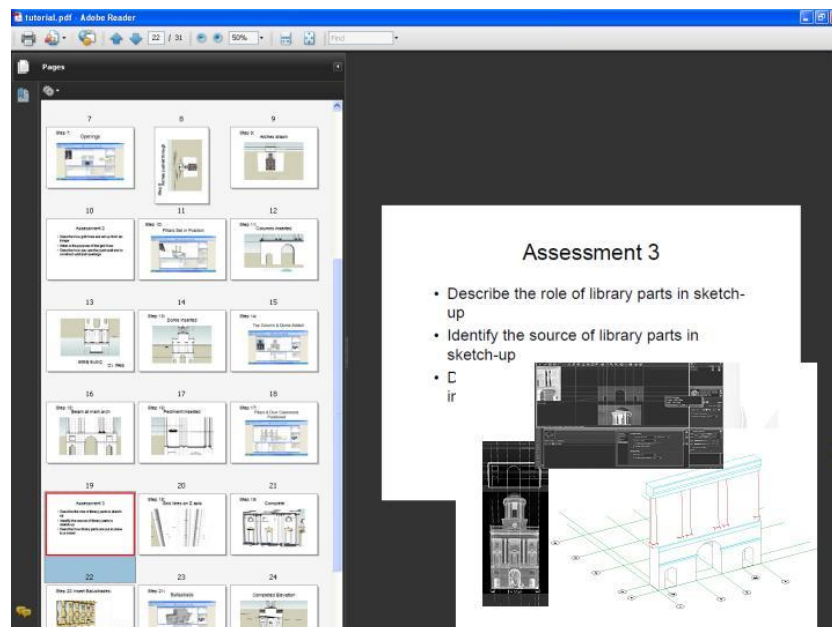

Figure 2.1: Initial assessment of Learning Environment

Defining Assessment

There are many reasons to assess students; these range from traditional summative assessment and the need for evidence and the classification of learning to formative assessment through guidance for improvement. There is also a move from teacher centered to student-centered learning (SCL) approaches, a higher degree of importance has been attributed to outcomes assessment and evidence of performance of what students know, understand, and can do as a result of their educational experiences (Lea, Stephenson & Troy, 2003). While there is evidence of a move to conceptualise learning through a constructivist lens, how we assess learning in this context has been relatively under-developed (Laurillard, 2002). Cross (1996) refers to assessment and feedback as providing one of three conditions for learner success. It is generally acknowledged that a student's approach to learning and the quality of learning achieved will be influenced by the way in which this learning is to be assessed (e.g. Entwistle & Ramsden, 1983; Gibbs, 1999). The critical importance of formative assessment (assessment that contributes to the student's learning through the provision of feedback about performance (Yorke, 2003) should not be under-estimated by educationalists and this is confirmed by Black and Wiliam (1998).

Assessment for learning, more commonly understood as formative assessment, is defined by Black and Wiliam (1998: 8) as 'all those activities undertaken by teachers and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged'. In very simple terms, assessment may be defined as such activities that measure student learning. Boud (1990) posited that assessment has two purposes: firstly that of improving the quality of learning where learners engage in activities and are given feedback that will direct them to effectiveness in their learning (commonly referred to as formative feedback). The second purpose concerns that of the accreditation of knowledge or performance, which occurs generally for the award of a degree or diploma (commonly referred to as summative assessment).

Nowadays, students are more focused and they approach assessment with a better understanding of what is involved. Bloxham and Boyd (2007: 19) refer to students as 'being cue conscious concentrating on passing an assessment'. Academics currently speak in terms of formative and summative assessment. A student-centered learning framework puts the learner at the centre of the learning process, in which assessment plays an important part. It is widely accepted that assessment has a direct impact on students' learning (Askham, 1997; Black & Wiliam, 1998; Stiggins, 2002). Research indicates that what the student will focus on during the course of their studies will be hugely influenced by the assessment methods employed to measure the learning experienced (Ramsden, 1992).

Assessment of learning (summative) is where assessment for accountability purposes is paramount; its function is to determine a student's level of performance on a specific task or at the conclusion of a unit of teaching and learning. The information gained from this kind of assessment is often used in reporting and is purely of a summative nature. Assessment *for* learning, on the other hand, acknowledges that assessment can be embedded as a regular part of teaching and learning and that the information gained from assessment activities can be used to shape the teaching and learning process. Gibbs & Simpson (2004) have developed a model that promotes eleven conditions under which assessment supports learning, as outlined in Table 2.1 below. It is within this theoretical framework that the development of the BIM assessment model is based.

Table 2.1: Eleven conditions under which assessment supports learning
(Gibbs & Simpson, 2004)

1. *Sufficient assessed tasks are provided for students to capture study time*
2. *These tasks are engaged with by students, orienting them to allocate appropriate amounts of time and effort to the most important aspects of the course*
3. *Tackling the assessed task engages the students in productive learning activity of an appropriate kind*
4. *Assessment communicates clear and high expectations*
5. *Sufficient feedback is provided, both often and in enough detail*
6. *The feedback focuses on students' performance, on their learning and on actions under the students' control, rather than on the students themselves and on their characteristics*
7. *The feedback is timely in that it is received by students while it still matters to them and in time for them to pay attention to further learning or receive further assistance*
8. *Feedback is appropriate to the purpose of the assignment and to its criteria for Success*
9. *Feedback is appropriate, in relation to students' understanding of what they are supposed to be doing*
10. *Feedback is received and attended to*
11. *Feedback is acted upon by the student*

Project Outcome – Combining Learning Technology and Theory

This stage combines assessment theory and the advanced technology of BIM in three levels:

Level 1 – Pre and initial assessment defines at what level a student should access the learning environment; this is built into tutorials to encourage the student to assess their entry level and encourage the student to revise and self-assess their work prior to moving to higher levels in the software. Figure 2.1 below is an extract from a set of tutorials based on sketch-up software platform.

Level 2 – Student motivation is enhanced using self-assessment techniques; this is scripted in the library objects using Geometric Descriptive Language (GDL), which is an open scriptable language that can be used to create parametric objects. GDL is an embedded programming language in ArchiCAD, which provides access to create and model parametric objects. The parametric objects are the components that the student brings together to form the entire building within a virtual environment. Figure 2.2 describes an example of a GDL script to form a Doric column.
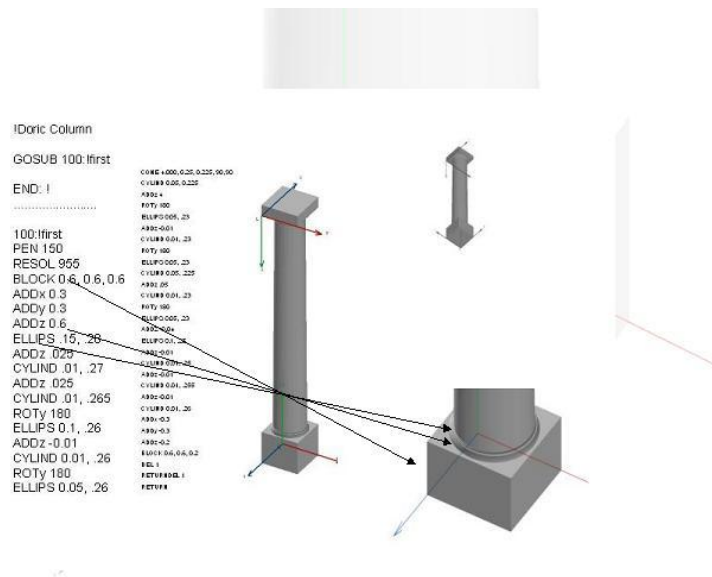
Figure 2.2: GDL Scripting to create a model

Level 3 – Formative assessments through information sharing is introduced using student–teacher WEB based interaction inside the Virtual Learning Environment (Salmon, 2002). Student–teacher WEB based interaction inside the Virtual Learning Environment using ArchiCAD BIM Server™ allows student and teacher to collaborate in real-time on BIM models through standard Internet connections from virtually any location. The BIM models are located on a single server and accessed by the student and can be observed and assessed by the teacher as the students work through the virtual building. The learning software and virtual building models can be accessed by the student on the Internet through PC, laptop and hand-held devices allowing participation and support for traditional and non-traditional learners.
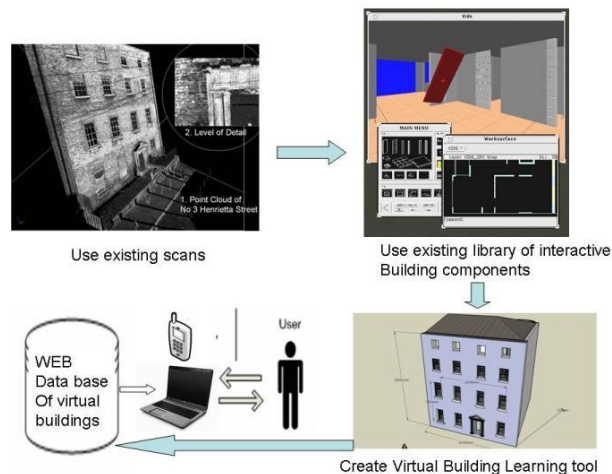

Figure 2.3: WEB interaction to support learning

Project Evaluation

The planned outcome of this project was evaluated through a pilot (see Figure 2.4 showing student field and lab BIM work) and subsequent interview process with 30 construction students. The majority favoured the technology based assessment methods to traditional assessment of exams.

They also favoured the virtual learning environment of the Building Information Model as a learning tool as it motivated them to progress through their programme module. To quote one student's reaction to BIM: 'extremely interesting and insightful' (Murphy & Scott, 2010). In contrast to the students' enthusiasm for BIM the students were critical of the pilot in terms of lack of the extra learning support required in learning to use the BIM software. When further questioned on the lack of support, the students described the extra support needed as additional computer lab time and small group tutorials. The concept of the students learning online using PCs, laptops or hand-held devices did not appeal to the majority of students, possibly creating problems in Stage 3; WEB based student/teacher communication environment.
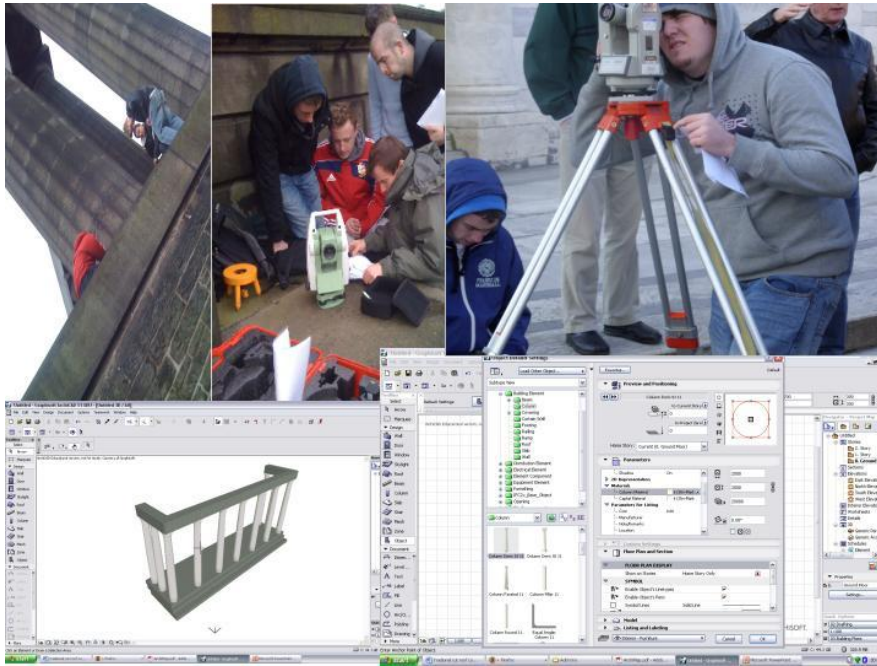

Figure 2.4: Student field and lab BIM work from the Pilot Programme

Proposed Future Work and Recommendations

The proposed future work will be to mainstream the virtual learning and assessment technology within the department in the academic year 2010/2011 and incorporate the identified improvements. This will be designed in particular for first and second year students in the department of construction technology and management to create an introduction to existing and historic building technology. In the initial design stage, it was assumed that many young students were comfortable with virtual learning environments because of involvement in social networking and game environments. This aspect will require introduction and promotion within small group lab tutorials alongside better training in the use of the BIM software. A more sophisticated evaluation process will be included in mainstreaming to measure how best this learning technology provides participation and support for traditional and non-traditional learners and how it best allows for progress at the student's own pace. The learning software will be continuously upgraded to include technology-based assessment, for initial and self-assessment and WEB based communication for formative assessment. The main recommendations at the institute level are the necessity to continue to create innovative pedagogic approaches through the teaching fellowship programme and other learning and teaching support programmes. There is also a need to create an ongoing link between formal research activities and developments in learning and teaching. As this project grew

out of DIT investment in learning and teaching and research and technology it offers a tentative example for other such approaches across the Institute. Both authors would like to acknowledge the assistance and support from the staff of the Learning and Teaching centre within the Dublin Institute of Technology.

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