The Situation Engine: A New Approach to Work Integrated Learning

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Abstract

Work Integrated Learning (WIL) is widely acknowledged as providing an excellent complement to academic study in vocational degree programs such as construction management. However, the current context of higher education, with its increasing enrolment numbers and tightening of available resources, makes the delivery of effective WIL quite problematic. One key element of WIL is the situated nature of the learning experience, where practical engagement with a work situation is core.

The Situation Engine represents a new approach to situated learning. A Situation Engine is an application that provides for specific and managed practical building and construction experience to be made available to students through advanced digital technologies. The same engine can drive a multitude of learning situations. To be effective a Situation Engine must provide tailored experiences of practical situations using the utmost in virtual reality capabilities.

This paper will describe and discuss the rationale for a prototype Situation Engine specific to teaching and learning residential construction technology. The particular development methodology framework used in the design and development process will be presented and reviewed. The prototype Situation Engine system has been trialled with 1st year undergraduate construction management students and is evaluated in that context.

Keywords: Work integrated learning, Situated learning, Serious video games

1. Work Integrated Learning

Programs of study with a specific focus on a particular occupational outcome (such as construction management) are increasingly being shaped by the imperative of employability. Employability skills in the context of higher education tend to render down to the same key factors: communication, teamwork, problem-solving, initiative, self-management, planning, life-long learning, etc. (see for example DEST, 2002). In a recent review of graduate employability (Cleary et al, 2007) the broad notion of Work-Integrated Learning (WIL) was proposed (logically) as the most important mechanism available for the development of employment skills. This broad notion of WIL refers to any practice-based experiences integrated into the higher education program of study. Practice-based experiences might include such activities as practicums, industry placements, case studies, role play and site visits. Of course, the effective integration of such practice-based experiences into the formal study program is what remains most crucial (Billett and Henderson, 2011). Arguably, however, what makes WIL so critical to the development of employability skills is the situated nature of learning itself.

Situated learning offers a particular orientation to teaching and learning. That orientation privileges a learning process based on direct personal observation. Direct personal observation of how practitioners and the industry actually work (Wenger, 1998: 3-17). Under the rubric of situated learning, the development of knowledge and skills requires the learner to engage directly with the socio-cultural practices that constitute a particular domain of professional practice. The socio-cultural practices are the shared routines, sensibilities, vocabulary, styles, artefacts, procedures, etc. that constitute a particular field of practice (Wenger, 1998: 73-84): what Schön (1983: 138) refers to as the language, media and repertoire of a particular professional community.

To be effective, participation in a community of practice must be legitimate. To be legitimate, the WIL experience must offer a framework for participation that is both competent and culturally attenuated to the requirements of learning (Lave and Wenger, 1991). A competent framework is one in which the learning outcomes are expressed in terms that are both deliberate and intentional (Washbourn, 1996). That is, the WIL experience must have explicit skills development that is demonstrable and assessable. A culturally attenuated framework is one where the process of learning is managed effectively. To be managed effectively the situation needs to be controlled from a pedagogical perspective. That means academics must be able and willing to police the specific WIL experience directly. Such policing has to go well beyond just the vetting and induction of a host organisation, for example.

In summary, situated learning places two key requirements on WIL. On the one hand, it must provide for explicit student development and assessment. On the other hand, it must provide a level of control over the learning experience. Those many practice-based experiences that do provide for explicit student development and assessment also tend to be problematic when it comes to exercising control. For example, an industry placement can develop important practical skills but the resources required and opportunities available to target particular skills are often prohibitive. Those practice-based experiences that might lend themselves to more direct control also tend to be more abstract in their learning outcomes. For example, a case study can be selected carefully to address a particular issue or skill but does so vicariously or once removed from the actual activity itself.

The current context of higher education in Australia, as it is elsewhere, is one of broadening access and participation in a climate of structural and organisational change (Bradley et al, 2008). Higher education must cater for increasing numbers of students and do so with a tightening of the available resources. In that context the integration of effective WIL is increasingly problematic. One of the most common strategies to promote learning through/from experience is reflective practice. Reflective practice has become synonymous with an abundant spectrum of approaches, including the keeping of diaries and journals, learning contracts, role play, critical thinking, visualisation, etc. (Atherton, 2005). Almost all of these approaches focus on the recording and subsequent review of accounts (in one form or another) of episodes in the (past) learning experience. What is generally missing is any consideration of how the experiences are to be noticed in the first place. Without first registering an experience as significant, subsequent reflections are going to be fruitless (Mason, 2002). Registering an experience is specifically addressed conceptually in terms of sensitisation, awareness and noticing (Marton and Booth, 1997). The strategies that enable sensitisation, awareness and noticing (learning how to experience), are a fundamental component of any curriculum that promotes a situated learning agenda.

WIL is proving difficult to realise as a legitimate learning experience. The current context of higher education is making that task increasingly difficult. Several key issues have been highlighted in this short consideration from the perspective of a situated learning framework:

(i) the need for effective control of direct practical experiences

(ii) the essential integration of practice-based experience into a formal study program, and

(iii) the practical development of a ‘learning how to experience’ strategy.

A new concept, the Situation Engine, is proposed to address these three key issues. A justification of the Situation Engine concept is presented in that context and a prototype Situation Engine is described. The prototype Situation Engine is specific to teaching and learning residential construction technology and is being trialled with 1st year undergraduate construction management students.

2. The Situation Engine

The Situation Engine is a new concept in WIL. We define the Situation Engine as:

> *An application that provides for specific and managed practical building and construction experience to be made available to students through advanced digital technologies.*

Figure 1 begins to un-wrap this definition in more functional terms. Each specific situation is comprised of: certain environmental conditions (weather, time, location, etc.); objects and their properties (buildings, equipment, materials, etc. with dimensions, mass, movement, density, etc.); actors and their behaviours (characters, interfaces, avatars, etc. with behaviours, scripts, intelligence, etc.); and data feeds (web, video, motion, devices, etc.). Various combinations of environments, objects, actors and feeds constitute a particular situation. Each situation is then articulated as a series of interactions. The interactions are not prescribed, but rather emerge from the basic physics and decision-making that governs the behaviour of environments in certain conditions, objects with certain properties, actors with certain behaviours and feeds with certain data manipulation. Howsoever the complex interactions resolve themselves at any given moment in time, is then rendered to the user as a display of some form (screen, goggles, digital cave, 3D, soundscape, etc.). The user interface needs to deliver an immersive, first-person experience of the situation to the user as it unfolds. The more realistic the immersive experience the better. First-person engagement is critical to an immersive experience in this context, as the specific situation is then presented as a person would typically engage with the world. Clearly, the same Situation Engine is intended to drive a multitude of tailored learning situations.

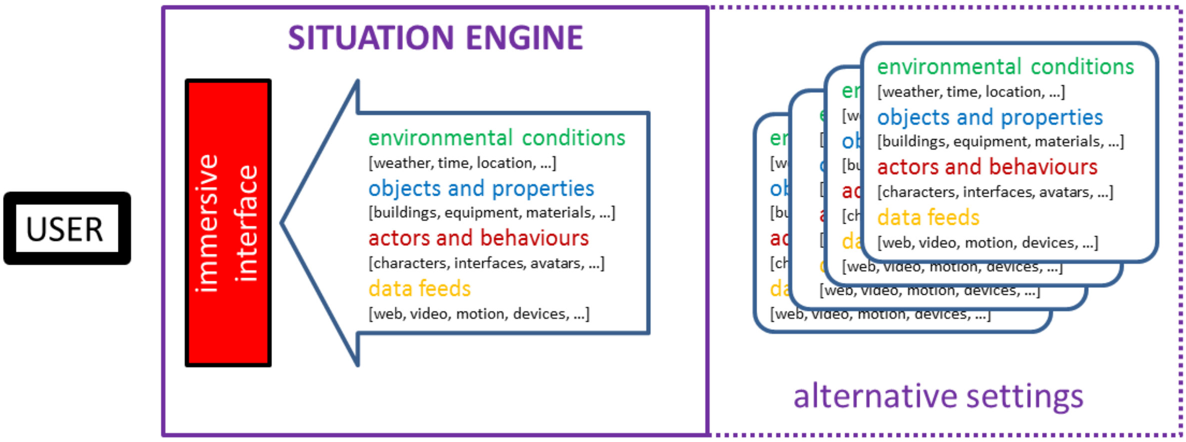

Figure 1: Concept Structure for a Situation Engine

The role of the Situation Engine is not merely to provide access to particular combinations of knowledge. That approach would associate specific learning outcomes to particular situation settings. It conceives of learning as a process of building a particular understanding from a prescribed series of building blocks. An alternative approach is to conceive the student as an active constructor of their knowledge in each situation setting. This latter approach recognises that learners themselves create knowledge through a subjective construction across different situations and experiences. The Situation Engine might afford particular learning outcomes, but the user might never construe their actual experiences to those particular learning outcomes. It is more likely that the simpler levels of knowledge (the facts and concepts) and deeper forms of understanding (the associations and connections) will act in concert (Billett, 2009). The goal-directed activities, performance monitoring, self-management, etc. all help the learner to generate understandings that reach beyond the intentional components of each situation. The learner might choose to reconcile, reject or ignore their learning experiences, which in any event may themselves be partial, incomplete or misconstrued.

The subjective construction of knowledge is as much dependent on the level and effort of the student as it is on the teacher. For such an approach to be effective the student disposition and motivation is important (Billett, 2009). Where learning is perceived to be of personal benefit, interesting and/or engaging, for example, these will more likely lead to richer and more substantive learning experiences. Fatigue, familiarity, complexity and a range of negative personal dispositions and behaviours will impact on the effectiveness of the Situation Engine, including attitudes to the use of new technologies and the pre-mediate experiences of the users (Valsiner, 2000). Luckin (2008:449) refers to a "learner centric ecology of resources" to broaden the consideration of new teaching technologies beyond their own technical design. This proposes that the traditional model of technology development must be extended. A design and evaluation framework based on de Freitas and Jarvis (2006) is proposed for the implementation and testing of the Situation Engine. This framework takes the more general form of a structured and rigorous consideration of the context (including the resources available to deliver, access and support the application), learner specifics (including learner attributes and preferences), representation (the form or mode in which the content of the application is made manifest to the user – explicitly, implicitly, vicariously, etc.), and pedagogy (the theory and practice models that frame the learning activities) within which the Situation Engine is to be deployed.

3. A Prototype Situation Engine

The target curriculum for the current Situation Engine development is the 1st year course of a 4 year program of undergraduate study in construction management and property. The course is the first in the program of study to introduce students to construction technology. It deals with the functional requirements and construction methods specific to single-storey residential/domestic construction typical in Australia. As such the course examines a range of key technical aspects, including: brick and timber frame construction methods and materials; domestic joinery; staircase construction; finishes; plumbing, drainage and electrical services; methods of setting out and supervision. The course also involves developing skills in on-site observation and the production of housing site reports.

A formal process of human factor analysis using focus groups and task analysis has been undertaken, along with an analysis of the learning needs of current students (Newton, 2012). For instance, the learning needs were assessed by reviewing the performance of several hundred students in their end-of-year examinations, to identify those topics where students were having problems and the typical mistakes they were making specific to construction technology. A small reference group of users has been established to trial prototype systems and evaluate various implementations. Formal evaluation of the current prototype is being conducted using a control group of students having no exposure to the Situation Engine, where the placebo is standard revision and tutorial support.

The most sophisticated interactive virtual reality simulation environments with practical application to teaching and learning are to be found in video games. Video games use high performance graphics engines to render moving photo-realistic scenes in real-time and 3D along with the potential for associated surround-sound audio and tactile feedback to a user who controls the action with a variety of input devices. What is particularly timely about the potential development of video games for learning and teaching, is the recent development in video game technology that has resulted in the ‘game engines’ themselves (the kernel of coding used to drive a collection of actual game implementations) being made available on an open-source basis. Even the most powerful game engines are now relatively cheap to acquire for teaching and learning purposes, are intentionally configured to allow third party modifications to be created and embedded seamlessly into the game engine, and are increasingly supported online by a significant and committed community of users and developers (referred to as ‘modders’).

The specific genre of game selected is termed a ‘first-person shooter’ (FPS). FPS games are characterised by the use of an avatar which presents the first-person perspective that enables the player to see and be seen as a person would conventionally occupy a space (ie. bound by and to one's own body). Other game genres adopt either a more abstract form of engagement (such as the third-person perspective characteristic of games like Sim City, and entirely command-driven game controls) or tend to focus more on the interaction and communication capabilities across a social network (as is the case in Second Life worlds, for example). The specific application is the proprietary video game engine CryENGINE, that features the most advanced graphical, physical and animation technologies (for further information, see http://www.crytek.com/cryengine).

Figure 2: First Person View from the Prototype Situation Engine

The quality of the visual rendering is illustrated in Figure 2, which is a screen grab from the application. It shows a situation where the construction site has been established with some initial plant, facilities and materials – as seen through the eyes of the user avatar. The same site can be used to present alternative situations, with other configurations of material storage, signage, waste management, security, etc. Multiple users can be represented and experience the situation collectively. A building can be constructed from the foundations through to the roof and finishes. At various points a user can interact with the building as it is constructed – checking the placement of reinforcement and formwork just prior to pouring the slab, for example. Users get to see how the work at different stages of construction has been prepared, measure and check sizes and distances, test the bearing capacity of members, assess details against building codes and best-practice guides, etc.

The gaming elements include an accuracy measure that reduces for each mistake made in selecting materials and/or the next step of the construction process. Progress indicates how far through the game the user has progressed. The time taken is measured and displayed, and the sun tracks across the sky and eventually sets each day.

Figure 3 illustrates another aspect of the wider site context. It shows one of the game actors following the partial collapse of a timber frame elsewhere on the site. Students are expected to note the lack of appropriate safety apparel and security fencing. They are required to investigate and determine what factors might have led to the collapse – such as having no temporary bracing, incorrect timber size selection, poor construction management, etc. Practical skills, such as reading and comparing design drawings with as-built construction, can also be highlighted and tested. The intention with every task is to present a situation for the student to experience, individually or as part of a group, and as far as is practicable to allow the user free-range in how they complete each task.

Figure 3: Investigating a collapsed timber structure

The current prototype can also be used to test a students' understanding of related issues, such as safe work practices, material storage and handling considerations, site security, environmental protection, wet-weather hazards, noise pollution, etc.

4. Discussion and Conclusions

WIL is most commonly used to refer to programs where students are physically located in a workplace as a formal part of their studies (Smigiel and Harris, 2007). The intended outcome is for students to learn essential skills that they cannot learn in a formal classroom setting. This paper has taken the broader view of WIL, to include any work-related experience included in a program of study.

Several key issues specific to WIL have been highlighted from the perspective of a situated learning framework:

(i) The need for effective control of direct practical experiences. Without adequate control of the practical experience, learning outcomes can be disparate and varied.

(ii) The essential integration of practice-based experience into a formal study program. WIL can serve to illustrate the theories and concepts presented in-class, and/or be used to test the veracity of the theory against the actual situations encountered in practice.

(iii) The practical development of a 'learning how to experience' strategy. The ability to register and re-register particular situations and situation settings enable, over time, improved sensitisation, awareness and noticing skills.

To address these three main issues the concept of a Situation Engine has been proposed. The concept fits well with the broad definition of WIL, but various implementation issues remain to be addressed. In particular, the subjective construction of knowledge requires a positive disposition and motivation to be effective. Careful design and development of the prototype Situation Engine is required if a range of negative behaviours is to be avoided. The use of a structured development framework has kept the focus on context, learner specifics, representation and pedagogy.

The prototype Situation Engine employs the most sophisticated virtual reality simulation environment available. CryENGINE provides for a first person experience of controlled practical experiences specific to domestic building construction. The current application is being trialled with 1st year Construction Management students to help develop and demonstrate a range of knowledge and skills relevant to domestic building construction. The application can successfully present different configurations (situation settings) of a particular site and enable a range of learning strategies to be examined.

The current implementation is an early version and is now being superseded in response to the feedback and findings of several trials and evaluations. First and foremost the building construction is being completely revised. The initial construction matched exactly the design drawings previously used to support a practical model-building exercise (Forsythe, 2009). New and more sophisticated domestic buildings are being developed. These will also be located in a more urban setting. It is clear that a more constrained site would present more realistic problems of access and material storage. There is also insufficient of the hustle and bustle, noise and people, typical of such construction situations.

Overall, however, the Situation Engine has demonstrated some of the potential that new technologies offer in terms of providing more effective and practical WIL experiences. As the context of higher education seems to continue to require more students be taught with fewer resources, effective development of new teaching methods becomes increasingly critical.

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