Situational eLearning: A Crowdsourcing Approach to the Definition and Assessment of Key Practice-Ready Academic Outcomes.

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List of acronyms used

3D            Three dimensional
ACT-UK        Advanced Construction Technology Simulation Centre
Adelaide      The University of Adelaide
BArchitecture Bachelor of Architecture
BIM           Building Information Model
LTAS          Learning and Teaching Academic Standards
MOOC          Massive Open Online Course
OnSite        Moodle site specific to construction technology
pdf           Portable Document Format
QUT           Queensland University of Technology
SeLAR         Situational eLearning Adaptive Repository
TEQSA         Tertiary Education Quality and Standards Agency
UniSA         University of South Australia
UNSW          University of New South Wales
UK            United Kingdom
url           Uniform Resource Locator
WSU           Western Sydney University
Executive summary

Australia must do more to develop graduates with the practice-ready skills they need to play an effective role in the workplace. This project addresses the potential for emerging virtual reality and related digital technologies to provide and assess particular clinical experiences. In order to provide a benchmark for practical skills in a professional context, adaptive learning resources based around realistic situations and experiences must be mapped to a learning framework of specific outcomes: student activities should be based on realistic situation models; learning resources need to support individualised learning; student engagement must be monitored and mapped against the learning framework; user requirements and preferences need to drive changes in the learning process; and learning resources must adapt and change accordingly. We term this approach to learning and teaching: Situational eLearning.

The project deals with emerging digital technologies. The technology development strategy used an agile methodology driven by crowdsourced feedback and use. That is to say, that the development and deployment of the learning and teaching resources produced a series of implementations, each one of which evolved and adapted in response to diverse stakeholder feedback and analytics.

The learning and teaching evaluation strategy rejected extant elearning evaluation frameworks because they mask the risk profile and degree of uncertainty inherent in such
contexts. This departure from a one-size-fits-all evaluation framework approach is on the basis that individual teachers bring a myriad of perspectives, capabilities and ambitions wrapped in multiple contexts and very different student cohorts. Every variation warrants a potentially different evaluation framework and so this project delivers a raft of potential metrics that provide only a partial and uncertain picture of performance. The proof of this particular learning and teaching pudding is really in the eating.

The project delivers three notable learning and teaching resource outcomes:

(i) The Situation Engine uses advanced video game technologies to model and manage practical situations. This project has further developed the functionality to include performance analytics, improved interface controls, expanded immersion options, complex task assessment, and multiuser situation models. Significantly, the technical capacity to develop and modify situation models has now been expanded to include five new academic institutions.

(ii) Situational eLearning Adaptive Repository (SeLAR) is an open access, online database of learning and teaching resources specific to clinical experience in construction technology. There have been over 8,350 individual resource downloads by the more than 770 registered users representing 13 Australian universities.

(iii) OnSite is a Moodle resource that binds the adaptive learning resources available through SeLAR to specific construction technology learning outcomes. In trials, 97 percent of students accessed OnSite and successfully completed the assessment tasks, spending an average of 15 minutes and 12 seconds on each multiple choice quiz. Significantly, 16 percent of those using the OnSite resource would have failed the course on the basis of their initial test score.

All project learning and teaching resources are available under the Creative Commons Attribution-ShareAlike 4.0 International License from: situationalelearning.com

Key findings

(i) The broader engagement of other institutions and students with SeLAR marks this project outcome as the most significant impact and most likely to be sustained into the future. The current system will be hosted by the University of New South Wales (UNSW) for at least a further three years and further developed in collaboration with Western Sydney University (WSU).

(ii) This project has demonstrated the capacity to grow technical expertise in the production of situation models suitable for deployment to support virtual clinical experiences in construction technology. Much of that success is a direct consequence of the agile development methodology.
(iii) The provision of adaptable situation models is more important than the particular delivery technology. Different staff with different technical skills all need to be able to access and tailor situation model resources if those resources are to have broader and longer term application/utility.

(iv) Where published articles have generated interest and provide a scholarly framework for the project, to promote engagement with the resources really requires face-to-face presentations to the teaching staff. The National Roadshows have been invaluable in that regard.

(v) The crowdsourcing approach has been successful in engaging a broad spectrum of individual learners and teachers.
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Notes
Figures 1 – 7 are captured screen shots taken from SeLAR and The Situation Engine developed for this project. They are provided to demonstrate the visual quality, realism and scope of the virtual reality resources available. Figure 1 shows how users access the construction site used to provide a common context for the technical training and assessment modules. Figure 2 shows a scene from the initial preparation and set-out of the site, marking up the ground for excavation. Figure 3 shows the excavation stage, where a water main has been exposed in accordance with the technical drawings associated with this scenario. Figure 4 shows foundations being prepared and requires users to identify and select appropriate materials. Figure 5 illustrates the SeLAR user interface, with search and display options. Figure 6 is ready for foundations to be poured and requires users to confirm that the prepared work complies with approved construction drawings and technical specifications. Figure 7 shows the framing stage and requires students to identify critical features and check compliance with relevant National Construction Code specifications.
Chapter 1: Project context

Figure 2: The Situation Engine site set-out

1.1 Rationale

Australia must do more to develop graduates with the practice-ready skills they need to play an effective role in the workplace (Bradley, Noonan, Nugent & Scales, 2008). Practice-ready skills can and should provide a significant focus for undergraduate learning (Orrell, 2011). This strong imperative has brought renewed emphasis to practical experiences and work-integrated learning (Patrick, Peach & Pocknee, 2008). Situated learning offers a particular orientation to learning and teaching that privileges a process of direct personal engagement in and observation of practice (Wenger, 1998). Under the rubric of situated learning, the development of knowledge and skills requires a learner to participate in the socio-cultural practices of a particular domain of professional practice. The socio-cultural practices are the shared routines, sensibilities, vocabulary, styles, artefacts, procedures, and so on, that constitutes a particular field of practice: what Schön (1983) refers to as the language, media and repertoire of a particular professional community.

Situated learning lends itself to the development of key practice-ready skills, but it is contingent on the availability of authentic clinical experiences. Clinical experiences include activities such as practicums, industry placements, case studies, role-play and site visits. Where the practice situation involves dangerous, expensive, temporal and/or sensitive
environmental, social and/or technological contexts (which can be often), the direct engagement of students in such situations is becoming increasingly problematic (Mills, Ashford & McLaughlin, 2006). For example, invasive health procedures, high-technology manufacturing processes, special events, remote mining operations, large construction sites, and so on, all represent particular and significant difficulties for a higher education sector facing increased class sizes, tightening occupational health and safety regulations, and more specific learning outcome requirements.

Against such a backdrop, the potential for replacing direct student engagement in practice with a simulated clinical experience is apparent. Whether it is by virtue of a flight simulator, a virtual cadaver, 3D interactive archaeological dig, scenario-based video game and/or a multitude of other highly immersive, virtual simulations, the clinical education landscape has been challenged and changed in a fundamental way (Connolly, Boyle, MacArthur, Hainey & Boyle, 2012). In Australia, a project by Cybulski, Holt, Segrave, O’Brien, Munro, Corbitt, Smith, Dick, Searle, Zadeh, Sarkar, Keppell, Murdoch & Bradley (2010) successfully deployed interactive simulations to support professional education by building academic staff capacity to create simulations directly. Other successes include the immersive digital imaging of complex engineering situations (Cameron, Crosthwaite, Shallcross, Kavanagh, Barton, Maynard, Tade & Hoadley, 2009); a computer-generated digital patient for teaching and assessment in pharmacy (Newby & Jin, 2011); and a hybrid immersive system for construction training (Carozza, Bosché & Abdel-Wahab, 2015). The Situation Engine is an application that provides for specific and managed practical building and construction experience to be made available to students using advanced video game technologies (Newton, 2012).

Recognising the technical and resource barriers to individual educators taking ownership of sophisticated simulation technologies, Ben-Naim, Velan, Marcus & Bain (2010) drew an important distinction between the technical skills required to work with a sophisticated technology directly, and the pedagogical control required to deploy appropriate instructional elements derived from and/or generated by that same technology. “Pedagogical ownership” is the term used where educators are able “to meaningfully reflect on the suitability of the resources to the students, gauging their reaction, its learning effect, and adapting – changing and augmenting them, or their usage – to suit specific students’ needs” (Ben-Naim & Prusty, 2010: 437).

The growing concern that graduate outcomes generally fail adequately to address the key practice-ready skills demanded by industry is sector-wide and international (Yong, Ryan, Yap & Goela, 2011; Barry, 2012). The establishment of the Tertiary Education Quality and Standards Agency (TEQSA), signals an important move towards a more outcomes-based focus for both compliance assessments and quality assessments. The outcomes-based approach challenges the definition and assessment of academic achievement. Assessment in almost every aspect is currently being rethought and renewed (Boud, 2010). One critical
aspect is how common academic learning outcome standards for a discipline can be expressed, agreed and assessed when they relate specifically to practice-ready skills. How can the potential vagaries of clinical experience be benchmarked effectively against sometimes competing provider, student and professional accreditation expectations?

1.2 Objectives
The purpose of the project was to explore how practice-ready skills might usefully be developed through the application of emerging virtual reality and related digital technologies. The objectives of the project were to:

(i) Build an open repository of authentic situation models specific to the development and demonstration of practical skills.

(ii) Establish and grow a community of academic, industry and student stakeholders technically versed in the Situational eLearning approach.

(iii) Evaluate the scalability of a Situational eLearning approach to the provision of effective clinical experiences.

(iv) Produce a harmonious context definition and assessment framework for key practice-ready academic outcomes that is coherent and explicit.

1.3 Scope
There has been a rapid development in the virtual reality technologies available to create authentic situation models for learning and teaching. The scope of this project is limited to the particular technologies available to the project team, and most especially to The Situation Engine. There is then a critical barrier to the effective implementation of emerging virtual reality technologies in learning and teaching because of the technical requirements of virtual reality technologies, in both systems and operational terms. The focus of this project is on staff teaching construction technology to undergraduate architecture and construction management students, who were prepared to incorporate the technologies as a component of their learning and teaching resources.
Chapter 2: Project approach

2.1 Technology development strategy

The key technology development strategy for this project adopts an agile methodology, driven by crowdsourced feedback and use. That is to say, the development and deployment of the learning and teaching resources produced a series of implementations, each one of which evolved and adapted in response to diverse stakeholder feedback and analytics.

The agile methodology is particularly well-suited to deal with unpredictable user requirements which emerge as solution options are provided and used. That is, in contrast to a conventional development approach where presumed user requirements are analysed and specified at the outset, and those requirements are then matched with the potential functionality of a given technology in order to drive the system development. A conventional development is then realised through a sequence of progressive stages from conception to initiation, analysis, design, construction, testing, and production (the so-called waterfall or cascading project management model).

The agile development progresses through a series of system implementations (often referred to as sprints), where each sprint is developed in close collaboration with users and provides for an operational implementation at the end of each phase. The specification of
the subsequent sprint is then determined on the actual user experience of the previous implementation – which clarifies both the user requirements and system functionality progressively. The agile methodology also encourages quite radical changes to requirements even late in the overall project, including adopting entirely alternative technology solutions. It also promotes growth in the technical capability of groups in the broader community of users, which more generally distributes the responsibility and opportunity to further develop technical implementations.

Crowdsourcing refers to a process of broad and open engagement with an online community in order to solicit contributions from interested parties that might otherwise have been excluded. The crowdsourcing strategy for this project involved primarily the development of a website containing project resources provided under a Creative Commons Attribution-ShareAlike 4.0 International License. The website enabled public download and use of resources and encouraged public development and contribution of new resources relevant to the project. Together with a series of formal and informal feedback opportunities, the crowdsourcing approach generated a sufficient scope and quality of feedback to inform and drive the technical development. In particular, the crowdsourced contributions successfully challenged some key preconceptions of the project team about what technology developments might be required and how such technologies might be adopted by the various stakeholders.

The technology development strategy outlined for this project was very constructive in the context of this particular project. That is to say, in the context of a project where user requirements and technology capabilities are in a state of flux and volatility. Adopting an agile methodology and driving the development through crowdsourcing provides a number of unique and significant benefits:

(i) The project technology is more diversified in nature. For example, one of the participants took the notion of a situation model but implemented it in a very different technology to the video game technology base used by The Situation Engine. In this particular alternative, the situation model is realised using Articulate Storyline. The alternative technology suited the technical capabilities of the participant and enabled them to utilise project resources but tailor them to specific and personal teaching needs and ambitions.

(ii) The development process is more dynamic and energetic. Even towards the end of the project participants were still proposing changes to basic functionality. The ability to propose late changes helped keep participants engaged with and enthusiastic about the technology development throughout the project. For example, an early decision was for the principal situation models to contain a set of potential errors or issues, each of which is particular to an individual problem and requires the identification of a particular object to represent the single, correct solution. This is typically how students have been assessed previously using multiple choice and simple mix and
match assessment formats. The approach worked well for particular kinds of problems, but not for problems that required a combination of objects and/or actions to resolve. The basic functionality had been developed presuming a single user and list of problems matched to solutions. The more complex problem solutions required a very different functionality, where different combinations of different items arranged in various orders might all address the same problem to some degree. Such a problem scenario is much more in keeping with professional practice that rarely involves black and white, single problem and single solution decisions. The agile methodology enabled not only fundamental changes to the functionality of later implementations, but also provided for such changes to be promulgated backwards to earlier implementations retrospectively.

(iii) There is a greater sense of individual ownership vested in each situation model. The crowdsourcing approach was used to enable participants to download existing resources and modify them to suit particular learning and teaching needs. When resources are tailored to individual teaching needs by the individual teachers themselves, this creates a natural sense of personal ownership. For example, a site establishment situation model developed by one participant was downloaded and amended by another participant because the original model contained a flat site and the second participant required an undulating site which illustrated excavation and fill to level the area prior to construction. This required the second participant to acquire new technical skills. Once mastered, the new skills were used to change the ground levels of the construction site and then make further changes to other aspects of the situation model.

(iv) The more resources developed, the easier it is to develop further resources. A critical factor in the success of an agile development driven by crowdsourcing approach in this project was the digital nature of the technology involved. Once a wheel-barrow has been modelled and made available, it could be copied and replicated in any number of new situation models. Once the capacity to record student activity had been developed for one situation model, then the same functionality was simply cut and pasted into other situation models. This characteristic of the technology means that online repositories of objects and functionalities are being established. The crowdsourcing extended well beyond the participants of the project. For example, ready-made objects for pipes, shovels, rocks, and ready-made functionality for inventories, menus, were all simply acquired as existing resources from the broader online community and incorporated into the situation models as appropriate.

2.2 Learning and teaching evaluation strategy
The key learning and teaching evaluation strategy for this project adopts a rather unorthodox approach. The evaluation of elearning developments is particularly complex because it involves relatively opaque interactions between curriculum, teacher, technology,
student and context (Attwell, 2007). Positive attempts to frame the complexity and
dynamics of learning and teaching evaluations that involve emerging digital technologies
include the four-dimensional framework of de Freitas, Rebolledo-Mendez, Liarokapis,
Magoulas & Poulouvasilis (2010) and the ecology of resources design framework of Luckin
(2010). However, none of the evaluation frameworks considered for this project adequately
recognise the extent of the uncertainty that now pervades the future of learning and
teaching: changing technologies, regulatory frameworks, students, markets, and so on. It is
not just that the extent of uncertainty is being ignored or underestimated, but more
significantly the typical evaluation frameworks adopt a single and generally undeclared risk
perspective. The uncertainty is being masked. Current elearning evaluation frameworks
ignore or discount key drivers of uncertainty: the novelty of the learning technology; the
often heightened enthusiasm of the participants in the study; the stronger engagement that
comes from being observed and surveyed; the use of prototypical technologies rather than
mature technologies; and so on.

The outcome of a typical elearning evaluation seeks to manifest a future scenario that is
precise enough to inform learning and teaching practice. Under conditions of uncertainty,
such an approach can be dangerous. One danger is that the findings of the evaluation are
taken as given and used to leverage major investment in that future scenario when in reality
there is neither the industry position, assets, or appetite for risk necessary to make such a
strategy work. For example, the apparent success of MOOCs in the context of a global
education leader has prompted many very different providers to invest heavily in similar
strategies with questionable success (Westervelt, 2013). Another danger is that the lack of
uncertainty evident in the evaluation allows those who may be risk-averse more readily to
identify the numerous short-comings and failings of an evaluation when viewed from an
alternative future scenario. Even when multiple future scenarios are considered, there is
always sufficient uncertainty to excuse doing nothing or ignore the findings entirely.

When faced with uncertainty, and most especially when faced with significant uncertainty,
the established assumption that a one-size-fits-all evaluation framework will be adequate is
entirely misguided (Courtney, Hirkland & Viguerie, 1997). Rather than evaluate under any
particular elearning evaluation framework, this project seeks to address the inherent
uncertainty by presenting a raft of potential metrics. The picture these metrics paint will be
partial, potentially conflicting and definitely uncertain. However, in the context of an
emerging technology and unpredictable learning and teaching future, an uncertain picture is
by far the more accurate picture.

The range of metrics reported in project outcomes includes: external technology
evaluations, external learning and teaching evaluations; student grades, questionnaires,
usage statistics, adoption statistics, and participant reflections. The evaluation outcome is
neither a best practice guide nor a benchmarking framework. The evaluation outcome is the
project outcome itself: the resources, performance statistics, reflections, etc. The proof of this particular learning and teaching pudding is to be found in the eating.

### 2.3 Situational eLearning

This project has addressed the particular definition and assessment issues of clinical experience using a crowdsourcing approach. Crowdsourcing involves the use of online technologies to garner the contribution of a larger group of otherwise independent stakeholders. A bottom-up, broad-based representation approach proved highly effective in the Learning and Teaching Academic Standards (LTAS) project, where discipline communities were brought to a consensus on what constitutes the threshold learning outcomes for key fields of study. The LTAS Statement for Building and Construction, for example, was endorsed by the Australian Deans of Built Environment and Design, the Building Discipline Reference Group and five relevant professional accreditation bodies (Newton, 2011). However, when the key practice-ready academic outcome is essentially a clinical practice (and therefore primarily context specific), the fundamental problem for those charged with compliance and assessment of learning outcomes (learning providers, professional accreditation bodies, government, and so on) is the definition and assessment of a particular, situation-specific interpretation of the learning outcome. Furthermore, a situation-specific interpretation of the learning outcome needs to be matched with a response (or responses) that can be deemed the most effective solution. In such circumstance, consensus across learning providers, professional accreditation bodies, government and so on, is needed in terms of both the most appropriate situation context as well as the most appropriate learning assessment.

To come to a consensus on an appropriate interpretation and response requires: first, that the practice context be controllable (specific); second, that the activities of the learners be available for analysis (measurable); and third, that a broad range of stakeholders is able to contribute to the negotiation and development of learning material (scalable). To address the specificity requirement, the project utilised the unique functionality of The Situation Engine (Newton & Lowe, 2012). The Situation Engine uses advanced virtual reality technologies to simulate and manage specific practice-based circumstances that represent authentic clinical experiences. To measure performance, key data was gathered from various digital sources, including: direct data recording from The Situation Engine itself; student access and use of a dedicated Moodle site (OnSIte); download statistics for a custom online repository of resources (SeLAR); student questionnaires; and grade outcomes in related assessment tasks. To provide for scalability, a custom online repository of relevant resources (SeLAR) has been developed and made available under a Creative Commons Attribution-ShareAlike 4.0 International License. Anyone can register with SeLAR to search for and download relevant learning and teaching resources. Registered users can also upload new resources to the repository and thereby contribute to the ongoing development of the facility and further the definition of an appropriate clinical experience. Collectively, we have termed this approach *Situational eLearning*. 

**Situational eLearning**
Situational eLearning is being proposed as a generic and entirely scalable vehicle for collaboration across a broad range of (crowdsourced) stakeholders (including academics, practitioners, industry bodies and students). The collaboration specific to this proposal is particular to the definition and assessment of key practice-ready learning outcomes in architecture and construction. A variety of bespoke situation contexts has been created and deployed using The Situation Engine and other related digital technologies. As shared resources, a range of stakeholders have contributed to the negotiation and implementation of changes to the situation models that improves the clinical experience particular to their individual learning and teaching needs. Collectively, the resources provide a specification and framework that represents a common benchmark for practice-ready skills specific to learning and teaching construction technology. As an open facility, the resources will continue to adapt to changing consensus and understanding of what it means to teach, learn and assess any given practice-ready learning outcome. Whilst specific to construction technology in this instance, the Situational eLearning model will enable the key practice-ready academic outcomes for graduates of any disciplinary persuasion to be specified by way of actual circumstances and the essential responses such characteristic circumstances dictate.
Chapter 3: Project outcomes

Figure 4: The Situation Engine site foundations.

3.1 Project deliverables

In line with the project objectives, the project deliverables include:

(i) An open repository of learning and teaching resources for architecture, building and construction in the built environment.

(ii) A national community of built environment educators, industry practitioners and students with specific interest in jointly developing and sharing learning and teaching resources.

(iii) A series of national workshops and published case studies on the development and use of Situational eLearning to disseminate and promote the findings of the project.

(iv) A sequence of trial deployments of the Situational eLearning platform, to build progressively in scale.

(v) An evaluation of educator, industry and student experiences of the Situational eLearning platform specific to the quality and utility of the clinical experiences it provides.
(vi) A specification of the key practice-ready skills for architecture and building.

### 3.2 SeLAR

![SeLAR user interface](image)

SeLAR (Situational eLearning Adaptive Repository) is an online database of learning and teaching resources specific to clinical experiences in construction technology. The resources may comprise of any digital file or active Uniform Resource Locator (url). The repository currently contains eight resource types, in various digital formats. The existing resource types are: drawing (for sketches, plans, elevations, and so on); game (for situation models in, for example, The Situation Engine and Articulate Storyline); image (for diagrams, site photographs, screen dumps, and so on); link (for web sites, external databases, larger files, and so on); model (for 3D computer-aided design models, building information models, sketchup models, and the like); notes (for example, for text documents, lecture notes, and Powerpoint presentations); other (for other types of resources); and video (for time-lapse, documentaries, how-to videos, and so on).

Resources can be searched and retrieved from SeLAR by any registered user using a simple keyword search facility. Figure 5 shows one example of the typical user interface available to users of SeLAR. Any keyword entered is matched to the resource filename, extension, owners name and/or a set of tags associated with the resource when it was uploaded. The tags are open format, so groups or collections of resources can be created by associating a distinctive tag to each resource in the collection. For example, all resources specifically associated with a particular assessment task in a particular course could be tagged with the course name and assessment reference. All data associated with a particular resource can
be edited at any time by the resource owner or system administrator. Bulk uploads are also possible for approved registered users.

To become a registered user requires any user name, password, valid email address and association with a listed organisation (including ‘other’ organisations). There is a simple email validation process and user details can be edited at any time.

The results of a search can be displayed in gallery or list format, depending on whether the thumbnail representation of the resource is going to be useful. The ordering of display can also be set as:

- Most downloaded
- Most liked
- Filename (A-Z)
- Filename (Z-A)
- Date (New-Old)
- Date (Old-New)

The most downloaded files are determined by an automatic system count of how often the download button is selected against any particular resource. The most liked files are determined by an automatic system count of how often the ‘Like’ button is selected by users who have downloaded the resource. By filename and by date listings are determined alphabetically or by upload date, and can be listed in either order.

When an individual resource is selected, a registered user has the option to download the file directly and/or to ‘Like’ the resource. Information about the resource is presented, including: the original resource owner; total number of downloads; total number of likes; the storage size of the file; when the resource was originally uploaded; and when it was last modified. Download statistics associated with the resource are provided to identify how popular the resource has been at which organisations, and which other users have ‘liked’ the resource. In addition, other collections of resources associated with the same stage of construction, provided by the same organisation, or uploaded by the same person, can also be linked to automatically.

SeLAR is available online at a dedicated website:

situationalelearning.com/selar/

Unless otherwise noted, all resources uploaded to SeLAR are provided under the Creative Commons Attribution-ShareAlike 4.0 International License.
Impact

The SeLAR system has been available to support learning and teaching across three full semesters. During that time users have joined and left, and resources have been added, updated and removed. As of March 2016, the following usage statistics are available:

- 8,351 individual resource downloads
- 621 individual resources available for download
- 777 individual registered users of the system
- 13 Australian universities represented by registered users

The 13 Australian universities represented by current registered users are:

- Curtin University
- Deakin University
- Queensland University of Technology
- RMIT University
- The University of Adelaide
- The University of Melbourne
- The University of Queensland
- University of Newcastle
- University of New South Wales
- University of South Australia
- The University of Sydney
- The University of Western Australia
- Western Sydney University

Registered users have also associated with overseas universities and other organisations of relevance, including:

- Beijing Jiaotong University
- University of Hong Kong
- The Australia China Business Council
Key findings

(i) The number and distribution of student users from the partner universities indicates the strength of student demand for a facility such as SeLAR. The commitment of learning resources by teaching staff not otherwise directly involved in the project is testament to the potential for SeLAR to be used more widely and to continue to grow into the future. Whilst there have been several requests for particular categories to be included with the data (to predefine collections of related resources, for example) the open format and simple search/download functionality is noted as a key strength of this repository. The crowdsourcing approach to resource development relies on an open and flexible repository.

(ii) The broader engagement of other organisations and students with SeLAR marks this project outcome as the most significant impact of the project. SeLAR is evidently the most likely of the technical developments to be sustained into the future. The current system will be hosted by UNSW for at least a further three years and further developed in collaboration with WSU.

3.3 The Situation Engine

Figure 6: The Situation Engine diagnosing errors.
The Situation Engine is an application built using a commercial video game development engine (Unreal4: www.unrealengine.com) that provides for specific and managed practical construction experiences (a ‘situation model’) to be made available to students (Newton, Lowe, Kember, Wang & Davey, 2013). Each situation model is created as an individual game level, where the context of the level is determined by the 3D models (such as landscape, buildings, vehicles, and artefacts) incorporated into the scene. Each object is assigned properties (for example, dimensions, mass, articulation, and texture) that determine how it behaves when the game is being played. Scenes can evolve differently depending on the user interactions and starting conditions of each individual use. Other parameters of a scene (including light, shading and visibility) can also be controlled in response to various triggers (time, location, weather, and so on). Triggers can result from user interaction, particular conditions or external data sources, including online websites, internet devices and physical movement. The Situation Engine is also able to represent actors and behaviours within the scene using a sophisticated rendition of artificial intelligence. Because the system is multiuser, the other actors can also be digital representations of other human users of the system – reflecting the behaviours and actions of other users and placing everyone in a common situation model/experience. The Situation Engine is also hyper-immersive, providing a first-person experience with full stereoscopic visualizations using the latest head-tracking devices, location-based 3D soundscapes, body-tracking and haptic feedback (Newton et al., 2013).

Figures 1 – 7 illustrate a particular situation model developed for The Situation Engine. This particular situation model takes the Building Information Model (BIM) of a typical domestic project home in Australia and renders it from the site set out, excavation, foundations and structural framework stages of construction. Different user interfaces and functionality has been trialled for each of the different stages. In the case of Figure 6, the user interface includes a play mode where a subset of four errors selected at random from a suite of potential errors is incorporated into each separate use of the system. Students are then required to identify the four errors and nominate how each might best be resolved. The potential errors are tied directly to the general teaching curriculum for domestic construction technology and support a series of quiz questions used in tutorial exercises and subject examinations.

The situated learning framework on which The Situation Engine is predicated is not without its critics (Frank, Dirven, Ziemke & Bernardez, 2008). The most substantive issue being that situated learning presumes an epistemological shift from empiricism (a storage and retrieval of discrete knowledge model) to embodiment (a model of knowledge and learning where understanding emerges through action). Embodiment requires a subjective construction of knowledge, or thinking on the fly rather than piecemeal storage and retrieval of conceptual knowledge. Assessment of an embodied understanding is especially problematic for conventional assessment methods such as an examination of knowledge retrieval or
abstract application of skills. Fundamentally, embodied understanding is all about changing and assessing student behaviour.

For the Situation Engine 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, it is more likely lead to richer and more substantive learning experiences. Fatigue, familiarity, complexity and a range of potentially negative personal dispositions and attitudes to immersive technologies will impact the effectiveness of The Situation Engine. This includes the attitude of users to the use of new technologies in general and the pre-mediate experiences of the users more specific to the learning task (Valsiner, 2000).

Beyond the use of the various situation models created using The Situation Engine, there is a growing community of built environment educators, industry practitioners and students with specific interest in developing and sharing the resources required to create and modify such situation models. For example, as a direct consequence of this project, sufficient expertise and interest to create and modify the existing situation models in various forms has now been identified at the following universities (in addition to the established expertise at UNSW and those organisations where expertise might exist in departments or faculties other than in architecture or construction management):

- Curtin University: Dr Jane Matthews
- Deakin University: Dr Rui Wang
- The University of Adelaide: Dr Amit Srivastava
- University of Newcastle: Dr Ning Gu
- University of South Australia: Dr Sean Pickersgill

Significantly, the technical skills necessary to create and modify resources for The Situation Engine are now being taught to large cohorts of undergraduate students in architecture and related programs of study in numerous universities in Australia and internationally. These skills are being taught for their relevance and application to architectural design or design computing rather than specifically to develop situation models for The Situation Engine. Nevertheless, the growing cohort of students and graduates with the expertise and interest in developing virtual reality applications is cause for optimism about the sustainability of The Situation Engine into the future.

The raw Situation Engine resources are available online at a dedicated dropbox:

www.dropbox.com/sh/e3pp4mqkueqi9w/SOD4i5ejJn
Unless otherwise noted, all Situation Engine resources are provided under the Creative Commons Attribution-ShareAlike 4.0 International License.

**Impact**

Development of The Situation Engine system has significantly expanded the functionality to include performance analytics, improved interface controls, expanded immersion options, assessment, and multi-user models. Most importantly, the technical capacity to develop and modify situation models has been expanded to include five new organisations. The notion of a situation model has also been generalised to apply to game technologies other than The Situation Engine.

The SeLAR repository now contains (and makes available for direct download) a total of nine situation models (games) developed specifically for this project by three different partners using The Situation Engine and Articulate Storyline software. All raw resources required to construct the basic situation models have been made available for direct download from a dedicated dropbox.

**Key findings**

(i) This project has demonstrated the capacity to grow technical expertise across organisations in the production of situation models suitable for deployment to support virtual clinical experiences in construction technology. Much of that success is a direct consequence of the agile development methodology.

(ii) The provision of adaptable situation models is more important than the particular delivery technology. Different staff with different technical skills all need to be able to access and tailor situation model resources if those resources are to have broader and longer term application/utility.

**3.4 Project dissemination**

Dissemination has occurred in different ways and achieved different types of change:

(i) Team members

The dynamics of a project team drawn from four different universities, two different disciples and across three levels of academics are always going to be complex. A critical outcome of this project has been the strengthening of existing and developing of new collaborations. In particular, technology collaboration between UNSW and UniSA is now very strong, involving direct exchange of resources and new joint project proposals. The learning and teaching collaboration between UniSA and WSU has also been significantly strengthened through the joint development of a shared Moodle-Blackboard site for construction technology. Further technology collaboration between UNSW and The
University of Adelaide (Adelaide) has also been established to further develop and integrate the use of game-based learning and teaching in architecture and construction management. A collaboration between UNSW and WSU to further develop SeLAR has been jointly funded by the two institutions.

(ii) Immediate students

The project has directly impacted students enrolled in six different courses of study in architecture and construction management at four different universities. The same courses of study are offered each year and it is in the nature of the teaching subject (construction technology) that the course content is unlikely to change radically from one year to the next. Whenever new material is available or required then relevant resources can be uploaded to the repository and included in the resources already available to students. The project resources continue to be promoted directly to students by the teaching staff of the relevant courses.

(iii) Spreading the word

With the establishment of SeLAR as an open-access repository of resources, students (and practitioners) from any program of study across Australia and internationally will have opportunity to engage with the outcomes of the project. New functionality in SeLAR will include notifications as new resources are added so that all registered users are advised and reminded regularly.

There has been positive interest in the project from all universities contacted as part of the national roadshow, and well received presentations at numerous seminars and international conferences. Of particular note is the invited international keynote presentation on the work of the project to the 8th International Structural Engineering and Construction Conference: “Implementing Innovative Ideas in Structural Engineering and Project Management”, Sydney, Australia, Nov 23-28, 2015.

(iv) Narrow opportunistic adoption

The learning and teaching framework developed in Moodle and Blackboard for this project will be used again across several programs and institutions in 2016, with good prospects for its further and expanded use in the future. A common program of learning and teaching offered across several institutions is a measure of the commitment each has to the project outcomes.

(v) Narrow systemic adoption

The direct outcomes of this project have been used at the institutional level by UNSW and WSU to promote relevant programs of study at open days, high school outreach programs, and elective studies.
(vi) Broad opportunistic adoption

The current focus of the learning and teaching material is construction technology. However, given the flexibility of the search facility in SeLAR there is no issue in providing a broader library of resources to support other courses of study in other programs altogether. For example, there is a proposal by staff at QUT to use SeLAR as a repository for resources in Parametric Geometry Modelling and at Murdoch University for Games, Art and Design. At UNSW there is funding to support the use of SeLAR as a repository for resources specific to the writing and sharing of course descriptions and learning outcomes in construction management and building, to be shared nationally.

Technical possibilities aside, there still remains an overall lack of engagement with elearning technology by academics more generally (Watty, McKay & Ngo, 2014). Overcoming academic resistance to change and time/workload issues is both challenging and critical. SeLAR offers a digital warehouse/crowdsourcing approach which differs from most extant learning management systems, where digital resources tend to be more closely controlled and access is restricted. In comparison, SeLAR offers minimal copyright protection and open access. The simplicity of the interface this open access affords and the lack of restrictions on how SeLAR might be used in a learning context should go some way to promoting broader academic engagement with the technology. Based on the number of resources uploaded, the evidence of this project is that academics are collecting and creating an increasing quantity and quality of digital learning resources which they increasingly struggle to manage and make accessible to students. Repositories such as SeLAR can provide an alternative somewhere between the freedom of a personal hard drive and the constraints of an institutional learning management system.

(vii) Broad systemic adoption

The broadest ambition for this project is to establish Situational eLearning as an effective approach to benchmarking practice-ready skills. Most particularly, the immediate goal is to establish the current content of SeLAR as an agreed expression of how construction technology should be taught and learned. As more universities adopt the resources and teaching framework developed for this project, then consensus about academic learning standards will build. However, key stakeholders for academic standards in construction management in Australia are the several professional bodies responsible for professional accreditation of related programs of study. Building consensus between those professional bodies is difficult, but the tangible nature of existing SeLAR resources and functionality makes at least beginning the conversation more realistic.

Recognition that Situational eLearning has the potential to change learning and teaching in construction management internationally and in the more specific context of industry training was confirmed when the project was awarded the Premier International Innovation in Education and Training Award for 2015 by the UK-based, Chartered Institute of Building.
Situational eLearning has equal potential to change learning and teaching practice in other professional-based disciplines. Most immediately, areas such as engineering could develop and apply equivalent resources for the teaching and assessment of technical skills, with civil engineering able to adopt the existing resources almost directly and mining engineering already having developed applications in mine safety (Li & Kang, 2014).

In other discipline areas with studio-based teaching equivalent to architecture, such as art and design, the development of equivalent resources for location-specific applications might include appreciation of site-specific installations or virtual visualisation of digital art and design creations.

Broader applications in health could include health worker – patient/client communication skills, and applications in areas such as triage have already been developed and trialled (Andreatta, Maslowski, Petty, Shim, Marsh, Hall, Stern & Frankel, 2010). In teacher education the virtual experiences could incorporate architectural aspects, such as managing the spatial arrangement of classrooms, or managing the behaviour of students in the classroom (Choi, Dailey-Hebert & Estes, 2016).

More generally, the rapid development of consumer-level virtual reality technologies makes the broader systemic adoption of Situational eLearning all the more likely and immediate.

**Impact**

The outcomes of this project have been presented and promoted to the broader community in a number of ways:

- Presented at 11 international or national forums specific to learning and teaching in architecture and construction management. This included one invited international keynote presentation on the work of the project to the 8th International Structural Engineering and Construction Conference in 2015.

- Presented to over 1,150 academics.

- In addition to the third-party forums, the project development and outcomes have been presented and discussed as part of a dedicated National Roadshow with relevant academic teaching, administrative and management staff at the following institutions:
  
  New South Wales:  
  University of Newcastle
  University of New South Wales
  University of Technology, Sydney
  Western Sydney University
Queensland: Bond University
Queensland University of Technology

South Australia: The University of Adelaide
University of South Australia

Victoria: Deakin University
RMIT University
The University of Melbourne

Western Australia: Curtin University
Murdoch University

• Key contributions to knowledge are presented in seven published articles in refereed journals and conferences. A further contribution has been invited for inclusion as a chapter in the forthcoming “Handbook of Research on Educational Resource Sharing in Engineering Programs”, edited by A. Rahman, G. Jenkins, R. Hadgraft, and D.B. Lowe and to be published by IGI Global.

The following publications relate directly to this research project:


Key Findings

(i) Where published articles have generated interest and provide a scholarly framework for the project, to promote engagement with the resources really requires face-to-face presentations to the teaching staff. The National Roadshows have been invaluable in that regard.

(ii) Further dissemination is still required to the industry. This will require promotion through professional bodies and industry trade magazines.

3.5 Project deployment

Situational eLearning is the term we use to describe an approach to teaching and learning where various online learning options are dynamically matched to the changing learning styles, focus and needs of a particular student (Kostolányová & Šarmanová, 2014). The basic proposition is that presenting learning material in an individualised way will help students learn at a faster pace, more effectively and with a greater depth of understanding. Based on the standards articulated by Paramythis & Loidl-Reisinger (2004), we propose that the significant aspects of Situational eLearning should include: basing student activities on realistic situations and experiences; providing adaptive learning resources to support learning; monitoring and mapping student engagement against a learning framework; interpreting user requirements and preferences to determine what needs to be changed in the learning process; and adjusting the learning resources and process accordingly.

By providing students with access as and when required to specific, personalised learning material, Situational eLearning offers significant advantage to the diverse learning needs of individual students. An adaptive approach to education is not new, but the development and use of Situational eLearning technologies which focus on clinical experiences has rendered the approach entirely more feasible and relevant in that context. The adaptive approach to teaching and learning has demonstrated potential for a wide range of learners across a broad spectrum of knowledge domains (de Wannemacker, Clarebout & de Caumaecker, 2011).

Personalised learning requires the provision of dynamic, user-driven access to a rich array of adaptable learning assets. In the Situational eLearning model that form of access is provided by SeLAR, which comprises a database of open-source learning objects of any digital format.
including: The Situation Engine executables, 3D digital models, pdfs, images, web-links, animations, videos, and so on. Each resource is tagged with an open selection of descriptors against which the resource can be searched for. Descriptors might be specific to the content (such as roof trusses and windows), the context (house, site layout, and so on), stage of construction (foundations, roof, and the like), program or course of study (for example, BArchitecture, Introduction to domestic construction technology), any access restrictions (open access, restricted by location, institution, program of study, and so on), or any other terms considered useful by the individual providing the resource. Other descriptors are tagged automatically as the resource is uploaded to the system, including: the date of upload; resource owner; file size; and file format. Over time other tags will also be updated, including: number of downloads; user ratings; and related resources. Individual resources are managed by the resource owner, who must be a registered user of the system.

A sequence of trial deployments of the Situational eLearning platform has been undertaken. In keeping with the crowdsourcing approach, each deployment utilised different elements of the platform, at different institutions, with different cohorts and at different times. The sequence of deployments and key elements used are as follows:

- 2014: Session 1: UNSW: Domestic Construction Technology: 143 students: exposure to rudimentary situation models.
Impact

The trial deployments have directly engaged the following student cohorts:

<table>
<thead>
<tr>
<th></th>
<th>Adelaide</th>
<th>UniSA</th>
<th>UNSW</th>
<th>UNSW</th>
<th>WSU</th>
<th>Total</th>
<th>ConsMan</th>
<th>Total</th>
<th>ConsMan</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch</td>
<td>Arch</td>
<td>Arch</td>
<td>Arch</td>
<td>ConsMan</td>
<td>ConsMan</td>
<td>Arch</td>
<td>ConsMan</td>
<td>Arch</td>
<td>ConsMan</td>
<td>Overall</td>
</tr>
<tr>
<td>2014, S1</td>
<td>143</td>
<td>0</td>
<td>143</td>
<td>0</td>
<td>143</td>
<td>143</td>
<td>0</td>
<td>143</td>
<td>0</td>
<td>143</td>
</tr>
<tr>
<td>2014, S2</td>
<td>161</td>
<td>300</td>
<td>161</td>
<td>300</td>
<td>461</td>
<td>300</td>
<td>300</td>
<td>461</td>
<td>300</td>
<td>675</td>
</tr>
<tr>
<td>2015, S1</td>
<td>205</td>
<td>175</td>
<td>295</td>
<td>205</td>
<td>675</td>
<td>360</td>
<td>244</td>
<td>360</td>
<td>244</td>
<td>604</td>
</tr>
<tr>
<td>2015, S2</td>
<td>139</td>
<td>105</td>
<td>205</td>
<td>318</td>
<td>1,273</td>
<td>955</td>
<td>610</td>
<td>1,273</td>
<td>1,883</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>105</td>
<td>205</td>
<td>318</td>
<td>1,273</td>
<td>955</td>
<td>610</td>
<td>1,273</td>
<td>1,883</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Student numbers for trial deployments

Key Findings

(i) The Situational eLearning platform has been trialled across a range of institutions and student cohorts over a number of teaching sessions.

(ii) The crowdsourcing approach has been successful in engaging a broad spectrum of individual learners.

3.6 Project evaluation

The formative evaluation was undertaken in early 2015 by Dr Ning Gu, Associate Professor and Student Academic Conduct Officer, School of Architecture and Built Environment, Faculty of Engineering and Built Environment, The University of Newcastle, Australia. The scope of the evaluation was to review the existing situation models (Site Establishment and Foundations) along with the prototype SeLAR system in technical (for example, user interface) and/or fit-for purpose (teaching and learning) terms. The focus was on technical issues and how the systems might usefully be improved.

The evaluation made a number of useful comments on the design of both technologies, and included the following key issues:

(i) Improvements were suggested for the interface design of the situation models in terms of the presentation and function of the user control options and help facilities.

(ii) A broader perspective on the learning and teaching purpose of the games was proposed to both make the learner more focused on particular activities and enable the teacher to assess process as well as outcomes.

(iii) Most usefully, the potential of including multi-user game-play was highlighted as a critical limitation for collaborative and team-based construction or design activities.
(iv) The importance for students to save and continue and to learn through trial and error within a game environment was also noted.

(v) The pilot SeLAR system was generally considered to be well designed and effective.

(vi) Modifications to SeLAR were primarily cosmetic, but the need for some form of communication facility with and between registered users and for improved classification/groupings of resources were specified.

The summative evaluation was undertaken in early 2016 by Jenifer Harvey, Principal Researcher, Heavyweight: Design and Education Specialists, Australia. The scope of the evaluation was to review consistency between the intended objectives and the outcomes of the project. Focus was on the SeLAR repository, examples of the OnSite Moodle lessons and feedback and assessment metrics material. As a summative evaluation the findings have not impacted the development of the project, but provide for a number of relevant project recommendations.

In addition to the two external evaluations, and in keeping with the approach to evaluation outlined in Section 2.2 of this report, a range of metrics has been reported. Specific to learning and teaching evaluation is an analysis of key student grades and a questionnaire response. The student grades are simply before and after comparisons for aggregated (average) student performance in Construction I (Adelaide) and Domestic Construction Technology (UNSW).

Construction I:

before (2013) = 57.1, after (2015) = 61.6, improvement = 7.9 per cent

Domestic Construction:

before (2013) = 63.5, after (2014) = 64.2, improvement = 1.1 per cent

Whilst both averages increase, and there is some notable improvement in one set of results (expressed as a percentage of the before score), neither demonstrates: long-term trends, strong statistical confidence, or isolates the effect to the project intervention.

The questionnaire responses were specific to the use of SeLAR and a situation model at The University of Adelaide in 2015. A total of 61 respondents represent a sample size of 58 percent. Three questions were posed with a 7-point Likert scale from negative (1) to positive (7):

(i) Did the online resource SeLAR prove useful for your learning needs?

The average response was 5.56, minimum 4 and maximum 7. This indicates a strong positive response to the question.
Would you consider using the online resource SeLAR in the future?
The average response was 5.67, minimum 3 and maximum 7. This also indicates a strong positive response to the question, but with a slightly greater spread of results.

Did you find the online game provided to be engaging and useful?
The average response was 4.93, minimum 1 and maximum 7. This result is generally positive, but clearly opinions are split.

Impact
The formative evaluation provided important and timely feedback on the technical implementation of SeLAR and The Situation Engine. Given the nature of an agile development methodology, extensive user feedback is already factored into each development cycle. The external formative review helped confirm and highlight key elements of that more generalised user feedback.

The summative evaluation contains a number of pertinent recommendations.

Key Findings
The summative evaluation recommendations are:

(i) The SeLAR repository be maintained and developed to include more resources from both current and future partner institutions.

(ii) The SeLAR repository be expanded to include search and recommendation functions that demonstrate the interrelatedness of the content.

(iii) That typical or recommended Learning Plans or Modules be created that demonstrate options of how to use the material most effectively.

(iv) That the full outcome of the academic research reporting of the process be submitted for peer review journal and conference dissemination.

(v) That further surveys of effectiveness and engagement of the student and academic user experience of the assets be undertaken.

(vi) That a strategy for developing more complex forms of immersive situation models be created.

(vii) That the research team capitalise on capabilities developed within this project to further develop and promote the research outcomes of the current project, and to develop further research projects that extend the potential for authentic immersive learning within the tertiary sector.
3.7 OnSite

In keeping with the proposed structure for Situational eLearning outlined in Section 3.5, the ideal specification of key practice-ready skills in architecture and construction management will take the form of a learning framework mapped to adaptive learning resources based around realistic situations and experiences. In the context of this project, the adaptive learning resources are primarily those relating to the various situation models available through SeLAR. These resources have been described in previous sections. What remains to be described is the learning framework that binds the resources to specific learning outcomes.

Once again the development approach was based on an agile methodology driven by crowdsourcing. The technology of choice is Moodle, as this is a well-established and popular learning management system. It provides for rapid development and trialling of a teaching program. Moodle courses can also readily be exported between different host universities operating Moodle or Blackboard systems.

The OnSite system comprises a Moodle course/site that contains a staged teaching framework for construction technology, where each stage is linked to a particular situation model and an associated set of assessment tasks. The initial learning outcomes and content for OnSite were derived from a desk-top survey of the first-year undergraduate construction technology courses offered by the partner institutions (Adelaide, UNSW, UniSA, and WSU). This review revealed a strong concurrence in both the content and staged delivery of course material.

Based on the curriculum review, five situation models were developed specific to key stages of the construction process and the teaching program: the site set-out and excavation of trenching; main foundation details and preparation for the concrete slab to be poured; timber wall framing particular to a ground floor/single storey construction; timber wall framing particular to an upper floor/double storey construction; timber framing for the roof. A common building model/design was used for all key stages, based on the existing models and drawings provided by one of the partner organisations.

For each stage of the teaching program (module), the Moodle learning platform was sequenced to provide the following resources:

(i) A general introduction to the module describing the aims, learning tasks and outcomes.

(ii) Instructions on the number and type of activities included in the module (typically two) and nature and size of the assessment task (typically comprising 10 multiple choice questions)

(iii) The first activity generally comprises a video, available for viewing through Youtube, of the instructor within the relevant situation model. The instructor comments on the
key features of the particular situation, the stage of construction and what aspects relate most directly to the learning outcomes.

(iv) The second activity then requires students to follow instructions on locating, downloading, installing and using the relevant situation model. All resources are available through SeLAR.

(v) Having experienced the situation model and noted relevant issues, students are then able to attempt the relevant multiple choice assessment task. At the completion of each attempt, students receive feedback on the results of their quiz and are able to then repeat the quiz multiple times to improve their grading. The capacity to repeat each quiz was intended to promote engagement with the material and enhance learning outcomes.

Successful completion of all five assessment quizzes is included as a 25 percent component for the overall grade for the course. A minimum score of 65 percent for each quiz is required before progress to the next module/situation model is possible.

OnSite has been trialled as a Moodle site and is currently being ported to run on Blackboard at another institution. A download of the site will be made available on SeLAR. The further adoption and adaptation of the existing Moodle site will provide a dynamic benchmark for learning and teaching outcomes specific to construction technology as a key practice-ready skill.

**Impact**

Uptake of the digital material and successful completion of the quizzes was achieved by 97 percent of the enrolment.

More than 16 percent of initial assessment attempts resulted in a failed grade.

The average time spent on any assessment task was 15 minutes and 12 seconds.

Students on average made at least two attempts at each assessment task.

The improvement was not random, as would be expected if students were merely guessing, but clearly developed as each new learning opportunity built on the previous.

**Key Findings**

(i) Students typically made multiple attempts to improve their overall grade, a successful aim of the pedagogical design.

(ii) The opportunity to make multiple attempts allowed a significant proportion of students to pass who would otherwise have failed. All students who made multiple attempts were able to improve their grade.
References


Appendix A

Certification by Deputy Vice-Chancellor (or equivalent)

I certify that all parts of the final report for this OLT grant provide an accurate representation of the implementation, impact and findings of the project, and that the report is of publishable quality.

Name: Professor Merlin Crossley

Date: 01-04-2016

Deputy Vice-Chancellor Education

University of New South Wales
Appendix B

External evaluator report
‘Situational eLearning: a crowdsourcing approach to the definition and assessment of key practice-ready academic outcomes’

Office for Learning and Teaching Innovation and Development Grant, 2013.

Evaluator: Jennifer Harvey

Dated: March 2016
Contents

1. Introduction
2. Scope of Document
3. Out of Scope
4. Affiliations

Section 1: Project Overview

1. Objectives and Outcomes
2. Pedagogical Framework
   (i) SeLAR and OnSite
   (ii) Smart Sparrow, Moodle, Blackboard

Section 2: Evaluation Questions

1. What processes were planned and what were actually put in place for the project?
2. Were there any variations from the processes that were initially proposed, and if so, why?
3. How might the project be improved?
4. To what extent have the intended outcomes been achieved?
5. What factors helped and hindered in the achievement of the outcomes?
6. What measures, if any, have been put in place to promote sustainability of the project’s focus and outcomes?
7. What lessons have been learned from this project and how might these be of assistance to other institutions?

Section 3: Recommendations
Introduction

This report will evaluate the 2013 OLT Innovation and Development Grant ‘Situational eLearning: a crowdsourcing approach to the definition and assessment of key practice-ready academic outcomes’ (ID13-3018) led by The University of New South Wales and including partner institutions The University of Adelaide, University of South Australia and Western Sydney University. It will evaluate the process and outcomes of the project against its stated objectives, giving consideration to the OLT recommendations on best practise for the evaluation of projects (ALTC, 2011).

The project abstract, published on the OLT website, summarises the aims as follows:

Australia must do more to develop graduates with the practice-ready skills they need to play an effective role in the workplace. Situated learning lends itself to the development of key practice-ready skills, but it is contingent on the availability of authentic clinical experiences. The potential for replacing direct student engagement in practice with a computer-simulated clinical experience is apparent. This project will utilise a unique combination of The Situation Engine (used to define specific circumstances that stakeholders can agree upon to represent/simulate key clinical experiences) and Smart Sparrow (used to measure and assess user activity and their interactions with the situation as it is presented to them). Stakeholders will negotiate improvements to the situation specification and measurement framework on the basis of the empirical evidence and analytics generated by the system. The aim is for key practice-ready academic outcomes to be specified by way of actual circumstances and the essential responses such circumstances dictate. (http://www.olt.gov.au/project-situational-elearning-crowdsourcing-approach-definition-and-assessment-key-practice-ready-ac, accessed 19/3/2016)

While this abstract summarises the key strategic intentions of the project at the time of commencement, developments consistent with the adaptation and management of the project have occasioned some variations from this aim. The evaluation report will address the overall success of the project with reference to both the original aims and the final outcomes.

Scope

The evaluation report will look at the consistency between the intended objectives and outcomes of the project as outlined in the original proposal with the outcomes completed by the Research team overall and the individual sub-projects undertaken by the partner institutions. It will review the content of the SeLAR repository, examples of the OnSite Moodle lessons and feedback and assessment metric material made available to the evaluator.

Out of Scope

The evaluation will not consider the individual effectiveness of the project outcomes at individual institution level. The effectiveness of the project as a whole and its ability to leverage impact across the
design and construction education sector was a principal aspect of the project objectives. Hence, the evaluation framework will consider the cross-institutional advantages and difficulties as a priority.

Affiliations

Jennifer Harvey is an independent design and education specialist who has 20 years of experience in the tertiary education sector and in private practise in the design and construction industry.
Section 1 – Project Objectives and Outcomes

Project Objectives

The objectives of the project, as summarised in the original proposal are as follows:

The objectives of this project are to:

(i) Build an open repository of authentic situation models specific to the development and demonstration of practical skills. [see Project Outcome (i)]
(ii) Establish and grow a community of academic, industry and student stakeholders technically versed in the Situational eLearning approach. [see Project Outcomes (ii) and (iii)]
(iii) Evaluate the scalability of a Situational eLearning approach to the provision of effective clinical experiences. [see Project Outcomes (iv) and (v)]
(iv) Produce a harmonious context definition and assessment framework for key practice-ready academic outcomes that is coherent and explicit. [see Project Outcome (vi)]

Project Outcomes

The project outcomes, again summarised in the original proposal document are as follows:

In line with the project objectives, the project deliverables will include:

(i) An open repository of teaching and learning resources for architecture, building and construction in the built environment. This will include at least 10 distinct simulations (situation models), associated user guides, technical guides, tutorials and related resources. The repository will comprise a dedicated project Website, Dropbox and Wiki. All resources will be provided under a Creative Commons Attribution 3.0 Australia licence.
(ii) A national community of built environment educators, industry practitioners and students with specific interest in jointly developing and sharing teaching and learning resources. This community of practice will specifically be trained and supported to develop, modify and deploy Situational eLearning resources to help ensure the sustainability of the project.
(iii) A series of national workshops and published case studies on the development and use of Situational eLearning to disseminate and promote the findings of the project. This will build credibility and familiarity and nurture ongoing community ownership and engagement. It will particularly
involves professional accreditation bodies as a key stakeholder in the development of academic learning outcomes.

(iv) A sequence of trial deployments of the Situational eLearning platform, to build progressively in scale from a user cohort of at least 300 students across at least 2 institutions in year one, to as many users and institutions as possible in year two.

(v) An evaluation of educator, industry and student experiences of the Situational eLearning platform specific to the quality and utility of the clinical experiences it provides. Of particular interest will be the perceived authenticity (presence) of the situation. The range of perceptions will be compared directly to the academic performance of the students.

(vi) A specification of the key practice-ready skills for architecture and building. Initial practice-ready skills will be derived from the LTAS Statements for Architecture, Building and Construction. Crowdsourcing will be used to further refine those statements and translate them into situation models and assessment frameworks. Professional accreditation bodies are critical to engagement with industry and the promotion of national learning standards.

Pedagogical Framework

The pedagogical framework employed by the project worked in two registers, one specific to the SeLAR website repository and the other to the OnSite situation engine model. The two environments can be seen to be supportive of the overall intention to provide a multivalent approach to the understanding of the course material for the different institutions. The core knowledge base for introductory domestic construction knowledge is relatively consistent across the partner institutions, and most tertiary level providers of construction management programs.

A third mode of delivery incorporated the overall Situational eLearning approach but was specific to the University of Adelaide. Material for assessment and evaluation of this third mode was not available to the reviewer at the time of writing.

The two principal modalities of learning can be summarised in the following ways:

SeLAR Pedagogical Framework

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Characteristic</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provides a comprehensive Open resource/repository of relevant visual (drawing), video, game-based and photographic examples that are relevant to becoming familiar with the</td>
<td>The SeLAR site provides an open source of material that is searchable via keywords. Material is provided on a user interest basis, without an overt pedagogical structure. In practice student downloads were made of</td>
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</table>
Situational eLearning

<table>
<thead>
<tr>
<th>OnSite Pedagogical Framework</th>
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<tbody>
<tr>
<td><strong>Objectives</strong></td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
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Situational eLearning

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<tr>
<td>4</td>
<td>Encourage synchronicity between context dependent material and assessment rubrics.</td>
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<tr>
<td></td>
<td>OnSite is constructed to provide a clear relationship between resource material, learning outcomes and assessment.</td>
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</tbody>
</table>

**Summary**

The overall pedagogical framework for the project assumes that there are consistencies in the development and use of teaching assets that reinforce the core curricula for construction courses in architecture and building courses across Australia. In doing so, it has positioned the research to be a viable emendation to existing teaching methodologies at the partner institutions and, by extension, similar courses and programs across Australia that are subject to the same requirements for knowledge of Australian Standards in domestic construction. This appears to be a reasonable aim, and one that has been successful to date. The proposal to create material that enables students to be practise ready has been governed by the need for engaged forms of education that reflect core objectives of the Learning and Teaching Academic Standards Statement (Building and Construction) (2011). It is noted that the Project Leader, Associate Professor Sid Newton was the nominated Discipline Scholar for this review. 

(http://environmentltas.gradschool.edu.au/uploads/content/drafts/ES_LTAS_Statement_Final.pdf)

**Moodle, Blackboard and Smart Sparrow**

As learning environments Moodle and Blackboard share similar functionalities in terms of the management of educational assets and the design of educational experiences for students. While the two platforms are not identical, it is possible to employ lesson design characteristics that ensure the progress of students are effectively tracked through the curriculum content. In addition, both platforms allow for metrics of engagement and assessment to be viewed and adapted to student progress.

Smart Sparrow, alternatively, also allows for the management of curriculum material and lesson design, however it has additional functionality within the lesson architecture which allows for bespoke adaptability to student progress, and enhanced visualisation of data behaviour. Smart Sparrow is currently a commercial product that has a limited presence in the Australian Tertiary sector in comparison with Moodle and Blackboard.

In terms of the project evaluation, the original intention to employ Smart Sparrow across the partner institutions was a logical effort to incorporate best-practise analytics for the
project. The difficulties in incorporating the software into existing institution learning platforms made the ongoing use of the application unviable.

For this reason, the project evaluation has concentrated upon the objectives that outline the general pedagogical intent and its effectiveness in being delivered to the various student cohorts across the partner institutions.
Section 2: Evaluation Questions

The evaluation questions have been adopted and adapted from the OLT/ALTC guide to Project Evaluation (http://www.olt.gov.au/system/files/Project_Evaluation_Resource.pdf). These questions enable the evaluator to discuss the project in terms comparable with other OLT projects, past and present, and for reasons of consistency and comprehensiveness, have been adopted. Two proposed questions regarding short and unintended outcomes have been deleted as they did not, in the opinion of the evaluator, add additional insight into the overall effectiveness and performance of the project.

1. What processes were planned and what were actually put in place for the project?

The processes outlined and described by the research partners to the evaluator were the following:

(i) Research partners established a standard domestic construction model that reflected the curricula from the partner institutions covering both building construction and architecture programmes.

(ii) A digital model of the standard house project, reflecting basic construction principles, was created.

(iii) Secondary support material including drawings, photographs, 3D digital models and 3D virtual environments were accumulated.

(iv) A digital repository including search functions, keyword recognition, extensive descriptors and download/use metrics was established.

(v) The SeLAR repository was established as the core location for all assets produced by the project.

(vi) A decision was made to focus on the employment of Moodle and Blackboard learning environments instead of Smart Sparrow, as originally planned. A Moodle Lesson plan centred around the OnSite material was created, tied to the SeLAR repository.

(vii) Partner institutions employed the SeLAR repository and the OnSite Moodle lesson module in teaching.

(viii) Metrics of use and engagement were created for analysis and reflection.
The processes generally have followed a logical sequence in terms of the accumulation of teaching material and the establishment of core teaching strategies across the partner institutions. Generally the argument that the material is relevant across the different courses and programmes has been well made, providing there remains room in these courses for individuation of course content.

While the establishment of the SeLAR repository was an important step in gathering these assets, there probably needs to be longer term development and tracking of user behaviour in determining the outcomes and effectiveness of the material. This would come from surveys of student use at partner institutions.

2. Were there any variations from the processes that were initially proposed, and if so, why?

Comments:

The principle change in the methodology outlined in the original project proposal was the departure from the employment of the Smart Sparrow analysis software. While Smart Sparrow is an effective tool for metrics it requires the individual purchase and employment of the software for each institution, possibly a bar to the use of the project material overall. The research team believed that the ubiquitousness of Moodle and Blackboard across the tertiary sector made the research outputs more effective for a greater number of current and potential users.

It is the opinion of the evaluator that this was a sensible and effective decision, that enhanced the potential impact of the project and its potential user base.

3. How might the project be improved?

Comments Generally:

Development of more structured pedagogical models from the SeLAR assets, possibly in the form of suggested or recommended teaching and learning plans would aid in the effectiveness of the repository. While this may go against the principle of open source material that may be freely used, some direction in optimal use of the material for new users would increase its effectiveness.

The OnSite material, while also effective in its employment in Moodle lesson modules, is essentially a single user experience. Researchers reported that students employed the
Situational eLearning 56

material cooperatively in practise, but this was an unintended form of social constructivist learning, rather than an explicit intention of the process. Further attention to how the material may be incorporated into more explicitly designed learning frameworks that presume group work, Jigsaw learning and social constructivist principles of learning would enhance its effectiveness.

More specific responses to possible improvements are listed in the table in the next section.

4. To what extent have the intended outcomes been achieved?

The observable outcomes can be measured against the intended outcomes listed above in Section 1:

<table>
<thead>
<tr>
<th>Intended Outcome</th>
<th>Comment</th>
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<tbody>
<tr>
<td>An open repository of teaching and learning resources for architecture, building and construction in the built environment. This will include at least 10 distinct simulations (situation models), associated user guides, technical guides, tutorials and related resources. The repository will comprise a dedicated project Website, Dropbox and Wiki. All resources will be provided under a Creative Commons Attribution 3.0 Australia licence.</td>
<td>The establishment of the SeLAR repository satisfies the first outcome listed. It is noted that the research team were able to create 5 distinct situation models which were employed in the OnSite learning environments, including the Moodle lesson plan. The SeLAR website performs the function of both information portal and data storage (satisfying the Dropbox capability). A Wiki has not been established, but may not be necessary for the employment of the material in the first instance. Future developments could include this function.</td>
</tr>
<tr>
<td>A national community of built environment educators, industry practitioners and students with specific interest in jointly developing and sharing teaching and learning resources. This community of practice will specifically be trained and supported to develop, modify and deploy Situational eLearning resources to help ensure the sustainability of the project.</td>
<td>The partner institutions have, through the project, established this outcome. Further popularisation of the resource should lead to greater uptake of the material.</td>
</tr>
<tr>
<td>A series of national workshops and published case studies on the development and use of Situational eLearning to disseminate and promote the findings of the project. This will build credibility and familiarity and nurture ongoing community ownership and</td>
<td>Associate Professor Sid Newton has led a series of workshops on the material across all mainland states of Australia. These workshops have satisfied the intended outcome appropriately. Further monitoring by the lead CI and the research team will be necessary to</td>
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</table>
Situational eLearning engagement. It will particularly involve professional accreditation bodies as a key stakeholder in the development of academic learning outcomes. encourage incorporation of the material into individual institutions.

<table>
<thead>
<tr>
<th>A sequence of trial deployments of the Situational eLearning platform, to build progressively in scale from a user cohort of at least 300 students across at least 2 institutions in year one, to as many users and institutions as possible in year two.</th>
<th>Initial tests of the Situation ELearning platform (OnSite) have been conducted by students at UniSA (220 students approximately) in 2015. Further testing is planned for 2016 for students from UniSA, UNSW and UWS (700-800 students approximately). Time constraints in the development, trialling and roll-out of the OnSite material have meant that the timeline of student use has not been achieved within the proposed period. However, it is noted that difficulties in incorporating and scheduling summative assessment at different institutions has affected this outcome.</th>
</tr>
</thead>
<tbody>
<tr>
<td>An evaluation of educator, industry and student experiences of the Situational eLearning platform specific to the quality and utility of the clinical experiences it provides. Of particular interest will be the perceived authenticity (presence) of the situation. The range of perceptions will be compared directly to the academic performance of the students.</td>
<td>Some effective survey information has been obtained for student engagement for the SeLAR website, but none that specifically targets the student experience of the ‘authenticity’ of the OnSite environments. Anecdotal evidence is that it was an effective and engaging tool, but comprehensive survey analysis has yet to be conducted. Analysis of the academic performance of the students indicates persistent efforts to engage with the material and undertake multiple attempts at the multiple choice quiz component of the Lesson Plans.</td>
</tr>
<tr>
<td>A specification of the key practice-ready skills for architecture and building. Initial practice-ready skills will be derived from the LTAS Statements for Architecture, Building and Construction. Crowdsourcing will be used to further refine those statements and translate them into situation models and assessment frameworks. Professional accreditation bodies are critical to engagement with industry and the promotion of national learning standards.</td>
<td>The material created as assets for the research project reflects current standards and recommended best practice behaviour for the domestic housing industry in Australia. This outcome has been achieved.</td>
</tr>
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</table>
5. What factors helped and hindered in the achievement of the outcomes?

Comments

Researchers reported that a number of hindrances affected the project in some measure, but none were of a scale that they could not be overcome through the research team’s initiatives. These factors included:

(i) Difficulties in employing Smart Sparrow analytic software at partner institutions outside of UNSW;
(ii) Some duplication of learning module structure between Moodle and Blackboard;
(iii) Delays in the scheduling of summative and formative use of OnSite material in different institutional environments. Typically, institutions require 12 months lead time to amend the detailed outline and assessment rubric of an individual course. This would require research teams to have a predetermined knowledge of the use and effectiveness of innovatory teaching materials in advance of their development.
(iv) Knowledge transfer in the development of Situation engine environments required the acquisition of skills in the development of 3D game engine software, a specialised knowledge that is beyond that of practically all academics within the architecture and construction sector. Whilst the research team achieved the aim of transferring these skills to other members, there will need to be further professional development for the ongoing creation of future OnSite environments.

6. What measures, if any, have been put in place to promote sustainability of the project’s focus and outcomes?

Comments

The SeLAR website is required to remain active and accessible for two years and the evaluator understands this commitment to be in place. In addition, there will need to be follow up on the ambition to have the material adopted by institutions outside of the research institutions.

If possible, a review of the learning and teaching outcomes of the project at the end of 2016, though beyond the scope of the timeline of the project, would encourage its ongoing use and popularisation.
7. What lessons have been learned from this project and how might these be of assistance to other institutions?

One of the principle lessons that has come from this project is the organisational challenges in creating and disseminating complex teaching resources, even within an open source model that has as few barriers to engagement as the SeLAR repository. While the general principle of allowing users unlimited access is encouraging, there still remains the need to popularise the site to potential users. Future learning and teaching projects that are based upon the acquisition and dissemination of assets will need to have in place a clear program for ensuring take-up of the material and assessing the impact of its value.

With regard to the more complex situation environments (OnSite), the future development of these standalone environments will require the maintenance of a core cohort of modellers and education specialists that understand the role of immersive, authentic digital learning environments in the learning process. In addition, there will need to be a clear understanding of the interrelationships between the digital assets and the design and metrics of learning environments such as Moodle and Blackboard. Effective use of these assets in the future will entail other institutions to be clear of their role within their own course and program structures.
Section 3 – Recommendations

The summary of recommendations below reflects the comments directed at particular aspects of the project listed above. These are:

1. The SeLAR repository be maintained and developed to include more resources from both current and future partner institutions.
2. The SeLAR repository be expanded to include search and recommendation functions that demonstrate the interrelatedness of the content.
3. That typical or recommended Learning Plans or Modules be created for the site that demonstrate options of how to use the material most effectively.
4. That the full outcome of the academic research reporting of the process be submitted for peer review journal and conference dissemination.
5. That further surveys of effectiveness and engagement of the student and academic user experience of the assets be undertaken.
6. That a strategy for developing more complex forms of immersive situation environments be created.
7. That the research team capitalise on capabilities developed within this project to further develop and promote the research outcomes of the current project, and to develop further research projects that extend the potential for authentic immersive learning within the tertiary sector.
Appendix C

Published article abstracts


ABSTRACT: The prospect of being able to place an individual within an entirely interactive, simulated environment has long been held, but only recently is it being realised. Flight simulators were the first to provide a hyper-immersive experience using a combination of very detailed and accurate models of aircraft systems, high-resolution visualization and motion platforms. More recently, advanced video game technologies have been coupled with augmented reality systems and sophisticated tracking technologies to provide hyper-immersive experiences of battlefield conditions, crime scenes, operating theatres, industrial processes, etc. A key problem for developers of any hyper-immersive environment is the significant overhead costs of modeling, programming, display technologies and motion simulation. The Situation Engine is an application platform that provides for specific and managed building and construction experience to be made available using low-cost, advanced digital technologies. The same engine can drive a multitude of learning situations. Multiple users collectively occupy the same simulated workplace but experience that situation individually by individual movement through the space. Head tracking, gesture recognition, voice communication, 3D head-mounted displays, location-based sound and embedded learning resources have all been incorporated into the Situation Engine at minimal cost. The total enabling technology cost per participant is currently around $600 Australian. This paper will focus on the hyper-immersive nature of the Situation Engine. In particular, the distinction between immersion (as a quantitative measure of sensory fidelity) and presence (as a qualitative perception of ‘being there’) will be articulated and clarified. The paper also highlights one of the various ways in which hyper-immersion is manifested in the Situation Engine: gestural control. Gestural control has been implemented using a Microsoft Kinect™ and proprietary gesture detection algorithms to monitor a range of gestures in parallel, including gestures that are context dependent.

KEYWORDS: Simulation, Hyper-Immersion, Cost, Situation Engine, Gestural Control.


ABSTRACT: Human experience of public space is changing as virtual space blends with real space and technology provides increasingly hyper-immersive virtual environments. This paper reports particularly on the integration of gestural controls as an important development of The Situation Engine immersive experience. Presence is the experiential counterpart of immersion. The paper argues that traditional conceptions of presence are inadequate to describe the experiences that blended spaces offer.

KEYWORDS: Hyper-immersive virtual environments, Presence.
ABSTRACT: Immersive digital technologies simulate key aspects of the physical world to provide visual, aural, haptic and other cues to the user that create a keen sense of presence or being in the simulated situation. There is broad potential application for such immersive technologies in construction, including the delivery of managed first-person experiences of construction activities where access to actual situations may be problematic or risky. The Situation Engine is an application that makes specific and adaptive practical experience available to users in a hyper-immersive digital rendition of a real-world context. This paper will describe a particular application of the Situation Engine to teaching undergraduate architecture and building students about domestic construction technology in Australia. The paper also reports on a student survey evaluating a trial of situational e-learning with 150 undergraduate students, gauging their views on of their learning experiences with the Situation Engine. There was strongest agreement that this video game technology is useful to a specific understanding of design and/or construction practice, with some reservations over the approach as a replacement for actual work experience.

KEYWORDS: Virtual reality, Simulation, Situation engine, Education.

ABSTRACT: There is a long-held sense in general that the increasing use of computers and digital technology changes how a user experiences and learns about the world, not always for the better. This paper reports on a longitudinal study of 245 architecture and construction students over a two year period which examines the impact that virtual reality technologies have on the learning style preferences of students. A series of controlled experiments tests for the impact that increasing exposure to a proprietary virtual reality system has on the mode of learning and learning style preferences of individuals and particular cohorts. The results confirm that when virtual reality applications are used in teaching and learning, the learning behaviours will favour a more concrete experiential mode of learning and a preference for the Accommodator learning style. However, the results also demonstrate, consistently and for the first time, individual students do not privilege any particular mode of learning or learning style preference to any significant extent but rather engage in all modes and represent all learning styles. Novel visualisation techniques are introduced to examine and discuss this contrast.

KEYWORDS: Virtual reality, Experiential learning model, Learning style inventory

ABSTRACT: The construction industry must do more to develop graduates with the practice-ready skills they need to play an effective role in the workplace. Situated learning lends itself to the development of key competencies, but it is contingent on the availability of authentic clinical experiences. Emerging digital technologies will help realize the potential for supplementing or replacing direct student engagement in practice with a simulated clinical experience. Situational eLearning is proposed as a generic and entirely scalable vehicle for a broad range of stakeholders (including academics, practitioners, industry bodies and students) to collaborate in developing authentic clinical experiences. A range of learning resources specific to bespoke situation contexts can be created and deployed using emerging digital technologies. Access to the

Situational eLearning
resources is monitored and student performance is measured and analysed. The adaptive resources are freely available on a crowdsourcing basis. This paper reports on the progress of a two-year collaborative project to develop and trial the Situational eLearning approach in construction and architecture undergraduate programs at four universities in Australia.

KEYWORDS: Practice-ready skills, Clinical experience, The situation engine, Learning analytics.


ABSTRACT: The ability to read technical drawings and to accurately translate scaled representations of buildings into full-sized artefacts is a core skill for the construction manager. It is primarily the designer’s role to document the building, but construction managers also need good visualization skills if they are to make useful contributions to a project team. The use of virtual models combined with guided practice through the documentation of a small residential building project has been used at a university in Sydney to help students develop familiarity with drawing conventions and standard scales. Such awareness can be the source of innovative building solutions that are grounded in a practical understanding of the relative constructability of building designs. The frequency of use of the visualization tools within an e-learning site was mapped in a first year, first semester subject with 267 students. There appears to be an optimum amount of time that most students need to commit if they are to acquire the necessary skills to be active participators in design development negotiations. It is evident that visual literacy is a distinct cognitive skill which requires construction educators to introduce active strategies if students are to successfully achieve this important graduate attribute.

KEYWORDS: Construction drawing, building design, scale, visualization.


ABSTRACT: Human experience of public space is changing as virtual space blends with real space and technology provides increasingly hyper-immersive virtual environments. The purpose of this study is to reformulate the framework within which our virtual experience of location and self might usefully be considered, and this is articulated in terms of presence. We review the distinction between immersion and presence, illustrate various facets of immersion using a current virtual reality system specific to architecture and construction, and consider the key features of prominent presence theories. The results of an empirical study to evaluate the utility of a widely adopted survey instrument (the Slater-Usoh-Steed presence questionnaire) are presented and discussed. Incongruously, results indicate that users reporting their experience of virtual reality score that experience higher in presence terms than users experiencing the physical world. New perspectives drawn from emerging brain theory are required.

KEYWORDS: Virtual reality, Hyper-immersive, Presence.