

Project Summary for IAL Website

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Project Title:	Evaluating the effectiveness of digital game-based learning (DGBL) for professional upskilling: bringing construction safety knowledge into architects' and engineers' workplace
Project Number:	GA19-05
Year of Approval:	2020
Funding Source:	WDARF
Objectives and intended outcomes of the project:	<p>The objectives of this project are:</p> <ul style="list-style-type: none">• Develop a digital game prototype of a construction safety digital game-based learning (DGBL) to teach Design for Safety (DfS)• Develop a DGBL protocol for professional upskilling• Develop a toolkit to assess the effectiveness of DGBL programs on construction safety education for design consultants. <p>The intended outcomes expected from this research are:</p> <ul style="list-style-type: none">• A prototype of a design-for-safety DGBL software for construction professionals• A pedagogy or protocol for developing work-integrated DGBL programs for professional upskilling• A toolkit for assessing the effectiveness of DGBL programs for professional upskilling
Project Team	
Principal Investigator:	Dr. Goh Yang Miang, NUS
Summary of Project (up to 300 words)	
<p>There is a lack of studies to examine the effectiveness of Digital game-based learning (DGBL) on adult learners in the context of professional upskilling. To address this gap, we created SafeSim Design (SSD), a single-player digital game to educate construction professionals on the difference between design risks and occupational hazards, conduct risk evaluation, and design out issues through various design-related controls. The content in SSD is a collective effort from the authors and industry professionals. Through developing SSD, we can examine the effectiveness of DGBL for professional upskilling and create an avenue for participants to learn about different design risks and the possible mitigations for these risks.</p>	
<p>The project follows these research questions:</p> <ol style="list-style-type: none">1. How to design and develop an effective DGBL for professional upskilling?2. How to measure the effectiveness of DGBL among working professionals in Singapore context?3. What barriers do professional service firms face to adopt DGBL for staff upskilling in Singapore? What support is needed?4. What barriers hinder professionals from participating in workplace DGBL programs? What support is needed?	

The project hypothesises a three-factor model to capture the underlying structure of an authentic learning environment (ALE) to guide and assess the design of a DGBL. The three dimensions are task authenticity, knowledge co-construction and expert modelling. The model will be validated through the test of two hypotheses:

H1: Authentic learning environment (ALE) is constructed in three dimensions, i.e., task authenticity, knowledge co-construction and expert modelling.

H2: In a DGBL context, the three dimensions of ALE predict cultural change (in the empirical context of this study, change of safety culture) and innovation (in this case, design innovation that addresses construction safety issues).

276 words

Summary of Project Findings, Deliverables and Impacts (up to 500 words)

This two-year study (GA19-05) investigated the effectiveness of digital game-based learning (DGBL) for professional upskilling in construction safety education. The team developed SafeSim Design (SSD), a 3D construction site simulation game that teaches Design for Safety (DfS) principles to construction professionals. The study employed a quasi-experimental design comparing DGBL against traditional video lectures, involving 246 construction industry professionals, including architects, engineers, project managers, and safety personnel.

Key research findings

The study revealed that DGBL was effective for experienced professionals when compared with video-based learning. Participants with prior DfS experience, longer working experience, and those who identified as non-designers showed significantly better learning outcomes when using the DGBL approach compared to video lectures. The research found that 74.2% of participants preferred DGBL over traditional video-based learning, exceeding the 50% threshold for indifference.

Several game features proved essential for effectiveness. The authentic 3D simulation of construction sites provided realistic learning environments, particularly benefiting desk-bound professionals like architects who rarely visit actual construction sites. A guiding character (e.g., Mr Chief Designer, who acts like a virtual “teacher” in the game) provided crucial scaffolding support, helping participants understand complex concepts through conversational explanations. The inclusion of authentic in-game activities that mirrored real-world workplace tasks enhanced learning relevance and application. Interestingly, competitive elements such as leaderboards proved less motivating for professional learners compared to traditional student populations.

Deliverables and outputs

The project produced several key deliverables that advance both theoretical understanding and practical implementation of DGBL. SSD represents the core technological output, featuring four different construction scenarios with identification and mitigation phases that simulate realistic DfS reviews. The research team also developed a comprehensive DGBL Toolkit, providing structured guidance for educators and game developers that covers learner profiling, course design, game development, and collaborative implementation processes.

The project generated significant academic output including two peer-reviewed journal articles published in Computers & Education (IF: 10.5) and Safety Science (IF: 5.4), alongside conference presentations at major international venues. A detailed evaluation framework specifically tailored for professional DGBL

contexts was also established, incorporating six quantitative measures and qualitative assessment methods that better capture professional learning outcomes than traditional academic metrics.

Impact and recognition

The research has achieved substantial industry recognition and practical adoption. Government bodies have expressed formal interest in implementing DGBL for their training programmes. Apple Inc. commissioned the research team to deliver the course for their personnel, demonstrating international corporate interest. The project received prestigious awards including the QS Reimagine Education Award 2022 (Asia - Bronze) and the NUS Annual Digital Education Award 2023.

The study provides evidence that interactive DGBL elements sustain professional engagement more effectively than conventional approaches. The research team has extended the research findings to project management training and developed machine learning approaches to analyse self-regulated learning patterns, establishing DGBL as a viable solution for professional upskilling across multiple domains.