Construction Hazard Identification Laboratory: A game for experimental learning about construction OH&S
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1 Executive summary

Safety in the construction industry is important because people continue to be injured on construction sites. To address this, the Australian construction industry and its regulator, the Office of the Australian Building and Construction Commissioner, have required that anyone who intends to work on a construction site must complete an Occupational Health and Safety (OH&S) construction induction (CI) training course.

A key challenge for OH&S training is to engage learners. One quite complex section of the construction induction training deals with the identification of hazards and the management of hazards through OH&S controls. To engage learners with the OH&S content and to support deep learning, this project developed an electronic game in consultation with experts in games, OH&S and construction. The game was used as a classroom activity for the construction induction (CI) training course. The game was designed to provide students with a safe but also engaging environment in which students could actively identify the most common hazards encountered on construction sites, and experiment by applying different OH&S controls without experiencing physical repercussions themselves. The game was developed for the iPad which provided an intuitive and accessible touch interface but also a mobile platform that can be handed out to students in a classroom setting.

To measure the impact of the game on the construction induction students, the project team used questionnaires, an on-line test and personal interviews to assess the students’ engagement, learning, retention and the transferability of the lessons learned in the game to real world situations.

To determine if the learning from the game was transferable to the real world, CI students were presented with photographs of real construction sites. Students were asked to identify the presence of any of a standard set of hazards. Preliminary results indicate that CI students who played the game were likely to detect more of the right hazards than those who attended the CI course alone. Further testing is being completed on larger groups of students to ensure verify preliminary results.

Interviewing the 37 students who played the game revealed an very positive response towards the game. Despite the voluntary nature of the experiment, all of the students played the game through to its end, and the students indicated that they were curious about which hazards they would encounter next. The students reported that the game managed to engage them in the subject matter. The vast majority of the students reported that they were completely focussed on the task and that the game increased their motivation to engage with the OH&S content. Even students who don’t usually play games reported that this was a fun activity and the majority of students reported that they see a lot of potential for the use of games as a teaching tool. Many students stated that they were exposed to situations in the game, which they did not know how to deal with before; But after playing the game, they felt they had learned how to deal with such situations in the future. Importantly, some students indicated that they had learned an important OH&S management concept, i.e. removing a hazard is better than wearing protective equipment.

Because the game can be distributed through the Apple App Store, this worldwide distribution network also makes the game accessible to students on their own iPad outside of class hours. The game is available for download through the Apple App store for iPad. The project has been showcased on numerous occasions and received very positive feedback and even a best paper award at the CIB W 099 International Conference on “Modelling and Building Health and Safety”.

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2 Project outcomes and impacts

The LTIF project achieved the following three outcomes:

- The development of a serious game addressing safety hazards in construction with potential for further commercial development.
- A better understanding of the value of games in learning and retention of specific information about OH&S in construction
- Information and experience concerning efficient and effective game development, with the aim of developing processes which make games accessible to wider education application

As the game was made available to the public via Apple’s App Store and the generated knowledge was disseminated via publications in conference proceedings, we believe this project to have an impact on safety awareness and understanding of the value of serious games in the OH&S domain.

2.1 The development of a serious game addressing safety hazards in construction with potential for further commercial development.

The game development required the development of a design document. The design document brought together the complex relationship of hazards on a construction site, the various stages of construction of a building and combined this with a game play mechanic that supported a constructivist approach to learning. One significant outcome of the game development phase was the production of a matrix that cross referenced 45 of the statistically most common hazards on Australian construction sites with 28 Occupational Health and Safety controls and resulted in 1260 data points.

The actual game was finalised as planned for testing on a PC in September 2012 and then further optimised for a release for the iPad via the Apple App store and released in November 2012. The actual game development was supported by feedback from industry professionals such as Tom Killen (Voxel Agents) and Conor O’Kane, who provided the development team with valuable insights on how to improve the playability of the game. The game was revealed at the Games for Change ANZ conference at RMIT in November 2012 and showcased to industry in the Games Arcade of the conference. It was also featured during this time on the RMIT website. The game was released on the Apple App store in early December 2012. Within the relatively short timeframe of just 3 months, the game has been downloaded over 500 times worldwide.

2.2 Information about the value of games in learning and retention of specific information about OH&S in construction

Preliminary testing of the game was done with 59 students completing a construction induction (CI) course. To determine the value of games in learning and retention within the OH&S context, we developed a questionnaire that showed participants photos of hazards taken from real construction sites.

Before and after the CI, the course participants were asked to identify the hazards in photos using a list of hazards derived from the content of the construction induction competency unit (see CPCCOHS1001A). We compared the results of students who played the game (two different CI courses) with the results of students who did not play the game. The student test subjects were selected from three different CI courses but taught by the same instructor. In addition, students in the construction-unrelated program Bachelor of Design (Games) were given the photo test to determine the usability of the test. To determine ‘the right’ answers to the question of hazards
present in the photos, the photo test was given to 10 OHS professionals working in the construction industry (the Experts). All responses were scored for Total Number of Hazards detected, and for % Right, using the Experts’ data as the denominator.

Findings:
On average, students from the Games program scored higher in the test than the students at the start of the construction induction course. (Possible interpretation: Games students might be better at noticing things in photos, or HE students might start from a higher level of hazard recognition than TAFE students).

The groups who played the game noticed more hazards and got more right than the group who did not play the game. However there was considerable variability among the groups (one CI group who played the game had consistently higher baseline scores than the other CI course and the control). As a result, the results were not statistically significant.

Students who played the game, in addition to participating in the photo test, were given an engagement survey. Uniformly, students played the game until its end, and commented favourably on the dynamics and enjoyment of the game.

Combined, the game play and surveys took almost an hour to complete. Although we provided sandwiches for the games players during the lunch time, one group in particular seemed to suffer from survey fatigue. Their results were more variable and they often detected fewer hazards compared to their baseline at the start of the course.

As a result of the preliminary testing, we are going to find other groups of CI students to test. We have made the photo test shorter, choosing the photos that best differentiated students from experts and have shortened the engagement survey. We anticipate testing the students early in Semester 1 2013.

2.3 Information and experience concerning efficient and effective game development, with the aim of developing processes which make games accessible to wider education application

The project team learned a great deal about the design, development and the successful implementation of electronic games to engage students in OHS learning activities. Through the development of a game design document, the team was able to bring together the information from OHS, Construction and L&T, from which the game could be designed and subsequently developed. The approach to use a spread sheet to bring together OHS hazards and OHS controls resulted in a clear representation of causal relationships used by the game development team and became one of the most central documents for communication between the project leaders and the development team.

Having Construction Industry experts on the team was essential to develop the visual style and the animations of the game for the target audience. In order to obtain acceptance from the target audience, the animations needed to mirror real world work processes. Similarly, the work wear, equipment and OHS controls needed to be recognisable and resemble the real-world counterparts. Mistakes made by the design team regarding the appearance of equipment or the process of a worker using a particular piece of machinery could be quickly identified and changed. Similarly, the advice from industry professionals was valuable from a game development perspective and helped to fine tune aspects of the user interface control and the gameplay.

Students are generally reluctant to pay money for a learning game. While the CI students were happy to play the game in class and realised its potential for learning and for reinforcing what they had learned in class, the majority of students stated in the interview that they would not pay money for the game. Instead they expected that learning games would be provided for free - like the other materials they received in class - or that their employer would shoulder the cost of the game.
The project was truly trans-disciplinary project spanning four Schools at RMIT. Through this project, we have developed interdisciplinary linkages between the Schools of Media and Communication, Applied Sciences, Property Construction and Project Management and Engineering (TAFE). We also developed a working relationship with members of the mobile game industry.

Employing recent RMIT graduates of the Games program worked well. The graduates had already worked together on projects during their studies at RMIT and their expertise in game development was useful throughout the design and testing phases. The project also provided the five recent graduates with an opportunity to gain more game development experience. Four of these five graduates are now continuing to work together on the development of another game and are support by the GEELab.

3 Dissemination strategies and outputs

3.1 Users and stakeholders

The stakeholders of this project included the researchers and the game development team, CI instructors, CI students, WorkSafe Victoria who approves the CI courses as well as academics who might use games in their teaching, and the wider audience of game developers and players.

The primary stakeholders were the researchers on the project who were interested in designing and investigating if a game could help to improve motivation, learning, transferability and retention of information within the context of Occupational Health and Safety training in the Construction Industry. The project brought together academics in Construction, Occupational Health and Safety, Games Design and Learning and Teaching.

Other stakeholders included the games development team who were recent graduates of the games program and used this opportunity to launch their careers as game designers. The development was informed by members of the games industry. User testing was conducted with the involvement of coordinators and trainers from RMIT TAFE.

As issuer of the “White Card”, WorkSafe Victoria approves the content of the CI training courses. Australia wide WorkSafe issued over 40,000 white cards in the 2011/2012 fiscal year. Teachers of the CI course would be interested to use the game as part of their teaching materials.

The game was developed primarily for students at RMIT University who need to complete the construction induction training in order to enter an Australian construction worksite. This includes students from the School of Property, Construction and Project Management but also the School of Architecture and Design and Engineering TAFE.

The game is also relevant to students and professionals at other institutions and in remote areas in Australia who need to complete the Construction Induction training before they can enter a real world construction site.

The results of the game testing will be of interest to academics who are interested in the use of games in education, particularly the aspect of transferability of learning from games to the real world.

People in the construction industry are also on the lookout for novel ways to induct their staff.

By extension this work is also relevant in other countries, as hazard recognition and the management of hazards via OH&S controls is a problem that is not limited to Australia.

Ultimately, the game is also appealing as a game itself as it is entertaining to play.
3.2 Dissemination strategies
To disseminate the information about game design the researchers presented at the following conferences and events.

2. CIBW099, the International construction industry special interest group on safety conference on “Modelling and Building Health and Safety”, Singapore, 10-11 September, 2012. The peer reviewed paper was given the award for the best paper.  
3. RMIT Learning and Teaching Expo, Bundoora, August 27-30, 2012  
5. Games for Change Conference 2012, Melbourne, November 15-16, 2012  

In addition to consulting with the CI Course quality controller, WorkSafe Victoria disseminated information about the game through their newsletter in early 2013. The project has also been presented to the GEELab’s industry partner Audi in Ingolstadt in August 2012 around the topic of OHS in the car industry.  

To showcase the research to potential CI teachers, the construction industry and students, the project has a presence on the GEELab website and its own webpage where the game can be downloaded for PC and MAC.  

Since mid December 2012, the game has been available for free on the Apple App store, making the game available worldwide. Within 3 months of its release on the Apple App store, the game has been downloaded over 500 times from users in 10 countries.

The stakeholders of the project can stay in touch with the development group via a social network page on Facebook.  

Websites related to the Trouble Tower game include:  
GEELab website: http://www.geelab.rmit.edu.au/content/trouble-tower  
Project website: http://raws.adc.rmit.edu.au/~e46990/  
Facebook: https://www.facebook.com/TroubleTower  

4 Remaining Activities
To finalise the activities associated with the development of the Trouble Tower game, the researchers will:

- Retest the game with a more robust test protocol. There are approximately 200 Diploma in Property and Construction students who will be undertaking the CI course in February 2013. The Program Coordinator has agreed to allow us to test these students. This should allow very robust statistical results, given that the students will have similar starting experiences and that the tests have been honed to be easier to assess.

- Given the resounding good word of mouth about the game, the researchers would like to have a proper publicity launch for the game. The publicity can then be used to distribute information to traditional media, social media, interested organisations and potential funding agencies.
Appendix B: Poster

TROUBLE TOWER

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