Serious EdGames©: Digital innovative serious educational gaming for mobile technology

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1. ABSTRACT

Serious EdGames is an innovation which sought to meet the need for enjoyable learning experience in education and training for built environment professionals. It incorporates innovation in e-learning methodologies and learning materials designed for mobile devices such as iPad, Surface Tablets, Galaxy Note Smartphones etc. It also meets the needs for a flexible solution where a large number of learners could do their training anytime, anywhere.

Serious EdGames (SEdG) improves best practice in education and training for built environment professionals. It attests the SEdG concept. The essence of SEdG is to enrich and enhance learning experience for built environment professionals, producing learning materials that work on devices that many learners are well familiar with.

2. INNOVATION

Recent developments and studies (e.g., Chee, Mehrotra et al., 2014; Cowley, Fantato et al., 2014; Eck, 2010) on serious games have shown its potential as a learning tool. A significant result of our Serious EdGames (SEdG) innovation is the major improvement in best practice that few educational establishments achieved - SEdG makes a breakthrough in this education technological space where the most modern technology is used to support the technology-savvy learners and learning professionals. In its use of prevalent mobile technology, this innovation significantly increases learning amongst the younger professionals. It delivers 'boring' subject matters in an engaging way. The engaging gaming format, the exploitation of already-familiar technology encourages learners to learn. Being an online game, it has similar *learning by doing* attribute where each learner could "outlive and demonstrate his individual values, thoughts, and opinions, and be sure that others thoroughly study and acknowledge his character." (Friedl, 2003, p. 31)

This innovation was funded for 7 months by the University of East London. This short time-scale presented enormous challenges in coordination with critical stakeholders and resources. To maximize success, we planned a tight schedule of intense collaboration based on the Dynamic Systems Development Method. Barrow and Mayhew (2000) set out several characteristics and reasons why this method in rapid application development was useful in such an innovation, including its emphasis on consensus and democracy.

The designer and the developer first discussed in detail the rapid design methodology for SEdG for built environment learners and professionals, and the required resources for implementation and outline plan. Having forwarded our resource requirements to relevant suppliers, we devoted our time to piloting SEdG applications which we then showcased to senior users and funding committee. This is a critical challenge because SEdG was a very new concept to support active learning: the funding committee gave us full support and encouragement and so we overcame these challenges.

Figure 1 Serious EdGame integrated into MOODLE

We suggested an outline plan to funding committee which they agreed upon. According to Kotter (2012, p. 126), achieving short-term wins from the beginning increased stakeholders confidence and interaction. This increased return on investment and innovation success. Our outline plan included milestones such as feasibility study, pilot applications and launch. Feasibility study included resource gathering, stakeholders and workflow. Pilot applications involved stakeholders who evaluated early versions of the SEdG against active learning principles and specific learning outcomes of each game. We then progressed on the games, gaining further feedback from stakeholders.

We showcased pilot SEdG applications to built environment learners, professionals and academics to elicit their feedback on serious game designs and implementations that were most engaging for learners. With this, we overcame potential knowledge and experience gap of learners. To prepare

for the launch, we published the game, and submitted full closure report to the funding committee. Having delivered what we set out to do, the funding committee agreed to the closure a month ahead of schedule, a testament to the innovation having satisfied all e-learning objectives.

The SEdG *Survey* and *Goals* are designed for learners to explore a plot of land, with the intention of deciding on the alignment of a trunk road. While key sites (e.g. factories, public venues, parks, Special Protection Areas etc.) are shown, learners are asked to survey the site by controlling the *Character* to walk around the site, in order to find out a number of areas on the site where there are particular concerns, e.g. Special Protection Areas. Learners find the style of these SEdG much richer and free flow than traditional structured simulation games, and much less intensive than third-person shooting games.

Figure 2 'Survey' Serious EdGame

Learners control the *Character* by using the cursor keys on their keyboard, or touching on the on-screen arrow keys if using a mobile device. If learners wish, they can click on the designated link to play in the game in its own window which can give them a better playing and learning experience.

In Figure 3, learners explore the site and go to locations that they can find out more information. If they come to the Special Protection Areas region, a pop-up box appears to give them an explanation. If they choose to they can then proceed to this next "stage" of the game.

Figure 3 Navigating the Character to learn about Special Protection Areas, a pop-up explanation is shown

Figure 4 Next stage of the game – the "Goals" Serious EdGame is where learners are presented a series of questions for them to respond

As shown in Figure 4, learners consider one statement at a time and can take as long as they want to "score" each ball. The statement is presented prominently to help focus learner's attention.

3. PEDAGOGY

This section elicits the pedagogic approach that underpins the design of the SEdG. There are different learning styles. Learners may learn better in different approaches to suit their learning styles. Some learners are *visual learners*, that is, they learn through visualization. They learn better

with pictures and diagrams. They prefer to record in visual form so that they can see them in order to absorb the materials. SEdG benefits most for this learning style.
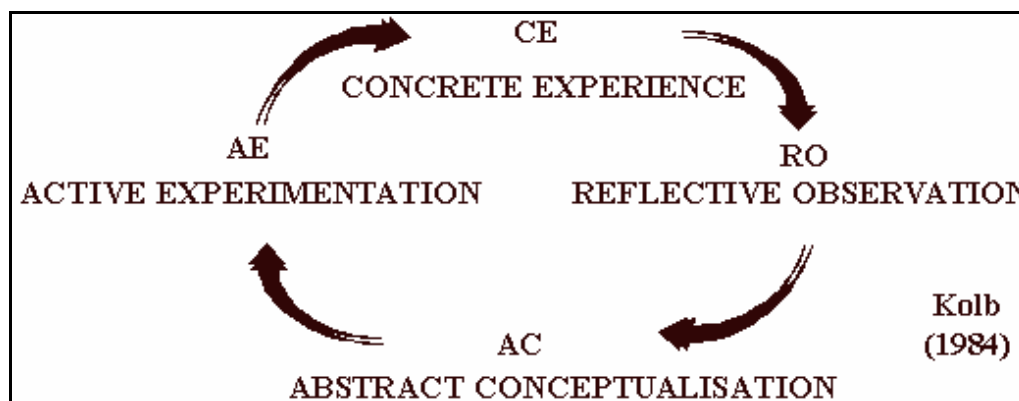
Another group of learners may learn better through listening. They are *auditory learners*. They absorb better when the materials are read aloud. The learners of this learning style interpret information in speech through listening to tone, pitch, speed and some other nuances. Written notes are less effective to their learning unless they are in audio form. SEdG is designed to be readable from a screen reader. This would unquestionably benefit auditory learners as most browsers support auditory provision for accessibility.

However, for *tactile learners*, a long lecture may not give much help to them as compared to doing hands-on activities. They learn more effectively by doing than thinking. SEdG works best suits this type of learning style as the learners will engage in interactive activities.

Kolb (1984) explained the learning cycle by his four learning styles: accommodators, divergers, convergers and assimilators. Figure 5 shows the Kolb's learning cycle. Accommodators (Concrete experiencer/Active experimenter) are active experimenter; they are doers rather than thinkers. They learn more effectively by doing, hence SEdG is the best way to learn for this category of learners. *Divergers* (Concrete experiencer/Reflective observer) start from the details and work up to the bigger picture. They like to work with others, and learn well from constructive feedbacks. SEdG can benefit them if the design of the learning materials contains great details; SEdG has feedbacks which fall into this category. Such feedback would contribute to the constructive feedbacks which benefit the divergers. *Convergers* (Abstract conceptualization/Active experimenter) are thinkers who ask questions and try to solve problems. They like to understand how things work. Assimilators (Abstract conceptualizer/Reflective observer) prefer thinking than acting. They like lectures with demonstrations, they appreciate the knowledge of experts. They learn best through conversation with a logical and thoughtful approach. The engagement with SEdG suits this learning style because the interactiveness creates a dialogue with the experts in a logical and thoughtful way.

Figure 5 Kolb Learning Cycle
Source: http://reviewing.co.uk/research/learning.cycles.htm

Fundamental to the pedagogical approach that underpins the design of SEdG is an awareness of the learners' readiness to learn. This must mean a readiness to change: acquiring new skills, attitudes and knowledge will affect learners' perception of themselves. This is consistent with a constructivist view of learning, the learner building new ideas into concepts based on their prior understanding (Light, Cox et al., 2009, pp. 22-23). The learners' readiness to change in learning with SEdG gives the learners the best opportunity to succeed.

The SEdG concept promotes activity-based learning so that learners can be fully engaged with the materials. This concept not only promotes learning at learners' preferred time and pace, it also promotes "multiple attempts" in assessment activities, in particular, the learners are less likely to feel embarrassed as they would in a class environment.

SEdG is a highly original concept: it promotes an exploratory approach to learning: learners apply their own prior knowledge and experience to make their own decision on structuring their learning experience. SEdG is an exciting implementation of the theory of active learning.

4. TECHNOLOGY

SEdG game design typifies online games where the technology is as importance as the look and feel. Friedl (2003, pp. 36-37) reminds us that online games is an art form in the way the designer conveys the message to players. Such a message includes the graphical and interactive content, as well as culture and worldview. In the *Survey* and *Goals* games, it is important to provide a world that has some similarity to the physical world, an environment that bears some resemblance to what professionals find in their physical work environment. Instead of a closed-up view for the learners, the game maintains an overall view, with some degrees of *panning*, so that learners have a strong sense of where they are and want to go to explore further.

The use of the *Character* adds fun, but also a sense of purpose. It puts learners in control of the game, in the same way they are responsible for their own learning. It reminds learners games such as *Pac Man* they might have played when young, making a smooth transition to playing *Survey* and *Goals*. This way of creating online presence is further explored by Tamborini & Skalski (2006, pp. 226-227) who says virtual social actors create their online presence, and self-presence can be invoked by an object that represents an individual player. Li et al's (2012) study on avatar further reinforces online presence in self-identification.

Friedl (2003) further says playing games is an exercise of deconstruction of information that players receive, enabling them to focus on what is important. As learners explore in the *Survey* game, they will soon reduce attention to the significance of some of the games artefacts (e.g. houses) which are not important for learning. Learners will walk to areas indicated by e.g. the *ducks*, because these are where learners find further information that leads to next stage of the game. They get further information they need for the survey. Having deconstructed the environmental information, learners have the relevant information to progress with their learning.

Due to rapid development constraint, SEdG is created using *Construct 2* (https://www.scirra.com). It provides a development environment to program sequences, interactions and conditions between objects, and between the character and objects. To publish games, it generates a collection of files to support playing on desktop computer and mobile devices. These files conform to HTML5 and web app standards. Affirming such best practices gains widest reach in smartphones running iOS and Android operating systems. SEdG applications are integrated into MOODLE virtual learning system. They allow the best resources of both organization of materials, assessment of understanding of the materials in MOODLE. Engaging, exploratory, self-paced activity-based learning is made possible by SEdG.

We overcame the challenge of IT resource by identifying alternative web hosting where we could add and update SEdG and related files in real time. We also overcame challenge of MOODLE integration by implementing document embedding and interoperability methods. This was critical so that learners would not see pop-up error or security messages when they activated the games.

We overcame the challenge of lack of devices for testing by acquiring several smartphones of different operating systems and versions (e.g. iOS on iPhone, Android on Samsung, Windows Mobile on HTC) and larger screen size devices (e.g. iPad2, Google Nexus 7). With this, we improved on our SEdG rapid design and implementation routine, thereby turning the challenge into our competitive advantage.

5. USEFULNESS AND BENEFITS OF THE INNOVATION

5.1. Evidence of Benefits and Achievement of Learning Outcomes

The learning outcomes of SEdG are to know planning law, including the system of development plans, planning applications, and acquiring consent for development, to identify the powers in land acquisition, compulsory acquisition and compensation, to comprehend the legal enforcement of development control and special planning controls, Nationally Significant Infrastructure Projects consent (NSIP) and environmental impacts of the development. In our survey on achievement of

learning outcomes, 47% of learners responded positively to enjoying the learning using SEdG better than the traditional methods of learning, while 21% didn't agree. Some comments included "people can learn more easily by loading examples via games", "it's more interactive way of learning, more fun and more relaxing", and "we would spend more time to learn a subject in the game than reading a book". Undoubtedly, SEdG contributes to the increase in retention of learners.

More learners (29%) agreed that they focused better when using SEdG as in contrast to reading printed books, compared to 24%. Regarding retaining what they learn, 29% said SEdG achieved this, against 21%. Asked how likely they would use SEdG for learning, 27% said no compared to 24%. Some suggestions were made, for example, less graphics, sound and animation; the use of immediate response or checkpoints when they have done an assessment action; and "the layout of questions could be a little more attractive with more figures, charts and different design."

The survey reflected no significant barrier these learners faced with the use of such an approach and this particular interactive medium. The majority was able to acquire their online presence with the aid of the character and proceeded with the learning activity. Over 92% of the learners progress to the final year of study towards their professional qualification.

SEdG has been used as a motivational trigger as the features of SEdG such as sensory stimulation, storylines related to fantasy, can raise learners' curiosity and interest. SEdG keeps the instructions short and clear with step-by-step disclosures, enhancing the learning experience of the learners. Learners could learn much more and apply what they learn with relevant applications to real-life situations. Learners acquire new learning skills which will improve their employability.

5.2. Developer's Achievement

A distinctive achievement is the implementation of SEdG concept to meet the need of built environment professional education and training. It is measurable in its implementation of e-learning principles: learners spent much shorter time compared to instructor-led or text instruction methods, to get involved in the learning and assessment due to its games setting. It is not a surprise that learners maintain a much longer time in the work because of the enjoyable nature of learning by playing, they involve at a much deeper level of critical engagement with the material, and relate the work more easily to real-life situations.

Another achievement of measurable outcome is the innovation demanded that the game design methodology maximizes re-use and re-purposing. In practical terms, a SEdG application can be easily modified to produce alternative versions of the games for different purposes, e.g. different sets of scenarios and questions. SEdG can also be transferred to design different learning materials.

SEdG creates a new world of learning for built environment professionals where they can learn their training materials of any size anywhere they find themselves in. For example, instead of waiting for attending lectures on a topic in a future session, learners can learn ahead of the scheduled lectures, keeping the interests of the fast learners. They can learn the materials and attempt the corresponding assessment whenever and wherever convenient to them. In this way, all learning styles are actively supported.

5.3. Support for learners with Special Needs

The success of technology integration is also an achievement of measurable outcomes. This involves specific standards (HTML5, responsive web design and document embedding and interoperability) to integrate with MOODLE and together present learning materials on learners' smartphones, laptops and desktop computers. Integration of several components give learners a rich, engaging and enjoyable learning experience, and also enable supporting features from each component: material categorization in MOODLE game interaction in SEdG, and finger navigation on smartphone. These can all be adapted to support for learners with special needs.

6. TRANSFERABILITY

SEdG concept is transferable since its focus is creation of enjoyable learning materials for built environment professionals, rather than proprietary or closed methods that are implemented for specific platform or set of users.

This innovation is highly transferable. SEdG applications are produced in HTML5 formats, the files could be placed on any computer and servers, and the code will run in any web browser. The SEdG can be transferred to any web pages that support document embedding; this is done on user's computer, independent of web server software. The SEdG code can also be transferred to any learning system that support learning tools interoperability methods including MOODLE. New versions of the *Goals* games can be easily created with a new set of text files, without the use of Construct 2. Construct 2 license is affordable with educational site license and students options.

This innovation is highly flexible. Many free, open source or low cost game creation programs are available that could produce files meeting HTML5 formats. This aspect is independent of the document embedding and learning tools interoperability methods that integrate third-party applications into MOODLE. In fact, any web-based learning systems would work apart from MOODLE. Together, they seamlessly deliver SEdG to smartphones or computers, proving that SEdG is highly transferable.

7. CONCLUSION

SEdG is an innovation which benefits built environment professionals undergoing training because the SEdG implementation provides a much more enjoyable and engaging environment where they could learn much more and apply what they learn with relevant applications to real-life situations.

Our evidence proves that SEdG improves learner learning, retention, the learners' success in progression to the next level of study. SEdG benefits learning designers and instructors by incorporating active learning methods. They can improve their own knowledge of teaching and learning styles. The gap between "play learning" (as would in kindergarten and primary schools) and professional learning championed by this innovation is very much reduced. This paves the way for education professionals to carry out further research on active learning through SEdG that maximizes learning goals.

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