Improving Learners Engagement with Use of Hybrid Approaches in Engineering Education

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This paper investigates the usefulness of a carefully balanced hybrid learning environment as an educationally viable tool in engineering education that provides for learners' engagement, participation and inclusiveness through personal coaching and supervision, distributed and collaborative work. It expands the scope of previously reported "Three-fold laboratory" concept (theory-simulation-experiment), enriched with virtual environments and mobile wireless technology components, to integrate different elements of social media and alternate reality games (ARGs) for a more effective learning strategy overall.

1. Introduction

The recent forms of technology enhanced education - virtual environments and social media, are offering today exciting new opportunities to engage learners into conversations and collaboration, and turn them from passive, knowledge-receiving audience into active, knowledge-generating participants. To provide for learners' engagement, participation and inclusiveness, today's engineering educators need to be proactive in launching meaningful reforms and innovations in their teaching practice, taking advantage of the new technological opportunities. To facilitate personal coaching and supervision, distributed and collaborative work, a new approach is to be considered that will provide for carefully balanced hybrid environment, consisted of contemporary information and communication technology (ICT) support for e-Learning integrated with conventional instruction.

2. Integrating Modern Technologies in Higher Education Instruction

Teaching in higher education (HE) today has become far more interactive than in years gone by, thanks to the new developments in technology. New technologies emerge at great pace and change the quality and efficiency of established practices in education (CAPITAL, 2010). However, integrating technology into classroom instruction means it must support four key components of learning: active engagement, participation in groups, frequent interaction and feedback, and connection to real-world experts. Effective technology integration is achieved when the use of technology is routine and transparent and when technology supports curricular goals. In the presented hybrid

approach Web 2.0 technologies together with Digital games and Virtual environments are integrated into an overall Alternate Reality Game.

2.1 Web 2.0 Technologies in Education

"The rights to be a creator, to govern and develop one's own knowledge, and to share with others are fundamental freedoms for the Internet age." Rossini (2010)

Today, the use of Web 2.0 technologies penetrates every aspect of people's lives. The amount of social media platforms available has significantly increased collaboration and communication among users with similar interests. Social media can exist in many different forms, including wikis, podcasts, social blogs, video, pictures and social bookmarking. Blogs can be defined as personal journals or diaries where the user posts digital material and others can comment. If used correctly, blogging can be effective when applied as part of learning initiatives, since it promotes collaboration, discussion and assistance, with comments that can be presented either formally or informally based on topics that are being discussed (Eng, 2010).

Wikis are inherently collaborative, extremely flexible and easy to use tools, which are resource of enormous amount of human knowledge. The flexibility of wikis has allowed instructors in HE to utilise them for organising ideas, or as a platform for engaging learners in collaborative activities. Using Web 2.0 technologies students can voice their own opinions on topics, review each other's work, and publish on the web to get feedback from other audiences. Since social media technologies can overcome physical and geographical barriers by facilitating communication, they actually promote environment that emphasises collaboration rather than competition amongst the learners. This collaborative environment can stimulate active problem-based learning and promote analysis, synthesis and other higher-order cognitive skills that provide focus on building learner's own mental model and knowledge.

2.2 Digital Games and Virtual Environments in Education

"Almost all creativity involves purposeful play." Abraham Maslow

One reason today's educators "are not more successful at educating children and workforce, despite no lack of effort on their part, is because they are working hard to educate a new generation in old ways, using tools that ceased to be effective" (Prensky, 2001). Thus, the immediate task in front of today's educators is to develop methodologies that speak the language of this highly technological generation (the Net Gen), to "stop telling", but to invent new teaching and learning ways in order to provide education on some of the driest and boring subject matter imaginable. The latest explorations of multimedia potential interactivity, influenced by the constructivist philosophy of learning resulted in re-discovery of play as the most fundamental concept of human instruction. Using the play with today's digital game technology as a 'remedy' to the problem of boredom and disengagement in the classroom, it is possible to build a unique and stimulating virtual reality in order to improve learners' understanding on abstract scientific/technological concepts that otherwise are difficult to grasp with the conventional educational methods. Digital games are a particular structured form of play where fantasy, curiosity, challenge and control, as intrinsic motivations for learning are met. Playing a game successfully requires engagement of critical thinking and problem solving skills in understanding the game concept and act

intelligently in challenging situations (Zheleva et al., 2002a). The interactive approach in games may involve role-playing, exploring and simulation, all of which provide significant advantages over the normal, static presentation of information by conventional teaching. Beyond their playful appeal games present other possible learner benefits, such as opportunities for construction, reflection, collaboration and networking. Through use of compelling story lines, analogies, metaphor, and simulation, learners may play an active role in creation of their own collaborative virtual environment, which can be even more educational, entertaining and "real" than the real world (Zheleva et al., 2002b). Games and simulations have long history in learning and presently they are increasingly more complex, networked and engaging for learners. There have been a range of well-publicised examples of games developed and successfully used in education (Rylands, 2007; Wastiau et al., 2009; Crook et al., 2009; Zheleva et al., 2010). They demonstrated that by instilling best practice in use of game technologies, aligned with sound pedagogy and instructional design, academics can introduce engaging, experience-centred and multi-sensorial learning activities.

A number of Virtual Environments (VEs) have been developed for educational purposes as well (Romano and Brna, 2001; Singh at al., 2002; Wolfe, 2001). They are particularly useful when the learning domain is complex, abstract in nature and difficult to master, and when the virtual features of the learning environment are critical to the success of the learning. To achieve both learner sense of presence and reflection in the learning process, such virtual environments suggest constructive knowledge and cognitive learning. Virtual environments are creative landscapes and when populated with the right mix of content and discovery, students remain engaged long after class ends.

2.3 Alternate Reality Games (ARGs) in Education

"Alternate Reality Games take the substance of everyday life and weave it into narratives that layer additional meaning, depth, and interaction upon the real world… The genre is not just a new direction in gaming but part of the more general evolution of media and creative narrative, and reaction to our increasing ability and willingness as consumers to accept and explore many media in parallel, simultaneously"

Martin and Chatfield, 2006, p.6

Over the past years, alternate reality games have captivated the imagination of millions of people by getting them to play with worlds that are as fantastic as they are real. Players and designers alike are embracing the trend of exploring real world spaces (Thompson, 2006, p. 21). ARGs are cross-media products with content spread widely and wildly through many different media, and a lot of the play experience is derived from this free-form use of any and all available channels (YouTube, podcasts, social networking sites, and even published books). ARGs are described as the "quintessential teaching mechanism" (Dena, 2006, pp. 58-82). Academics play, design and watch ARGs. Their research offers insight into what ARGs are, how they differ from the other media forms, and how the design and experience of them can be utilised in education for engagement. The skills ARG players have to learn are highly appropriate for what students need to be prepared in today's world, and the low-tech nature of ARGs means they are accessible to students and can be created using limited resources. As Barlow

(2006, p. 19) concludes, “Education/training ARGs promote a non-traditional product. The product isn’t a movie or a shirt you can wear, it is simply knowledge and ARGs become another way for people to learn while having fun.”

3. Using a Hybrid Approach to Improve Learners’ Engagement

“I hear and I forget. I see and I remember. I do and I understand.” Confucius

From the many cited in the literature examples, including the discussed above, it is evident that interactive multimedia and game environments can be powerful educational tools, and today’s educators should embrace the changes in technology, and provide meaningful reforms and innovations in their teaching methods. One way ahead might be the use of combined conventional methods with technology integrated teaching and learning. In the present paper a new hybrid approach is proposed - a mix of social media and digital game is added to the fascinating new trend of Alternate Reality Games (ARGs) to target real-world problems. The new approach is an extension of the research that has first been reported in Zheleva at al. (2010), aiming to utilise advanced methodologies for teaching and learning in the original concept of a Three-fold laboratory (theory-simulation-experiment). The Three-fold laboratory concept has presently been extended to accommodate social media in the educational context of E-learning as part of an Alternate Reality Game. The purpose of the concept is the development of a new type of interactive course for industrial process integration and energy conservation. The engineering specific methods include evaluation of combined energy and water efficiency of industrial processes with clear identification of eventual scope for improvement and bottlenecks. The classical methods include mathematical modeling, corresponding computer simulation of combined heat and mass transfer processes and application of the extended Pinch design for combined management of energy and water resources. Total site energy analysis, heat and mass transfer, wastewater management and fresh water minimisation are interwoven themes for scenarios of challenge worlds in the Alternate Reality Game. Players take on a mission each month. The scenarios with clues and puzzles, artifacts and associated resources (web sites, rich media, etc.) are designed by a supervision team of educators. In each scenario story plays an essential role by presenting players with a problem to resolve a mystery. An appropriate story line employs fantasies and challenges that are used to encourage the creation of learner-generated analogies. Analogies and metaphors in educational games are means of integrating new information with prior knowledge to produce deeper comprehension. In the ARG students find clues anywhere – websites, libraries and databases, on/off campus real locations, or in virtual worlds, printed materials or mobile voice messages, provided by real persons, or supplied by virtual characters of a digital game embedded in the ARG scenarios. Learners even find GPS coordinates as clues that are sending them to real field sites (e.g. waste-water treatment or pharmaceutical plants), where interviewing lead engineers provides them with significant information to solve the problem on hand. Or, the clue points to a digital game on the website where a virtual character is holding the knowledge needed to solve a puzzle. Learners meet online or at physical locations to plan and talk about their strategies, they post their findings and experiences on blogs, and have discussions in

online forums. They use their prior knowledge, imagination and thinking 'outside the box' to act in real world situations. The ARG scenario has a short narrative of the challenge and a short case study presented in a lecturer's wiki page or blog, which has video material embedded, or include a link to a particular digital game or simulation, along with some links to resources, all of which combined forms the topic of a mission. Based on the case study, as well as the additional resources found online/offline/as part of the ARG clues, students, encouraged to work in groups, derive their own views on the issues. Use of mobile technologies enhances the exploratory and field learning by enabling gathering and reporting of rich data (images, video, audio). Through use of new generation devices and GPS services learners can share their real world experiences with peers. The development team of educators has to pre-design a clue-based algorithm and some limiting conditions generation for the purpose of problem-solving navigation (Zheleva at al., 2010). Students have to demonstrate and apply all the knowledge and skills acquired in various engineering modules, when they take part in the game scenarios. They are faced with many uncertainties, have to work with unstructured data and understand the real-world problem from which feasible solutions must be generated. Problems encountered help students to develop better communication, collaboration, team-building, leadership, conflicts resolution and project management skills. The problem solving process follows deductive "what-if" algorithm cycles leading to a deeper knowledge acquisition. The simulation step allows for process design improvement or process operation changes. Students perform sensitivity analysis and allocate the most influential control variables to optimise the process. The laboratory part includes activities related to design of own laboratory setup. Learners use their prior knowledge to assemble a flowsheet for the required process, followed by design of separate unit-operation to build the process system. Each scenario of the game allows for accommodation of uncertainties and non-standard solutions. Educators watch, mentor, and provide feedback. The design of the learning process in such environment is to support achievement of 'threshold-level knowledge' and guided transition to the next higher level of problem identification, formulation of hypothesis, information gathering, analysis, and natural approaches towards target solution and testing.

4. Conclusions

An important principle in the research reported in this paper has been to exploit variety of contemporary ICT support for students' engagement, like social media, digital games, and wireless mobile technology, all integrated into an ARG. Through such hybrid approach, learners are gaining knowledge by participating in both immersive virtual environments and online communities, where they collaboratively identify problems, form and test hypotheses, share information as appropriate, deduce evidence-based conclusions about underlying causes, and provide solutions. By playing the game learners gain a whole new experience that is transforming them from passive spectators into active participants in creating their long lasting knowledge and preparing themselves for living in today's Technology era. The presented research attempts to demonstrate that by instilling innovative technology enhanced practice with sound pedagogical principles academics are able to introduce engaging, experience-centred

and multi-sensorial learning activities for which the new social media and game-based technologies provide ample opportunities. With this hybrid approach the educational experience has been taken beyond the classroom and laboratory space to guide the transition from teaching and learning environment into the space of real world industrial problem solving and troubleshooting. The approach attempts to educate and in the same time – to engage and entertain learners. Future work will look into its expansion based on formal evaluation.

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