Collaborative Virtual Learning in Education in STEM Education

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There has been a recent explosion of interest from academics across a wide range of disciplines in the use of Multi-User Virtual Environments for education, driven by the success of platforms such as Internet Communication Technology learning skills in higher education. While digital virtual worlds are used in the 21st century learning, advances in the capabilities and the spread of technology have fed a recent boom in interest in massively multi-user 3D virtual worlds for entertainment, and this in turn has led to a surge of interest in their educational applications. As these platforms are used more often as environments for teaching and learning, there is increased need to integrate them with other institutional systems, Web-based Virtual Learning Environments (VLE) in particular. In this paper, we briefly review the use of virtual worlds for education, from informal learning to formal instruction, and consider what is required to turn a virtual world from a Multi-User Virtual Environment into a fully fledged 3D Virtual Learning Environment (VLE). In this we focus on the development of Moodle—a system which integrates the popular 3D virtual world of Second Life with the open-source Virtual Learning Environment.

Keywords: Multi-User Virtual Environments, 3D Virtual Learning Environments, moodle, second life, digital virtual worlds, internet communication technology

Introduction

Despite the fundamental importance of science, technology, engineering, and mathematics (STEM) education, diffusion of knowledge about technology itself—which is important to engage in a knowledge-based economy is very useful but has some noticeable problematic. We propose an approach based on a digital devices smart gaming experience (digital devices serious game) as a promising approach to allow children to have a multisensorial experience of concepts and facts which are difficult to learn with standard learning tools (books, lessons, multimedia contents, etc.) (Arnab, Berta, Earp, de Freitas, Popescu, Romero, Stanescu, & Usart, 2012), in particular related to STEM concepts.

The development of such an approach involves a multidisciplinary perspective in order to gather the latest advances in learning theories and educational psychology; moreover, it needs to exploit state-of-the-art electronic devices and gaming technology to provide users with the best learning and interaction support. The proposed approach arises from the observation that we are progressing into a new technological and innovation driven world that demands a change in the way coming generations learn and think. Being an active participant and contributor to innovation necessitates a solid understanding of STEM fields. However,
several topics (e.g., concepts related to technology) are difficult to learn in an abstract way (books, lectures, etc.) and practical activities are needed not only to apply concepts but also to help learning itself. This is particularly challenging in a younger age, where this concern is often neglected, frequently leading to poor instruction, if any. However, these topics typically involve facts and concepts that could be effectively implemented and/or shown through smart objects, according to the Digital devices Bits paradigm. Such objects could be manipulated by educators and learners in teaching and learning of various types of phenomena/artifacts and compose new aggregations. The state of the art in the field involves Web-based Virtual Learning Environments (VLE), Moodle, class teacher clouds, Digital Virtual Worlds, Internet Communication Technology, blogs, etc.

In this chapter we propose to go beyond these attempts and to design and implement a new approach based on digital devices intelligent things (also called “iBlocks”) equipped with sensing/computational/communication features and linked to an advanced game engine to define different sets of (programmable) rules for combining them to obtain different behaviors. We borrow the concept of iBlock from the well-known children’s games (e.g., Lego bricks), which children can freely compose to build complex objects and scenarios. An important aspect of the proposed approach is that it can also support the definition of digital technologies, so that users are stimulated and invited in educational paths involving guided exploration, competition, and collaboration using Virtual learning technologies (Bellotti, 2010).

**Approaches to the Advancement of Teacher Development**

The need for close-to-practice research and close-to-research practice in teacher education at all levels is a lively current concern (Tattoo & Furlong, 2015; BERA, 2014; 2018; la Ville & Kendall, 2019) and establishing a working synergy between these two building blocks of teacher education, both initial and continuing is a priority for curriculum development that conforms with the fourth industrial revolution. A contribution of new knowledge about team teaching revealed by this phenomenological study is that it is characterized as a four-stage process: first, building trust and confidence in the organizational stage; second, mutual stimulation in the planning stage; third, support and sharing in the performance stage and in the concluding fourth stage, profound introspection, self-empowerment, personal and professional growth. Using the framework of cultural-historical activity theory, a study suggests that teachers are responsible for making it possible that knowledge is accessible anywhere where students are and having insights into students’ needs and progress; choices of curricular activities and materials; rules that govern their participation; expectations and the norms and rules that govern them as teachers. The addition of technology further complicates the equation and presents many new questions as most teachers still use traditional methods of teaching. In some countries where recruitment and retention of teachers is a major issue, these outcomes may be seen in a negative light. However, the claim in the context of this study, which took place in South Africa where teaching is a high-status and noble profession, is that initial teacher education settings with a high level of complexity such as in “adoption week” can be seen as a positive challenge, given sufficient structured preparation and support in the advancement of teacher development to adhere to the innovation of the fourth industrial revolution teaching techniques and to deliver learning virtually using media platforms.

**Technology Literacy and STEM in Higher Education**

As information and communication technologies have become ubiquitous, society has transformed greatly.
More information than can humanly be processed is always available at our fingertips; the citizens of the world who are connected in overlapping social networks and accelerating technological breakthroughs afford rapid and unpredictable innovation. As such, the demands of becoming productive and leading a self-actualized life have also changed over the course of the last decades. This has precipitated a change of thinking about education, leading to the formulation of twenty-first-century skills (Dede, 2010). One of the central concepts in this twenty-first-century paradigm on education is that children have to become literate in information and communications technologies. This in turn means being able to learn and appropriate knowledge and concepts from logical thinking and algorithms (Levin et al., 2000), more in general from science, technology, engineering, and mathematics (STEM) areas (Trilling & Fadel, 2009), being able to analyze and explore complex systems (Zimmerman, 2009), as well as being able to use and create technological content in collaborative settings (Jenkins, 2009). The knowledge, skills, and attitudes intrinsic to technological literacy, which are required to lead a self-actualized and productive second life in the twenty-first century, however seem to be inappropriately learned through conventional classroom instruction. Technological literacy demands an integrative approach, with hands-on application of knowledge, psychomotor learning elements, and interacting with dynamic processes (International Technology Education Association, 2003). In order to reach all of these learning goals effectively, already from an early age, we contend that collaborative virtual learning environments should be created that revolve around playing while learning. This makes teaching and learning in the 21st century more interesting and desirable.

Reviews on How Students Prefer to Learn

For young children, playing is a learning tool but for adult students technology is very significant and they use their smart phones to access and get information anywhere around the world. They have been observed to have derived their enjoyment using technology and search engines to get information. If the element of enjoyment is nonexistent, the child will not continue playing and will choose a different activity. The element of enjoyment is an emotional component, which drives the child to continue and advance in his or her learning. While playing, the children experience a dynamic process of intriguing occurrences in different fields of interest. Todays student is not concerned with failure, and since he or she is merely playing a game, the acquiring of knowledge is not overwhelming. The important properties during such a game are a virtual learning environment and the sensation of the learner while playing (Bruce, 2011). The design and use of digital devices has a certain theoretical foundation in the constructivist learning theories that stress that knowledge is created through experience while exploring the world and performing activities (e.g., Dewey, 1933; Kolb, 1984). Implications on game design involve the creation of virtual environments, typically 3D, where the player can gain knowledge through exploration and by practice (e.g., manipulating objects), possibly in collaboration with others. Constructivists stress the importance of the learner to build his or her own knowledge.

Observing the gameplay, the authors noticed that “high-achieving students tended to utilize more traditional science resources such as textbooks and worksheets while attempting to solve the presented problems. In contrast, low-achieving students employed the help of expert nonplayer characters and virtual lab equipment to aid in their quest.” These observations seem to stress the fact that learning is a complex activity that requires graduality and needs several steps that have to be supported by various tools (e.g., paper and digital, reading and writing) and generally have to be guided, possibly by a real adult, in order to be
meaningful/compelling for the learner and not to waste time and energies. Maps, landmarks, contextualized helps, and objectives’ lists with status information are game elements that could be employed in order to support avoidance of player’s cognitive overloading. Another important theory is flow, based on Csikszentmihalyi’s foundational concepts (Csikszentmihalyi, 1990). Flow was first employed to measure engagement in an educational game in Johnson and Chen (2004). Sweetser and Wyeth (2005) drew together various heuristics present in the literature into a concise model, the GameFlow, consisting of eight elements: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. Digital devices are being used in a variety of training and educational settings ranging from elementary schools (e.g., with games for mathematics and foreign languages) to universities (e.g., in particular with games for business management, logistics, and manufacturing, e.g., Oliveira et al., 2013).

**Playful Learning**

Results for primary and secondary STEM education through serious games so far have been decidedly mixed (Young, Slota, Cutter, Jalette, Mullin, Lai, & Yukhymenko, 2012). Serious games are often designed as a solitary immersion into a virtual world, whereas games that offer collaboration show better learning (Wouters et al., 2013). In addition, the virtual world may obfuscate real world interactions such as friction and torque, and the strictly preprogrammed nature of many video games may hinder student-driven experimentation (Young et al., 2012). Furthermore, serious games are often designed and tested with an adolescent or young adult demographic in mind, but this may be too late. Already from a very early age, technology literacy is determined by external factors such as sociocultural background and gender socialization, where for instance girls are less likely to experience self-efficacy with computers and subsequently are less likely to choose a career in STEM areas (Vekiri & Chronaki 2008). Therefore, this project targets children in elementary and early secondary school age in learning central STEM and systems concepts in Virtual learning settings.

Digital devices user interfaces seem to engage children more than screen-based interfaces when it comes to science learning and learning how to program, an effect that is especially strong for young girls (Horn, Solovey, Crouser, & Jacob, 2009; Sapounidis & Demetriadi, 2013). More importantly, an embodied approach to learning with digital devices can help children understand the physical properties related to STEM subjects (Young et al., 2012) and interact with difficult problems (Bakker, Van Den Hoven, & Antle, 2011) in systemic settings, as the digital devices can act as distributed cognition (Hornecker & Buur, 2006). An embodied approach is crucial in understanding the evolution of simulated systems over time and its configurations in space, thus improving systems thinking as core concept in STEM education and ICT literacy learning (Clark, 1999). According to Papert’s constructionist approach, the learner must create or construct an Object-to-think-with: a digital devices product that serves as a focal point for thinking, linking sensory perception with abstract thinking, and linking the personal world to the social world. This digital devices product can take the form of a LEGO structure, a robot, a computer program, or any other artifact, as long as it has meaning for the learner that has created it, is situated in the public space, and is accessible for examination, evaluation, and reflection by the learner or others (Kafai & Resnick, 1996; Papert, 1993). Additional perspectives of this approach can be found in modern educational approaches, which complete Papert’s approach and implement the use of technological objects as focal points for thinking. Mitchell Resnick, the
head of MIT Media lab (Resnick, Martin, Berg, Borovoy, Colella, Kramer, & Silverman, 1998), proposed upgrading and replacing traditional building blocks, such as LEGO bricks, with similar objects that will also contain integrated technological abilities of communication and data processing (Digital manipulatives). The computerized elements allow manipulations with complex objects, which can assist the learner in developing an understanding of dynamic systems. These manipulations are performed by the learner, who uses these complex objects to create a product, which he or she will program to behave as required. This occupation will involve the learner in psychomotor, social, and cognitive processes, which will promote communal knowledge construction. Having demonstrated the need for a mixed model approach of using digital devices with the power of serious games in order to develop technological literacy, we propose the concept of a digital devices serious game framework. The framework focuses on the technology that is necessary to teach the required STEM concepts through smart digital devices. That is, designing context-aware blocks with embedded sensors and actuators (called iBlocks) that can be mixed and matched and a digital devices serious game development and assessment tools (Bellotti et al., 2013).

**Technologies That Are Used in VLE**

The use of digital devices, often metaphorically described is very new in developing countries but in developed countries has been around for some time. Because of this reason, collaborative learning is advised as students can learn from their peers anywhere in the world using VLE. As technology progressed over the years, increasing sensing and actuating capabilities in more diminutive forms, the operating intelligence moved from external computers to inside the digital devices. Digital devices as a way of interfacing with internet connectivity gave way to interfacing (interacting) with the objects themselves, leading to, e.g., applications in collaborative work and education (Ullmer & Ishii, 2000).

Very popular digital devices interface for teaching and learning are 3D Virtual Learning Environment (VLE), Blogosphere, Moodle (Modular Object Oriented Developmental Learning Environment) project and Class teacher clouds that are working on integrating learning and teaching across the use of Virtual learning Environment; which teaches children basic imperative programming skills in and out of school (McNerney 2004). Digital technology user interfaces for learning developed at project partner Eindhoven University of Technology include, among others, digital devices to stimulate learning social behavior for children with special educational needs (SEN) (Barakova, van Wanrooij, van Limpt, & Menting, 2007), such as speech impediments and communication (deaf and dumb) (Hengeveld, Voort, Hummels, de Moor, van Balkom, Overbeek, & van der Helm, 2008; Soute, Markopoulos, & Magielse, 2010).

Consequently, our concept is significantly not more advanced than the state of the art as most educators are not well conversant with the digital technologies by providing an open system that allows a large number of developers to develop pedagogically relevant collaborative learning approaches directly to the digital system. This setup should empower developers, educators both in formal and informal education, and researchers in developing the best educational instruments to develop technology literacy in teacher development.
How Does Virtual Learning Environment Improve Teaching, Learning And Assessment

- Students have good access to ILT and the VLE, with help and support available. Teachers show students how the VLE can help them to support themselves, which raises expectations. For example, students can access resources, assignments, and extension materials remotely that are specifically tailored to their own courses. They can monitor their own progress and goals in their individual learning plans. In short, learning is more personalised.

- Support staff and teachers need to receive appropriate continuing professional development to develop their skills in blended/e-learning and producing e-learning and assessment materials. This has enabled them to improve their understanding, confidence, and capability in making effective use of the VLE and incorporating this into their teaching, assessment, and course materials.

- There is a simple folder system for all courses on the VLE, each with its own logo for recognition. The VLE is not only for storing resources such as Power Point presentations, handouts, music clips and videos; it has a wide range of other functions to enhance teaching and learning, such as online tests, forums for discussions, and interactive quizzes. Students and teachers like these facilities and talk enthusiastically about how useful they are in the learning process.

- Information and learning technology champions and the professional support staff, work with teachers to make integration into teaching and developing resources simple, and to encourage them to be innovative. For example, in the pre-vocational areas teachers personalise National Learning Network materials and help learners to modify the materials for themselves, to suit their own level of understanding and pace of learning.
• Students expect to find help and resources on the VLE and, as a result, teacher are expected to engage them more effectively in taking responsibility for their learning. The facility to be more interactive in assignments and the immediacy of feedback are the main reasons for this. Online assessments and end tests for the BTEC diplomas are regular features, and good examples of the different ways that assessment is being developed and linked to students’ course markbooks and calendars.

• Consolidation of learning in readiness for tests or examinations as part of revision and for reflection enables the independence and control over learning that teachers seek to develop in students. E-safety is a priority and staff and students receive regular updates and training.

Impact

• Courses that are below minimum levels of performance have been improved as a result of the support offered, through direct observation and working with IT Champions. For example, five out of six such courses improved success rates in the period 2009/10. Retention has risen because students are able to catch up with their coursework if they cannot attend for any reason.

• Finally, teachers themselves say that their professional competence and confidence with IT has to be improved which has had a positive impact on teaching and learning.

Methodology

Crotty (1998, p. 3) has defined methodology as “the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes”. Opie (2004) views this as a process whereby the best approach is established to gather evidence in order to answer a particular research question. Moustakas (1994, p. 104) has argued in the context of educational research that “a method offers a systematic way of accomplishing something orderly or disciplined, with care or rigor”. This study has adopted a qualitative research methodology, using focus group interviews to collect data. The authors considered that a qualitative approach would deliver quality data, with focus group interviews providing an opportunity to rigorously discuss this data. Gillham (2000) advises that interviews are more than a conversation; they must be formal, have a research agenda, and are subject to some form of control. He argues that they are appropriate where a relatively select number of individuals are involved, and are accessible to be interviewed. Gillham (2000) discusses the advantages of interviews in that they are effective in collecting expert opinion, and that information produced can be rich in quality and vividness. Barbour and Kitzinger (1999) suggest that focus groups were initially embraced enthusiastically by market researchers, however are becoming increasingly popular in many areas of research, especially in the political arena. Morgan (1993) recommends that the design of a focus group interview requires careful thought and reflection, and the design will depend on its purpose. The group of students involved in this study was confined to second year students on both the undergraduate courses in Construction Management and Construction Economics. It was important that the students were free to offer opinions on their experiences on the Project. Puchta and Potter (2004) inform that focus groups facilitate people in giving their views in their own ways, and in their own words.

Conclusion

There is a need to reiterate that one must not use technology for the sake of it. The use of technologies like the 3D VLE needs to fit into and add value to the lesson. Most 3D VLE is in line with inquiry-based learning
and this encourages self-directed and independent learning. Undoubtedly, 3D VLE has a part to play in education more especially in institutions of higher learning as it possesses the potential to motivate learning and engage students to learn out of the classroom situations. In the emergence of the fourth industrial revolution teaching strategies are changed for the better to fit with the digital age.

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