JYU DISSERTATIONS 171

Stylianos Mystakidis

Motivation Enhanced Deep and Meaningful Learning with Social Virtual Reality

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF INFORMATION TECHNOLOGY

Stylianos Mystakidis

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ABSTRACT

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Current online teaching and learning practices in distance education face limitations in terms of quality and effectiveness. The theories of deep and meaningful learning have the potential to address these challenges by placing emphasis on the cognitive, social and affective aspect of learning by engaging the person holistically. New e-learning models and frameworks are needed to develop and sustain learners' high levels of motivation, engagement and satisfaction.

This dissertation's focus is on the motivation enhancement methods for deep and meaningful learning in distant education. The overall goal is to find out the effect of motivation-enhancement approaches using social virtual reality environments in e-learning and open education. Game-based approaches for enhancing intrinsic motivation include playful design, gamification and serious games. Previous empirical research in attendance-based, blended learning and online settings has shown promising results. However, there is a need for researching the effect of motivation enhancement methods in e-learning regarding the quality of learning.

Can we improve learning quality and help learners achieve deep meaningful learning when instructional design and teaching focuses on intrinsic motivation? To understand the effect of motivation enhancement, eight articles were authored using research designs based on qualitative and quantitative methods. The dissertation proposes four tentative frameworks towards deep and meaningful e-learning utilizing game-based motivation enhancement methods; OpenQuest, Serious E-scape Room, the Blended Model for Deep & Meaningful E-learning in Social Virtual Reality Environments and the Patras Blended Strategy Model.

The results from this study can accelerate the improvement of e-learning quality to address pressing societal and economic educational needs that affect the future of higher education and life-long learning. Facilitating deep and meaningful learning in online education to provide high-quality, flexible, personalized and transformative learning for large audiences could open new educational frontiers towards new milestones of economic growth, social progress and well-being.

Keywords: e-learning, distance education, deep and meaningful learning, motivation, social virtual reality, game-based learning, open education, MOOCs

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Mystakidis, Stylianos
Motivaatio syvän ja mielekkään oppimisen parantajana sosiaalisen virtuaalitodellisuuden kontekstissa
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Nykyisillä verkko-opetuksen ja –oppimisen käytännöillä on rajoituksia etäopetuksen laadun ja tehokkuuden suhteen. Syvän ja mielekkään oppimisen teorioilla on potentiaali vastata näihin haasteisiin sekä korostamalla oppimisen kognitiivista, sosiaalista ja affektiivista näkökulmaa että sitouttamalla henkilö kokonaisvaltaisesti. Syvälle ja mielekkäälle verkko-oppimiselle tarvitaan uusia malleja ja viitekehyksiä, jotka kehittävät ja ylläpitävät oppijoiden korkeaa motivaation, sitoutumisen ja tyytyväisyyden tasoa.

Tämän tutkielman keskipisteessä on motivaatiota lisäävät menetelmät syvälle ja mielekkäälle oppimiselle etäopetuksessa. Yleisenä tavoitteena on selvittää motivaatiota lisäävien lähestymistapojen vaikutusta verkko-oppimiseen ja avoimeen koulutukseen kun käytetään sosiaalisen virtuaalitodellisuuden ympäristöjä. Peleihin perustuviin lähestymistapoihin lisätä sisäistä motivaatiota kuuluvat leikkisä suunnittelu, pelillistäminen ja hyötypelit. Aikaisempi osallistumisperusteisten, sulautuvan oppimisen ja verkkoympäristöjen yhteydessä tehty empiirinen tutkimus on osoittanut lupaavia tuloksia. Kuitenkin on tarve tutkia motivaatiota lisäävien menetelmien vaikutusta verkko-oppimisessa oppimisen laadun suhteen. Voimmeko parantaa oppimisen laatua ja auttaa oppijoita saavuttamaan syvä ja mielekäs oppiminen, kun opetuksen suunnittelu ja opettaminen keskittyy sisäiseen motivaatioon? Motivaation lisäämisen vaikutuksen ymmärtämiseksi on kirjoitettu kahdeksan artikkelia, joiden tutkimusasetelmissa on käytetty laadullisia ja määrällisiä tutkimusmenetelmiä.

Tämän tutkimuksen tulokset voivat nopeuttaa verkko-oppimisen laadun parantamista vastaamaan kiireellisiin yhteiskunnallisiin ja taloudellisiin koulutustarpeisiin, jotka vaikuttavat korkea-asteen koulutuksen ja elinikäisen oppimisen tulevaisuuteen. Helpottamalla syvän ja mielekkään oppimisen saavuttamista verkkokoulutuksessa tuottamalla korkealaatuinen, joustava, henkilökohtaistettu ja transformatiivinen oppiminen suurelle joukolle ihmisiä voisi avata uusia koulutuksellisia rintamia kohti uusia taloudellisen kasvun, sosiaalisen kehityksen ja hyvinvoinnin virstanpylväitä.

Asiasanat: verkko-oppiminen, etäopiskelu, syvä ja mielekäs oppiminen, motivaatio, sosiaalinen virtuaalitodellisuus, pelipohjainen oppiminen, avoin koulutus

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Completing a Ph.D. is like an Odyssey, a perilous cognitive journey from a far-away land across unchartered sea, and hostile places to Ithaca. My journey was no different. It started serendipitously, under warfare-like circumstances and victory aspirations; with optimistic days and doubtful nights; unexpected blessings and catastrophic setbacks; moments of enlightenment and monstrous attacks; derailing adventures and inspirational encounters; testing situations and joyful celebrations, and more.

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Stylianos Mystakidis

INDEX OF FIGURES

CONTENTS

LIST OF ORIGINAL ARTICLES

I. Mystakidis, S., & Berki, E. (2018). The case of literacy motivation: Playful 3D immersive learning environments and problem-focused education for blended digital storytelling. *International Journal of Web-Based Learning and Teaching Technologies*, *13*(1), 64–79.

II. Herodotou, C. & Mystakidis, S. (2015). Addressing the retention gap in MOOCs: Towards a motivational framework for MOOCs instructional design. In *16th Biennial EARLI Conference for Research on Learning and Instruction Proceedings*. Limassol, 25–29 August 2015.

III. Mystakidis, S., & Herodotou, C. (2016). OpenQuest: Designing a motivational framework for MOOCs instruction. In *MOOCs in Europe* (pp. 141–145). European Commission.

IV. Mystakidis, S., Berki, E., & Valtanen, J. (2017a). Designing and implementing a big Open Online Course by using a 3D Virtual Immersive Environment – lessons learned. In *9th Annual International Conference on Education and New Learning Technologies (EDULEARN17) Proceedings* (pp. 8070–8079). Barcelona, 3-5 July 2017.

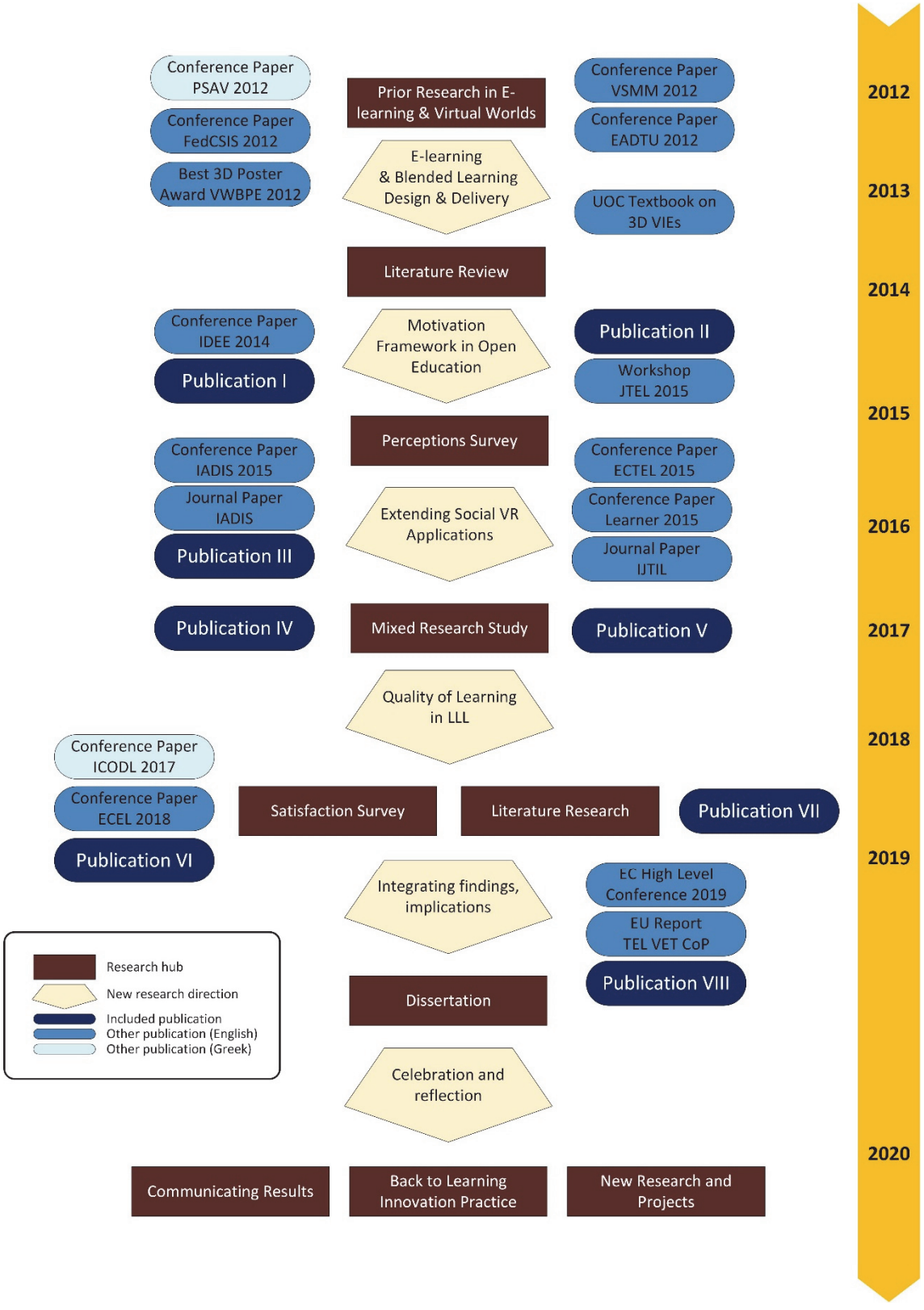
V. Mystakidis, S., Berki, E., & Valtanen, J. (2017b). Toward successfully integrating mini learning games into Social Virtual Reality Environments – Recommendations for improving Open and Distance Learning. In *9th Annual International Conference on Education and New Learning Technologies (EDULEARN17) Proceedings* (pp. 968–977). Barcelona, 3-5 July 2017.

VI. Mystakidis, S., Berki, E., & Valtanen, J. (2019). The Patras blended strategy model for deep and meaningful learning in quality life long distance education. *The Electronic Journal of e-Learning*, 17(2), 66–78.

VII. Mystakidis, S., Berki, E., & Valtanen, J. (Submitted). Deep and Meaningful E-learning with Social Virtual Reality Environments in Higher Education: A Systematic Review. *Australasian Journal of Educational Technology*.

VIII. Mystakidis, S., Cachafeiro, E., & Hatzilygeroudis, I. (2019). Enter the serious e-scape room: A cost-effective serious game model for deep and meaningful e-learning. In *Proceedings of the 10th International Conference on Information, Intelligence, Systems and Applications (IISA 2019)*. Patras, 15-17 July 2019. IEEE.

GRAPHICAL REPRESENTATION OF THE STUDY



1 INTRODUCTION

1.1 Research context and significance

Deep and meaningful learning is a theory with a long academic record with the potential to address some of the most pressing educational challenges. In 2015, the United Nations General Assembly adopted 17 Global Goals for Sustainable Development to guide the aspiring transformation of our world by 2030 (United Nations, 2015). The fourth of these goals is 'Quality Education' (p. 19) declaring the intention "to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". At the same time, exponential technologies and trends transform work and economy and lead to a profound systemic change termed fourth industrial revolution (Gleason, 2018; Schwab & World Economic Forum, 2016).

Higher education has the potential to transform society by shaping graduates who can make a substantial difference and has therefore been mandated to address these associated challenges. A global political and academic debate is raging over depth or breadth of higher education curricula, generalist vs. specialist education, multiple accountabilities and university mission overload (Shay, 2016). Should universities prioritize formative theoretical knowledge or applied theory and problem-solving for employability (Blackie, le Roux, & McKenna, 2016; Valtanen, Berki, Georgiadou, Ross, & Staples, 2011)? To answer to this dilemma, it is essential to consider the alternative future outcomes in the macro scale of higher education sector.

Young and Muller (2010) posited that there are three alternative scenarios. The until recently predominant 'traditionalist' ahistorical, under-socialized paradigm validated empiricism and elevated theory (Muller, 2015). Currently there is a rising movement of over-socialized 'progressivism' rooted in the epistemological theory of constructivism that valorizes skills at the expense of knowledge.

Both paradigms have important strengths that should not be neglected. The proposed solution is an emergent mixed 'social realist' scenario that integrates the best elements of both previous approaches; a university that delivers a robust combination of conceptual, theoretical knowledge and cumulative procedural, practical knowledge and skills. The latter, procedural knowledge has multiple layers and can be divided into essential, domain general and domain specific problem-solving skills (Greiff et al., 2014).

One framework that can support theoretically this balanced and complex learning mix is deep and meaningful learning. The question is how? Behind this dichotomy between 'pure' and 'applied' lay deeper issues and questions about the epistemological foundations of knowledge, teaching and learning, linked also with well-being (Berki & Cobb-Payton, 2005; Walker, 2015). Additionally, the actual direction of the subsequent higher education policies depend on the actual employed teaching and learning practices in the field as curricula are lived experiences (Alvunger, Sundberg, & Wahlström, 2017). These approaches and practices are influenced in turn by teachers conceptions of what constitutes good teaching (Barnett & Guzmán-Valenzuela, 2017). The two main categories of teaching conceptions are teacher-focused and student-focused (Ginns, Kitay, & Prosser, 2008). The teacher-focused conception adopts the notion that knowledge should be transmitted to students. The assumption behind the student-focused approach is that the student has to develop personally (Åkerlind, 2003). Biggs (1999) emphasizes student activity and advocates for the linking of outcomes and activities with higher order thinking processes. However, there are multiple paths and good practices to quality teaching (Pratt, 2002). Slavich & Zimbardo (2012) argue for the value of transformational teaching practice. Cheville (2016) suggests a personalized organization of the structural stage of curriculum as self-narrative; learners are empowered to actively decide and shape their own path of mastery towards a formal credential by undertaking self-directed learning experiences. In this context, students autonomy, self-regulation, satisfaction, interest and motivation are crucial for learning (Hickey, 1997).

Teaching and learning in an era of smart, digital innovation face further the challenges of increasing upskilling and reskilling demands and higher education massification driven by non-traditional students (Blackie et al., 2016). As a result, new policies, reforms and initiatives have been deployed to increase participation in all levels of education and improve its standards. Lifelong learning includes formal, informal and non-formal processes of knowledge and skills acquisition in anticipation to societal, economic and technological changes (Illeris, 2009). High participation in effective tertiary and lifelong learning has been observed to mediate economic growth and social prosperity (Jarvis, 2007) and well-being (Saariluoma, Cañas, & Leikas, 2016). The rapidly rising demand for tertiary education and lifelong learning surpasses the global capacity to provide education by traditional, brick-and-mortar, campus- and classroom-based models (Altbach, Reisberg, & Rumbley, 2009). In any case, more education does not lead automatically to more or better learning or social mobility. For instance, the people facing the highest levels of urgency to address skills and knowledge gaps are

in unprivileged condition to engage in lifelong learning (Boeren, 2009). For a society, country, nation or state to thrive in a global, knowledge-based era, citizens should learn to (i) know, (ii) do, (iii) be and (iv) live together (Delors, 1996; Faure et al., 1972). New educational models and practices are needed to open up education and meet pressing learning demand.

One educational practice that rose to prominence from the periphery to the mainstream with the emergence of Internet and mobile access with smart, handheld devices, was distance education and, electronic learning, e-learning or online learning (Clark & Mayer, 2003). Educational technology, open education and internet carry the potential to deliver anywhere, anytime, flexible education for all (Weller, 2014). However, this has not happened yet; the mere emergence and application of information and communication technologies in education has not addressed the aforementioned challenges (Ossiannilsson, Williams, Camilleri, & Brown, 2015). The quest for mass quality, flexible, personalized education remains (Jansen, Rosewell, & Kear, 2017).

It can be argued that this unfulfilled potential of e-learning can be attributed to a lack of a new, effective theory of learning specifically for e-learning (Andrews, 2011). E-learning does not just enhance an existing learning process; it is fundamentally different mode than traditional learning as it changes the nature of learning and knowledge (Bates, 2015). As Andrews notes (2011), e-learning differs from attendance-based learning as these two modes differ in the social aspect of learning; online communities are fundamentally different than communities in physical spaces. E-learning extends the affordances of learning in terms of spatial limitations, resource use and implementation time as it features a different mode of transactional distance (Moore, 1997). Gilbert (2005) argues pragmatically that knowledge in the digital age is not an object but a process, produced in interpersonal interactions. Also, e-learning promotes a more democratic, less hierarchical relationship between learners, teachers and knowledge that allows new ways of organizing learning unrestrained by institutional boundaries (Bonk, 2012).

One emergent theory of learning that claims to provide a new, better lens to organize and better understand learning with the use of digital technologies is connectivism (Anderson & Dron, 2011; Siemens, 2005). It argues that knowledge is a network of connections and therefore learning consists of the ability to construct and explore those networks (Downes, 2007). Connectivism principles have social constructivist underpinnings (Kop & Hill, 2008). The application of connectivist principles in online learning lead to the movement of massive open online courses – MOOCs (Rhoads, 2015). Critical accounts of connectivism (AlDahdouh, Osório, & Caires, 2015; Clarà & Barberà, 2013, 2014; Goldie, 2016; Wade, 2012) point out that connectivism introduces a radical shift with pedagogical merit but it requires further development and testing, among others regarding its association with other, existing theories; it describes how student learning should be organized but not the role of educators.

In this fluid context of networked learning, it is essential to investigate how we can design and organize e-learning in ways that keep students engaged, motivated and self-directed and at the same time be able to overcome adversity and manage the cognitive load of learning (Stevens, 2018). Cognitive load theory (Sweller, 1994) bridges psychology with biology and points our attention to the limits of working memory. It encourages efforts to maximize useful, germane cognitive load that drive learning in the form of schemata construction (van Merriënboer & Sweller, 2005). At the same time it strives to minimize distracting, extraneous load that threatens to overload student mental activity (Kirschner, 2002).

Deep and meaningful learning has structural conceptual correspondences with both connectivism and the cognitive load theory; all three of them focus on mental link creation among entities or concepts. Deep and meaningful learning embraces learning as a complex cognitive mental model building process with a social dimension where emotions play a central role. Deep and meaningful learning has been researched in the frame of e-learning (Morin, Thomas, & Raafat, 2012; Offir, Lev, & Bezalel, 2008; Rourke & Kanuka, 2009; Tsai, Shen, & Chiang, 2013). Findings suggest it is hard but possible to facilitate deep and meaningful learning achievement in distance education settings if teachers are committed to effective, student-centered learning techniques that combine domain-general and domain-specific skills (van Merriënboer & Kirschner, 2012), elicit high satisfaction and avoid the pitfall of student overload (Delotell, Millam, & Reinhardt, 2010; Ke & Xie, 2009; Mimirinis & Bhattacharya, 2007; Yoon, 2003).

E-learning has its share of challenges that the field tries to overcome: technology shortcomings, access problems, ineffective learning design, insufficient organization, lack of effective social discourse, lack of support, learner isolation, difficulty to monitor, manage and support learners' emotions are factors that lead to low satisfaction and high attrition rates in distance education (Tyler-Smith, 2006; Willging & Johnson, 2009).

One promising new technology that can address social and emotional aspects of learning in open distance learning by transcending limitations of 2D, web-based interfaces is 3D virtual worlds, multiuser immersive virtual reality environments. Immersive learning environments add a new dimension to e-learning with increased degrees of teaching freedom, learning flexibility and creativity (Kampylis, Berki, & Saariluoma, 2009). Social Virtual Reality Environments (SVREs) can facilitate superior self-expression, formal and informal genuine peer communication and enable active, authentic, motivating experiences. Although several technologies can contribute to the enhancement of learning (Kirkwood & Price, 2014), the use of 3D virtual immersive environments has promising characteristics to facilitate the transformation of distance learning towards deep and meaningful learning (Steils, Tombs, Mawer, Savin-Baden, & Wimpenny, 2015). Effective learning in desktop virtual reality simulations can take multiple paths but all them involve affective factors and students' beliefs (Makransky & Petersen, 2019).

These characteristics of SVREs along with technical features such as cross-platform compatibility of open 3D resources enable educators to support the application of teaching and learning methods that amplify learners' motivation. Motivation enhancement methods can be structured with the appropriate adoption and adaptation of game design principles and game elements (Williams, Paunesku, Haley, & Sohl-Dickstein, 2013). Game-based motivation amplification methods include playful design, gamification and serious games. Thus, SVREs appear to have the necessary affordances to address two eventually neglected aspects in distance education; rich social interaction and motivation, two vital, often missing dimensions to enable deep and meaningful learning achievement in quality distance education along with cognitive engagement (Hassouneh & Brengman, 2014; Mystakidis et al., submitted).

Deep and meaningful learning has not been studied sufficiently in the context of social virtual reality environments for distance education and game-based learning motivation enhancement methods. This research aims to make a theoretical contribution towards deep and meaningful learning in distance education. Deep and meaningful learning at scale leads to the improvement of e-learning quality. High quality e-learning can be utilized to address pressing societal and economic educational needs that affect the future of higher education and lifelong learning. Facilitating deep and meaningful learning in online education to provide quality flexible, personalized, transformative learning for large audiences could open new educational frontiers and achieve new milestones of economic growth, social progress and well-being (Saariluoma & Leikas, 2010).

1.2 Research goal and objectives

The overarching goal of this dissertation is to explore and describe the effects of motivation-enhancement approaches using social virtual reality environments in e-learning and open education. In this way, this research strives to make a theoretical contribution towards high quality, deep and meaningful e-learning and distance education. In the pursuit of the overall aim, the research objectives of the current thesis are to:

1. Acquire empirical knowledge on various game-based motivation-enhancement methods in e-learning and open distance education settings (Articles I, IV, V, VIII)
2. Design theoretical motivational frameworks and models for open education and e-learning (Articles II, III, VI, VIII)
3. Assess the effect of game-based motivation-enhancement methods on participants' drop-out rates (Article IV)
4. Collect data about the effect of game-based motivation-enhancement methods on student satisfaction (Articles IV, V, VIII)
5. Articulate recommendations for the design of quality open education and e-learning. (Articles IV, V, VI)

1.3 Thesis structure

This thesis has six chapters. In Chapter 1 the research area and the rationale for this study is introduced. In Chapter 2 we define and explain the background theoretical concepts with the assistance of previously conducted research. In Chapter 3 we present the research approach and methods used in the thesis. In Chapter 4 we summarize the published articles and their main findings. In Chapter 5 follows the explanation and discussion of the results. In Chapter 6 we conclude with the contribution of this research and the future research recommendations.

2 THEORETICAL BACKGROUND

2.1 E-learning, open education and MOOCs

Electronic or e-learning is defined by Sangrà et al (2012) as

> *...an approach to teaching and learning, representing all or part of the educational model applied, that is based on the use of electronic media and devices as tools for improving access to training, communication and interaction and that facilitates the adoption of new ways of understanding and developing learning.*

Anderson and Dron (2011) identified three generations of distance education design pedagogy that reflected the practitioners' epistemological beliefs and worldview; cognitive-behaviourist, social constructivist, and connectivist.

Open Education is an online learning approach that emerged from the need for open access and distance mode learning that was initially provided by Open Universities. E-learning and more specific Open and Distance Education is recognized as a key contributor for the achievement UN's Global Goal for Sustainable Development 4 for Quality Education (Lane, 2017).

Recently Open and Distance Education aspired some of the values and culture of Free/Libre Open Source Software (Raymond, 2001) to facilitate the access of all to education and social learning. Initially the movement for openness in education was focused on content, namely Open Educational Resources (OECD, 2007) and Open Courseware (Vest, 2004). Next, the attention was shifted to Open Educational Practices, such as Open Access to research results and/or publications and the Open Online Courses, educational programmes that are mostly free and accessible for all via the Internet (Deimann & Farrow, 2013).

The Connectivism and Connective Knowledge course (CCK08) offered by the University of Manitoba in 2008 was the first open online learning programme in a massive scale, with approximately 2,200 informally enrolled participants. A

few years later, open and distance learning got a new distribution vehicle in Massive Open Online Courses (MOOCs) offered by prominent professors in famous western universities that became very popular partly due to the cost-free enrollment (Conole, 2013). MOOCs constituted a revolutionary development in teaching and learning with the assistance of technology that enabled free and flexible access to knowledge for millions of learners globally. 2012 was hailed by mass media as the year of the MOOC (Chacón-Beltrán, 2014; Mystakidis & Berki, 2015). Ever since one evidences the emergence of Massive Open Online Courses as the means to help thousands of people all over the world learn online, and access tertiary education, life-long learning and training. Notably, universities, organizations and business companies design and offer OOCs to address skill gaps, organizational and societal needs while policy makers encourage the adoption of Open Education and MOOCs (Milligan & Littlejohn, 2014). For instance, the European Commission chose Open Education as an official strategy to encourage rapid, flexible, cost-effective training, upskilling and reskilling of large population groups and workforce (European Commission, 2013, 2014; Mystakidis, Berki, & Valtanen, 2017a).

According to various research studies' findings and reviews, distance education when designed, planned and implemented with an appropriate blend of pedagogical approaches, methods and technological means is equally effective and in some specific cases more effective than classroom-based instruction (Means, Toyama, Murphy, Bakia, & Jones, 2010; Mystakidis, Berki, & Valtanen, 2019; Siemens, Gasevic, & Dawson, 2015).

As a result, more MOOCs are being produced and offered by an increasing number of providers and attract millions of enrolments (The Harvard Gazette, 2015). However, MOOCs are suffering from extremely high drop-out rates (Jordan, 2014; Parr, 2013), a phenomenon which is attributed to various factors such as *low quality of instructional design, learner isolation* and *lack of motivation* to complete the courses (Margaryan, Bianco, & Littlejohn, 2014; Mystakidis, Berki, et al., 2017a). This is a phenomenon with serious implications for learners and MOOCs providers as it affects the learners' lives negatively and impacts the business model of MOOC providers, to mention but a few stakeholders. Already, major MOOC providers are transforming "common", free MOOCs into courses with entrance fees or limit the access to courses to "view-only" (EdSurge, 2016). Failure to the sustainability challenge of Open Education could mean a significant backlash in the development of the learning subject fields.

The same phenomenon of low completion rates has been observed systematically in e-learning courses and distance education programmes, in general (Levy, 2007). Consequently, the following critical issues emerged (Mystakidis & Berki, 2015):

- Do MOOC participants really learn? There is valid criticism that many MOOCs and distance education courses provide rather poor experiences (Margaryan et al., 2014) that lead to surface instead of deep and meaningful learning.

- How can we improve the quality of the learning, the acquired knowledge, skills and outcomes in Open Education and E-learning?
- How can we increase learners' engagement, participation and completion rates in Open Education and E-learning courses in general?

2.2 Deep and meaningful learning

Humans are socially curious beings. Humans' learning is considered to occur mostly within and through social interaction with others (Ataizi, 2012). Thus, learning is considered as a cultural and social process. It occurs in the context of human relationships and activities rather than just in the minds of individual learners. Hence the socio-cultural context affects what is learned and how people learn. Deep learning is characterized by the inherent interest in and active engagement with a discipline in a quest to grasp its underpinning principles and associate it with existing concepts and knowledge (Mystakidis, Berki, et al., 2019). The term deep learning stems from the research by Craik & Lockhart (1972) on the processing levels and Marton & Säljö (1976) on studying approaches during execution of cognitive tasks. Students exhibiting a deep studying approach aimed at deeper subject matter understanding and achieved durable, transformative learning. In contrast, surface, reproducing learning approaches lead to a quantitative increase of information, facts and knowledge (Marton & Säljö, 1997). A learner using deep learning approaches takes control of learning, attempts to understand the learning content and process, make sense, link it with existing concepts and transform the organization of the self (Marton & Säljö, 1976). Deep learning can lead to radical transformation of current understanding rather than the confirmation of past knowledge. Deep learning occurs when students are actively involved actively in the learning process and are given opportunities to construct meaning (Hay et al., 2008; Mystakidis & Berki, 2015). In so doing, they should be able to transform the course's concepts to personal experiences and meaning that help them develop as persons. Deep learning is directly linked to manifold thinking and, in particular, creative, critical and reflective thinking (Valtanen, Berki, Kampylis, & Theodorakopoulou, 2008).

Meaningful learning builds on the interconnected attributes of teaching, studying and learning (Mystakidis, Berki, et al., 2019). Ausubel (1961) posited that meaningful learning should be the goal of formal higher education through sustained critical discourse. He associated meaningful learning construction with learning approaches such as discovery and problem solving resulting in the ability to identify the underlying structure and connect existing with new concepts (Jonassen, 2003; Mystakidis, Berki, et al., 2019). Learning becomes meaningful when it exhibits five descriptive characteristics: active, constructive, intentional, authentic, and cooperative or relational (Jonassen & Strobel, 2006). Short explanations for each feature follow according to Howland, Jonassen and Marra (2012) as presented by Mystakidis et al. (2019):

- Active: Learning is an active mental process. This dimension signals the active participation of learners by interacting with content and the learning environment, and engaging with a subject matter so as to make a personal cognitive contribution.
- Constructive: Learners are expected to construct continuously their own meaning by interpreting and reflecting on observed phenomena, content and the results of their actions.
- Intentional: Learners are encouraged to exhibit individual ownership, agency, be self-directed, set goals consciously and commit emotionally.
- Authentic: Meaningful learning requires tasks linked to an authentic experience or simulated, realistic context so that they become personally significant and transferable.
- Cooperative/relational: Human learning is also a social process involving learners and teachers. Group collaboration and peer conversation occurs naturally in knowledge building communities. Also, the engaged, passionate teachers contribute significantly to the emotional involvement of learners.

The two concepts, deep learning and meaningful learning, have been used combined and unified in the term "deep and meaningful learning" as there are correspondences in their construction (Hay, 2007; Rourke & Kanuka, 2009).

2.2.1 Related concepts and theories

In this research we encountered and considered holistically also other relevant concepts and theoretical frameworks with similar underpinnings in literature. These are significant learning, transformative learning, and deeper learning.

Significant learning is a result of student-centered teaching and involves a personal change or development in learners (C. Rogers, 1951). For learners to achieve significant learning, they need to participate in an educational experience that engages them on many different levels, thereby leading to the creation of lasting knowledge, applicable to real-world situations (Delotell et al., 2010). Fink (2003) distinguishes six interactive learning categories; Foundational knowledge; Application; Integration (making connections); Human dimension (social dimension); Caring (affective dimension); Learning how to learn (meta-cognition) (Mystakidis, Berki, & Valtanen, submitted). Researchers have also proposed the terms transformative, expansive and biographical learning with similar meanings and interpretations (Illeris, 2004). Mezirow's (2003) theory of transformative learning stresses the importance of personal development and change of view and beliefs through critical thinking and self-reflection facilitated by deliberate disorienting challenges and dilemmas (Christie, Carey, Robertson, & Grainger, 2015). Deeper learning advocates learning beyond rote content knowledge accumulation. Deeper learning is associated with higher-order thinking skills and mastery of transversal skills such as critical thinking, collaboration, communication and problem-solving (Martinez & McGrath, 2014).

All the mentioned theories and concepts orbit around the transformative potential of powerful learning experiences leading to knowledge that lasts and helps learner evolution and self-betterment. Indeed, deep and deeper learning are expected to achieve learning transfer. Profound changes of transformative learning can happen with the help of significant and meaningful learning (Mystakidis, Berki, & Valtanen, submitted).

2.2.2 Deep and meaningful E-learning

Achieving deep and meaningful learning is a challenge in all settings -classroom-based, distance or blended- considering that the key stakeholder of the learning process is each learner with his/her unique features, characteristics, mental and emotional capacities (Mystakidis, Berki, et al., 2019). Institutions, teaching and administrative staff need to design and implement multi-faceted quality learning experiences that enable deep learning (Entwistle, Peterson, & Elizabeth, 2000). Deep and meaningful learning requires considerable care, preparation, attention, mastery and effort (Mystakidis, Berki, et al., 2019). Technology and computers can support meaningful learning when used for knowledge construction, conversation, articulation, collaboration and reflection (Howland et al., 2011; Jonassen, 2003; Yoon, 2003).

Deep learning is an even more daunting challenge in distance education (Baeten, Kyndt, Struyven, & Dochy, 2010; Mystakidis, Berki, Valtanen, & Amanatides, 2018). From the early years of Internet and the World Wide Web, e-learning aimed at providing quality learning for higher-order thinking skills. Bonk & Reynolds (1997) proposed that online learning should have a student-centered focus; meaningful, demanding activities should help students link new information with existing knowledge and develop metacognitive skills.

The community of inquiry model was developed to promote high quality, deep and meaningful learning in distance education (Garrison, Anderson, & Archer, 2010). Coming from social constructivist background, its empirically supported premise it that successful online learning experiences combine teaching, cognitive, and social presence. The teaching presence consists of the responsibilities and actions of tutors such as design, facilitation and direct instruction. Cognitive presence is defined as "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication" (Garrison, Anderson, & Archer, 1999). Social presence signals the shared social identity in a trusting environment where students can communicate purposefully.

Distance education features predominantly flexible self-directed study in asynchronous mode. Even when learning combines synchronous teacher-lead or peer collaboration activities, *learner isolation* is an inherently inhibiting factor (Mystakidis et al., 2018; Paulus & Scherff, 2008). Researchers suggest using active and challenging learning activities, collaborative problem-solving tasks and emotional empowerment to promote deep learning in distance education (Hacker & Niederhauser, 2000). Also neglecting the importance of intrinsic motivation in distance education has resulted in high drop-out and attrition rates

(Mystakidis, Berki, et al., 2019; Tyler-Smith, 2006). When e-learning students cannot socialize with their peers they are more likely to drop out (Willging & Johnson, 2009). This effect has been observed in a magnified scale in Massive Open Online Courses (MOOCs) where global participation in MOOC iterations rose to thousands and even hundreds of thousands but completion rates typically fluctuate around or below 10% (Jordan, 2015; Mystakidis et al., 2019).

Deep learning suggests an outcome or competence-based design approach in distance education (Berki & Georgiadou, 2001; Guàrdia, Maina, & Sangrà, 2013). Studies in the context of distance education and e-learning connect deep learning with active learning, peer communication and collaboration (Morin et al., 2012) as well as high levels of teaching and social presence (Bangert, 2008; Mystakidis et al., 2019). Meaningful learning in distance education is based on quality versus quantity of meaningful online interactions of learners with content, instructors and peers (Yoon, 2003). These interactions should be designed around authentic online activities that require complex knowledge construction tasks and provide opportunities for collaboration and reflection (Garrison & Cleveland-Innes, 2005; Mystakidis et al., 2019; Woo & Reeves, 2007). Distance courses designed with constructivist approaches combining a flexible curriculum with fluid content and strong emphasis on community interactions, open-ended discussions and team assignments achieve higher levels of learner satisfaction and deep learning (Ke & Xie, 2009).

2.2.3 Deep and meaningful learning dimensions

In all learning situations we interact with and within an environment and context around a specific subject content to be acquired. This process is also being influenced by our incentives, interest, engagement and motivation. Thus, according to the deep learning theory, a quality learning process should engage participants holistically, namely cognitively, socially and emotionally (Fink, 2003; Garrison et al., 1999). Learning thus encompasses three essential elements: content, social interaction and incentive that are linked to respective dimensions: cognitive or logical; social or intrapersonal; and emotional or affective (Illeris, 2018).

Next, we will describe briefly each of these three dimensions.

1. *Cognitive dimension:* Learning is a complex cognitive process (Craik & Lockhart, 1972). In an attempt to describe and classify the level, depth, complexity and quality of student learning and cognitive understanding in the context of deep learning, Biggs & Collis (1982) formulated the Structure of the Observed Learning Outcome taxonomy. SOLO taxonomy distinguishes two phases in student learning. In the quantitative, surface phase learning is mainly superficial, additive accumulation of unlinked facts (Mystakidis et al., submitted). In the qualitative phase, learning results to advanced, deeper understanding, ability of application, reflective abstraction and transfer. The two higher levels of SOLO taxonomy, namely relational understanding and extended abstract understanding, are evident of deep learning and correspond to the higher-order thinking levels of

Bloom's revised taxonomy (Anderson et al., 2000), i.e. Analysis, Evaluation and Creation.

2. *Social dimension:* Humans are socially curious beings. Humans' learning is considered a social and cultural phenomenon occurring mostly within and through direct or indirect interaction with other humans, teachers and learners. (Hartnett, 2016). Hence the socio-cultural context influences what is learned and how people learn. The social aspect has been brought to the forefront in the last decades thanks to the work of several important theorists and researchers (Jarvis, 1987; Lave & Wenger, 1991; Wenger, 1998). Interaction, collaboration, and reflection are integral parts of deep and meaningful learning (Jonassen & Strobel, 2006). In the Community of Inquiry framework, social presence is recognized as one fundamental element for deep learning experiences (Rourke & Kanuka, 2009). Building and maintaining online communities of inquiry and practice is an instructional factor that facilitates learner motivation (Bonk & Khoo, 2014).
3. *Affective dimension:* Emotions are an inherent element of the learning process. Knowledge is associated with emotions and feelings. Feelings and emotional states evoked by internal or external factors can either facilitate or inhibit learning (Juutinen & Saariluoma, 2010; Mystakidis, Berki, et al., 2019). In e-learning attitudes and self-efficacy towards technology influence the quality of the learning experience (Pellas, 2014). The Community of Inquiry framework incorporates emotional expression, as a part of social presence. There are empirical evidence and claims to recognize and integrate emotional presence as a fourth fundamental element to online learning experience (Cleveland-Innes & Campbell, 2012; Majeski, Stover, & Valais, 2018; Stenbom, Jansson, & Hulkko, 2016).

2.3 Motivation

Motivation is one of the most important affective aspects of learning because it influences the cognitive processes of learning (Schiefele, 1991). It has been described as the 'engine' of learning (Paris & Turner, 1994). Motivation in the context of education is defined by Wentzel and Wigfield (2009) as:

> *...the energy [learners] bring to [educational] tasks, the beliefs, values, and goals that determine which tasks they pursue and their persistence in achieving them, and the standards they set to determine when a task has been accomplished.*

Motivational factors include goal orientation, interest and self-efficacy beliefs (Eccles & Wigfield, 2002). Despite students' intellectual capacity, their level of motivation determines their actual learning performance (Cole, Feild, & Harris, 2004). Humans can have multiple goals and motives of different nature in parallel, extrinsic or intrinsic (Covington & Müeller, 2001). Learners with extrinsic oriented goals engage learning for external incentives such as passing an exam, getting a high grade, material rewards or avoiding a negative consequence

(Mystakidis, Berki, et al., 2019). Extrinsic motivation is associated with surface learning, anxiety and high drop-out rates (Rothes, Lemos, & Gonçalves, 2017). Learners with autonomous, intrinsic motives and goals are driven by the practice of learning itself. The self-determination theory (SDT) is a theoretical framework that studied motivation from a psychological point of view to determine what motivates learners, how and why (Ryan & Deci, 2000). SDT postulates that intrinsically motivating actions can be enacted in learning environments that exhibit choices, direct feedback, optimal challenges, mastery of meaningful tasks, self-directed interaction and social connectedness (Mystakidis & Herodotou, 2016; Ryan & Deci, 2008). Ryan and Deci (2000) define intrinsic motivation as "the inherent novelty to seek out challenges, to extend or exercise one's capacities, to explore, and to learn". When people like a course and enjoy a learning experience that is meaningful to them, they tend to participate more, set relevant, intrinsic goals and achieve them in it (Schunk, Meece, & Pintrich, 2014). Personal interest in the studied subject is a predictor of deeper comprehension (Schiefele, 1992). Intrinsic motivation is associated with deep learning, high performance and learning resilience (Mystakidis, Berki, et al., 2019; Zainuddin, 2018). Also, many intrinsically motivating teaching and learning practices are inherent in learning environments with social constructivist underpinnings (Hickey, 1997).

Seeking to achieve and sustain a high level of intrinsic learning motivation, it is essential to consider that motivation is situative and is influenced by intermingled contexts (Nolen, Horn, & Ward, 2015). More specific, motivation can be moderated by individual characteristics, environmental and social conditions, and learning design factors (Rosenzweig & Wigfield, 2016). Especially in learning communities, motives are linked to desired identities under construction in particular contexts (Nolen et al., 2015). Hence, teachers designing learning environments with appropriate cultural norms and values, can support identification with a social practice and change individuals' motive for learning.

However, motivation's dynamic, responsive nature to different situations means that self-regulation in study can be disrupted. Multiple action tendencies and conflicting motives concerning leisure and instant gratification are active, this is why motivational interferences can occur at any point (Grund, Schmid, & Fries, 2015). Therefore, elaborate efforts are required to enhance intrinsic motivation to learn. These efforts can focus on learners' traits, instructional design or other situational factors. One suggested course of action for students is establishing study habits (Galla & Duckworth, 2015). Another practical suggestion towards teachers seeking to enable deep learning experiences is providing opportunities for the alignment of students' actions with core aspects of the self, such as their interests (Grund et al., 2015).

2.4 Motivation enhancement in E-learning

Learners' emotions and motivation's complexity are often neglected in e-learning. Thus, ignoring the effect of emotions such as frustration and low intrinsic

motivation in distance education and other factors such as user isolation and conflicting adult roles and responsibilities, have resulted in high drop-out and attrition rates (Paulus & Scherff, 2008). Education practitioners do not always know or are able to motivate, engage learners and integrate meaningful social activities (Mimirinis & Bhattacharya, 2007). MOOCs typical high drop-out rates are a symptom of this problem.

One potential answer to tackle this deficiency is the purposeful focus, nurturing and enhancement of learners' motivation in the direction of cultivating a learning atmosphere conducive to intrinsic motivation. An e-learning environment and a shared ethos supporting students' needs for the three integral components of SDT, autonomy, competence and relatedness, has a higher probability to record increased satisfaction, engagement and achievement (Chen, Jang, & Branch, 2010).

SDT postulates that intrinsically motivating actions can be enacted in environments that exhibit choices, direct feedback, optimal challenges, self-directed interaction and social connectedness (Herodotou & Mystakidis, 2015; Ryan, Rigby, & Przybylski, 2006). These attributes are inherent characteristics of games (Salen & Zimmerman, 2004). There is a great deal of commonality between the characteristics of games and the characteristics of effective learning experiences such as challenge, goals, outcomes, interaction, exploration and safe environment (Mystakidis & Herodotou, 2016). Yet, the aspect of competition might shift the focus from learning to winning, which might not be motivating for some learners. Indeed, recommendations to address the retention gap in distance education include adopting a participation-driven approach (Ross, Sinclair, Knox, & Macleod, 2014), using game design techniques in the courses' pedagogical design for the enhancement of participants motivation (Kapp, 2012) and supplementing the predominant asynchronous learning paradigm in MOOCs with synchronous learning activities and virtual meetings (Mystakidis & Berki, 2014; Mystakidis et al., 2017a).

The theory of Situated Motivational Affordance (Deterding, 2011) stresses the need for a meaningful integration of game elements in a system, including understanding users (expectations, skills) and the organizational context of learning (e.g. continuous professional development acquisition, curiosity), if it is to work motivationally (Herodotou & Mystakidis, 2015). Flow theory is an appropriate framework for designing impactful learning experiences. To become absorbed in an activity requires a match between a person's capabilities and level of difficulty (Csikszentmihalyi, 1990). If this analogy is maintained, learners experience the optimal enjoyable psychological condition of flow; high immersion and energized concentration while overcoming obstacles. It is advisable learning to have a flexibility mechanism for learners to customize and self-direct it based on their own learning needs (Mystakidis & Herodotou, 2016).

Motivation enhancement strategies (Williams et al., 2013) are essential to engage participants in active learning experiences. The value of game and play for learning is not new. Plato in ancient Greece argued in favor of the value of play, positive motivation and voluntary participation in education: "Do not,

then, my friend, keep children to their studies by compulsion but by play" (Bloom, 1991). Game design, mechanisms, processes and effects are proposed foci of study for all education professionals so as to derive useful conclusions on practical ways to enhance and facilitate learning by increasing students' intrinsic motivation (Gee, 2004). Game-based learning strategies include playful design, gamification and serious games. Game-based motivation enhancement strategies have been applied in education and e-learning, and are at the epicenter of interdisciplinary research and business development. Next, we will present shortly each of them in increasing degree of design complexity and implementation difficulty.

2.4.1 Playful design

Play has fundamental differences to a game. A game has rules, boundaries and organizes participants' activity towards specific objectives by exercising strategy, skill and effort. Play on the other hand is the free, improvised expenditure of energy for its own sake and is not moderated. Playful design is the simplest way to integrate the enjoyable element of fun in a 'serious', non-gaming context (Borges, Durelli, Reis, & Isotani, 2014). One example of playful design in the field of web design is the use of a clever graphic image or text message in an otherwise mundane, indifferent webpage such as an error page. This application of playful design principles in an external context can be also called playfication.

In the context of education and e-learning, playful design can be applied with the intention to arouse students' positive emotions such as attention, interest and curiosity. One basic method to introduce playful design in e-learning is by using appropriate metaphors, and multimedia resources such as images, music and video in the design of the learning environment and the communication with participants (Mystakidis, 2010). This tactic allows educators to create an inviting, non-threatening environment and learning atmosphere where distant learners can feel safe, welcome and free to express themselves. Playful communications prompt educators to treat each interaction with participants as motivation opportunity and invitation for engagement.

One advanced playful design technique is to create a background story and add a layer of narrative in the educational programme. Stories and storytelling have been used since the emergence of mankind to relay knowledge and wisdom from one generation to the other (Bruner, 1991). Narratives and stories have been used to share culture and communal values across time and shape collectively human behavior (McAdams, 2006). Humans have always used interactively words and actions to depict elements and images of plots that elicit imaginative responses in a social setting. Storytelling can occur orally or in written form. Oral storytelling can eventually integrate dramatic, theatrical performance elements such improvisation, gestures and body language. The emergence of modern, digital media enabled digital storytelling. Digital storytelling adds an emphasis on multimedia, visual representation and auditory elements such as music and sound effects (Ohler, 2006).

Stories combine several pedagogical advantages that make them a powerful method in education. When we share stories within a community, members learn from each other without suffering the consequences of the actual experience (Van Eck, 2007). A comparative study has shown that narrative in written communication improves knowledge retention. Adults tend to recall better and more facts and declarative knowledge elements when they encounter them linked in a plot than when they process them in an unstructured simple format (Adaval & Wyer, Robert S., 1998). Digital storytelling can be used to design playfully and creatively teaching or active learning in individual or group projects (Mystakidis & Berki, 2018). Assignments in playfully designed setting can become quests and students become fictional or existing role-playing characters. In this way, activities are tied to the story; learners are no longer passive recipients of a rigid curriculum but active participants with agency, vested in the final outcome.

2.4.2 Gameful design (gamification)

Gameful design or gamification is the application of elements of game design and elements such as game dynamics and mechanics in other, non-gaming contexts (Deterding, Dixon, Khaled, & Nacke, 2011). Early examples of gameful design in business include airline miles accrual schemes and hotels bonus systems. These systems were designed to encourage repeatable actions and reward desirable behaviors that resulted in customer loyalty. In short, gamification adds a new informational and operational layer on top of an existing activity or system that helps administrators and managers turn the said activity or system into a game.

It can be argued that education is already gamified as students pass tests and complete exams so as to earn points, more specific, a grade. However, this universal arrangement alone clearly does not promote optimal engagement and motivation in schools worldwide (Malone & Lepper, 1987). What other alternatives are there? Synthezing meaningfully structural gaming elements such as points, levels and leatherboards can turn learning into an enjoyable, engaging, gameful experience. Adding gamification on learning elements in a mechanistic way does not guarantee a lasting positive effect on learning (Sanchez, Langer, & Kaur, 2019). Extra effort is required to create a compelling experience with sufficient variability and progress so as to maintain a constantly high level of motivation and engagement.

Various gamification methods have been applied in education and e-learning. One popular gamification strategy in formal and informal attendance-based and distance education is the use of badges. Digital badges are digital, virtual rewards in the form of a visual, graphical icon (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2015). A student earns a badge when he or she completes the conditions for its achievement. Once these conditions are met, the badge appears in the student's profile in the online platform. Digital badges are promising tools to keep e-learning students engaged and motivated (Hakulinen, Auvinen, & Korhonen, 2013). For example, badges can be associated with positive, meaningful behaviors or achievements such as submitting an assignment early or by helping a peer. There are several strategies of varied sophistication on

how to deploy badges in e-learning. For instance, badges can have an impact on grades but in some other cases it makes more sense not to be immediately connected. Also, some badges can be hidden and be earned surprisingly, providing another motivational element. It is worth noting here that when digital badges are connected with learning outcomes, they can be used for the certification of skills as micro-credentials. Platforms such as Open Badges and Badgr Backpack (formerly known as Mozilla Backpack) provide tools for education providers to verify credibly and make acquired skills and competencies transparent and displayable in social networks (Jovanovic & Devedzic, 2015). This option is supported further and strengthened through the use of educational blockchain (Jirgensons & Kapenieks, 2018). Gamification methods such as badges can be combined with playful design to feature aesthetics and appealing language appropriate to the participants and the educational context.

2.4.3 Serious games

Serious or epistemic games comprise a set of meaningful choices in a restrictive context with a primary educational purpose (Michael & Chen, 2005). Serious games invite players to adopt a new identity, to become active actors, interact with peers and the game, receive immediate or automated feedback. Serious games prompt learners to think, analyze problematic situations, formulate hypotheses, take decisions, test and experiment, explore, fail in a safe way, reflect, adapt, converse and keep learning by doing. Serious games are structured around the following basic components: (i) an entertaining plot involving a fictional character, (ii) visual aesthetics and artistic elements, (iii) game mechanics implemented in a technical, software programming system, and (iv) a pedagogical approach that links the conceptual representation of specific skills and competencies in a field or discipline with learning outcomes through specific game challenges and activities (Zyda, 2005). Serious games can be used as appropriate learning experiences that allow players to enter their zone of proximal development (Lambropoulos & Mystakidis, 2012; Vygotsky, 1978); learners engage with academic and disciplinary content and competences of appropriate complexity just beyond their current level of ability. In this engaging state, learners can achieve the aforementioned sense of flow.

A serious game can be a part of a blended learning design or comprise the complete experience of a distance education programme (Romero & Usart, 2013; Thirouard, Bernaert, Dhorne, Bianchi, & Pidol, 2015). Mini learning games are 'bite-sized' educational activities with specific learning purposes and of short duration that can be played in the context of a broader educational programme (Smith & Sanchez, 2010). Studies have confirmed that serious games can be supportive environments for effective learning in multiple fields (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012).

One essential, general disadvantage of serious games is that they are the most complex, costly and time consuming game-based motivation enhancement method. Effective serious game design requires interdisciplinary approaches that

unify pedagogy and learning outcomes with game attributes and dynamics taking into account aspects such as technology, user profile, objectives, theme and evaluation methods. Therefore, democratizing serious game development, and enabling more educators to design and develop their own serious gameful experiences is a challenge.

2.5 Social virtual reality environments

Social Virtual Reality Environments (SVREs) are three-dimensional computer-generated virtual reality spaces that facilitate the social or psychological immersion of participants (Mystakidis, Berki, & Valtanen, 2017b). SVREs can be accessed either by a desktop or laptop computer. Some of them can be also experienced using a headset or a head-mounted display (HMD). In the literature, multiple other synonymous or neighbouring terms are used such as 3D virtual worlds, synthetic worlds, social virtual worlds, collaborative virtual learning environments (CVLEs), multi-user virtual environments (MUVEs), 3D virtual immersive environments (3D VIEs), collaborative virtual environments (CVEs), educational immersive environments, 3D virtual learning environments (3D VLEs), immersive virtual reality. In the context of e-learning and computer-assisted learning, the educational use of immersive systems such as virtual worlds, virtual reality or game-based systems is called Immersive Education (Bredl, Groß, Hünniger, & Fleischer, 2012).

It is worth clarifying here that the terms "*immersion*" and *"immersive"* can be associated to two different connotations, namely (a) multisensory or multimodal immersion and (b) psychological, social immersion. Multimodal immersion implies the use of a headset or a HMD. In this thesis, I have adopted the latter connotation of psychological or social immersion. According to this choice, 3D virtual world platforms or MUVEs can be considered immersive environments. Moreover, in the literature, terms such as "immersive environment", "immersive learning", "immersive virtual worlds" and "immersive education" refer commonly to desktop-based and not exclusively to headset- or HMD-mediated virtual environments (August et al., 2016; Dalgarno & Lee, 2010; Hew & Cheung, 2010; McKerlich & Anderson, 2008; Mikropoulos & Natsis, 2011; Potkonjak et al., 2016).

Virtual reality (VR) is a technological field that traces its origins in the late 1920s and the "link trainer", the first flight simulator (Jeon, 2015). In the 1960s, the "sensorama machine" provided immersive, multimodal theatrical experiences for entertainment (Robinett, 1994). In the first years of networked computing, during the 1980s, the first generation of social virtual reality systems were text-based. They were called Multi-User Dungeons (MUDs), role-playing games in fantasy settings where players choose avatars from different classes to develop specific skills or powers, explore or complete quests (Bartle, 2004). The second generation of SVREs in the 1990s and 2000s such as Traveler, Croquet, Active Worlds, There, Blue Mars, Second Life and Open Simulator used client-server

architecture and integrated graphical user interface and multimedia communication. A new, third generation of SVREs and social VR spaces offering sensory immersion such as Sansar, High Fidelity, AltSpaceVR, VRChat, Rec Room, Sinespace, Mozilla Hubs and Facebook Horizon are in their early stages. Regards education, new developers often do not take into account the long experience in immersive education (Savin-Baden, Falconer, Wimpenny, & Callaghan, 2015) and tend to "reinvent the wheel" or present already well-documented characteristics as novelties (Strange, 2017). It is wise and practical to remember that text-based SVREs had been used successfully for educational purposes decades ago (Towell & Towell, 1997).

SVREs feature a set of affordances that open new horizons of learning enhancement in comparison to 2D virtual synchronous and asynchronous learning platforms. First, they feature a superior sense of self since the participant controls his or her embodied representation, digital persona or agent, the avatar (Hinrichs & Wankel, 2012). Avatars' characteristics can be customized and modified with great detail to reflect each learner's preferences of self-expression; they can appear in human-like or completely fictional form. The identification with one's avatar in a virtual environment can have profound psychological impact on behavior and learning; embodied experiences as avatars in virtual reality spaces have direct influence on human behavior and transfer to the physical world (Yee & Bailenson, 2007).

The embodied digital identity, and the ability to engage with the environment and virtual objects in multiple points of view, such as the third-person perspective, creates the psychological sense of being in a space, experiencing presence. Presence is the perceptual illusion of non-mediation (Lombard & Ditton, 1997). This feeling is extended though the social communication with other people (Casanueva & Blake, 2001). Although real-time interactions in physical contexts carry a great pedagogical value that is difficult to replicate in online environments, SVREs offer a rich alternative; when meeting synchronously in the same 3D virtual space with other avatars and acknowledging the persons behind the personas lead to experiencing a prevalent power of co-presence. Undertaking intentional, collaborative or cooperative action as avatar in a meaningful virtual context, leads to the experience of embodied social presence (Mennecke, Triplett, Hassall, Jordan-Conde, & Heer, 2011).

Second, avatar nuanced interactions can be organized in persistent, complex, simulated or completely synthetic environments of high fidelity (Dalgarno & Lee, 2010). An existing physical place or structure can be recreated with great detail and accuracy; equally easy creators can opt to create fully fictional environments of artistic or scientific nature in the nano- or terra-scale (e.g. visualizing the solar system or a molecule in the sub-atomic level). 3D environments can be responsive through programming the dynamic behavior of virtual objects under certain conditions and states.

Third, in these environments avatars can engage in rich, embodied, interpersonal interactions. Students and educators can communicate not just in voice and text modes (e.g. private, public and group voice or text chat messages) but

also through non-verbal channels such as movement, gestures and virtual body language. Further, virtual reality environments allow the exercise of agency; avatars are free to move and navigate in the virtual space. Also, these environments are flexible and adaptable; avatars with sufficient rights can construct, modify and control the parameters of the space; if given this opportunity, learners are not passive spectators in a pre-defined sequence, they can adopt the role of active participants who can co-create, manipulate or share objects and co-shape the learning experience.

Immersive educational experiences in SVREs can act as a synthesis of learning activities that can help participants achieve learning outcomes in multiple domains of learning. In each domain, one can pursue the attainment of skills and abilities in various levels of sophistication and mastery. As described in the Cybergogy Blended Taxonomy for Learning Domains model (Chase & Scopes, 2012), immersive educational experiences can be used to facilitate the enhancement of competences in four intersecting domains (Scopes, 2009): Cognitive (intellectual) competences; ranging from remembering and understanding up to creating, following the revised Bloom's taxonomy (L. W. Anderson et al., 2000); Emotional competences (perceiving, integrating and managing emotions and feelings); Dextrous competences (virtual kinesthetic skills such as doing, being, moving, organizing, communicating); ranging from imitating to mastering; Social competences (fostering the sense to community, collaboration); ranging from personalising to channeling.

However, just like other novel educational technology systems, desktop-based SVREs in education faced early the trap of routinization (Drucker, 1999), namely the tendency to use new tools to replicate old, existing teaching and learning methods of instead of striving for new solutions that utilize their affordances. When educational institutions –largely unaware of their unique attributes- started creating their educational environments in SVREs, the trend was to replicate existing spaces, namely virtual campuses that resemble the physical buildings, with classrooms, tables and chairs (Twining & Footring, 2010).

SVREs enable educators to enhance both face-to-face teaching and distance education by applying creative and innovative instructional methods; for instance approaches with a socio-constructivist or connectivist epistemological background, where the focus is the activity of the student and the formation of communities of inquiry and practice. These methods include situated, contextual, collaborative, cooperative and experiential learning (Dede & Dawley, 2014) and also virtual coaching, mentoring and apprenticing.

SVREs combine a series of affordances that make them usable and effective platforms for all, close- or open-ended game-based methods for motivation enhancement; playful design, gameful design and serious games. First, SVREs support the development of playful design approaches, environments and activities (Warburton, 2009). Every educator and student can easily modify his or her avatar appearance by buying or creating and sharing virtual clothes and accessories, thus promoting a communal identity. In the same manner, interactive 3D objects can be shared to encourage spontaneous playful activities that promote the social

cohesion and the camaraderie of the group (Twining & Footring, 2010). For example, higher education tutors motivated their distance learning classes by providing opportunities for extra curricular group bonding activities that took place outside of formal meetings such as themed scavenger hunts, snowball fights etc. (Campbell & Cameron, 2016). Moreover, users with the appropriate administrative rights in the SVRE can create spaces that foster creative cognitive formal and informal discourse (Carr, Oliver, & Burn, 2010). For instance, a geographically dispersed team could hold a brainstorming session in an exhilarating outdoor setting that sparks creativity instead of convening as avatars in a trivial virtual indoor office meeting room (Kapp & O'Driscoll, 2010).

Second, SVREs have advanced technical systems and programming features that allows the implementation of complex gaming mechanics to accommodate gameful design, interactive simulations and serious games (de Freitas & Dunwell, 2011). Although some researchers have made in the past a clear distinction between virtual worlds, games and simulations (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014), SVREs platforms are mature systems for the development and deployment at scale of complex immersive experiences such as multiplayer role-playing simulations and games (Leigh, Courtney, & Nygaard, 2012; Mystakidis, Cachafeiro, & Hatzilygeroudis, 2019). SVREs platforms are interoperable with gaming software applications, support gaming industry standards, such as mesh, Collada files. They also include programming languages that allow the behavior specification of virtual objects and environments, and the creation of advanced features such as heads-up displays (HUDs), and conversational agents or non-player characters – NPCs (Beaumont, Savin-Baden, Conradi, & Poulton, 2012).

In the pedagogical dimension, Dalgarno & Lee (2010) point out that 3D multiuser VLEs have the potential to enable learning design strategies entailing learning activities that can enhance engagement, rich collaboration, intrinsic motivation, as well as conceptual knowledge and competences transfer to natural settings in the physical world (Garrett & McMahon, 2013), in other words, deep and meaningful learning.

3 RESEARCH DESIGN & METHODS

3.1 Research questions

The following main research question was formulated to investigate the effect of game-based motivation-enhancement approaches using social virtual reality environments in e-learning:

- What is the effect of game-based motivation enhancement methods in e-learning using social virtual reality environments?

Subsequent research sub-questions were the following:

1. Can game-based motivation enhancement methods improve the quality of learning in e-learning, and open education? (Articles I, II, III, IV, V, VI)
2. Can game-based motivation enhancement methods help participants achieve deep and meaningful learning in e-learning and open education? (Articles IV, V, VI, VII, VIII)

In the beginning of the thesis, a hypothesis was developed of the effects of game-based motivation-enhancement approaches using social virtual reality environments in e-learning. The hypothesis stated that appropriate motivation enhancement methods would have a positive effect on learning quality and that it would facilitate students' deep meaningful learning approaches. To investigate the hypothesis, articles were authored and four models were designed based on theory and empirical work.

3.2 Research methods

In this Ph.D. thesis primarily mixed research methods were utilized. The research was conducted using both qualitative and quantitative data analysis. Figure 1 shows the utilized research approach in this dissertation.

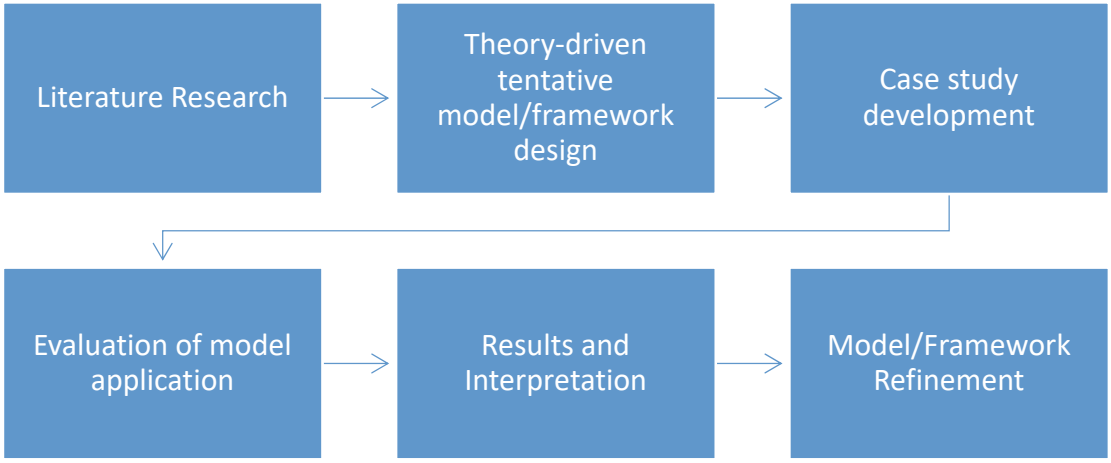


FIGURE 1 Thesis research approach

3.2.1 Mixed research

In this thesis, the main research method used was mixed research (Creswell, 2014; Venkatesh, Brown, & Bala, 2013). Mixed research is defined by Creswell, Plano-Clark, Gutmann, & Hanson (2003) as

> *"a collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially and they are prioritized. A mixed methods study involves the integration of data at one or more stages in the research process".*

The mixed method paradigm can be expansive, more creative and has less constraints than single research methods that rely strictly on one form of data. Qualitative and quantitative methods have distinct strengths and limitations. According to the fundamental principle of mixed method research, the strategic integration of quantitative and qualitative methods can combine their advantages and enrich research results (Johnson & Onwuegbuzie, 2004). The fundamental principle is followed for at least three reasons: (a) to corroborate findings, (b) to eliminate plausible alternative explanations deriving from the research data, and (c) to elucidate divergent aspects of a phenomenon (Johnson & Turner, 2003). Combining different but complementary data can help researchers validate results. Mixed methods allow the deeper explanation of quantitative data analysis results and the expansion of qualitative results interpretations. Researchers have the advantage to triangulate findings to uncover phenomena that could remain undetected if examined by a monomethod approach.

In this study we use mixed research methods systematically in a sequential explanatory strategy to study the effects of motivation enhancement methods in learning interventions. This strategy is shown in Figure 2. In this strategy, the first stage is the quantitative data collection and analysis. Next we collect and analyze qualitative data taking into account also findings from the previous phase. The rationale behind this sequential explanatory strategy is to use qualitative data to verify, explain deeper and interpret the initial quantitative results (Creswell & Plano Clark, 2011).

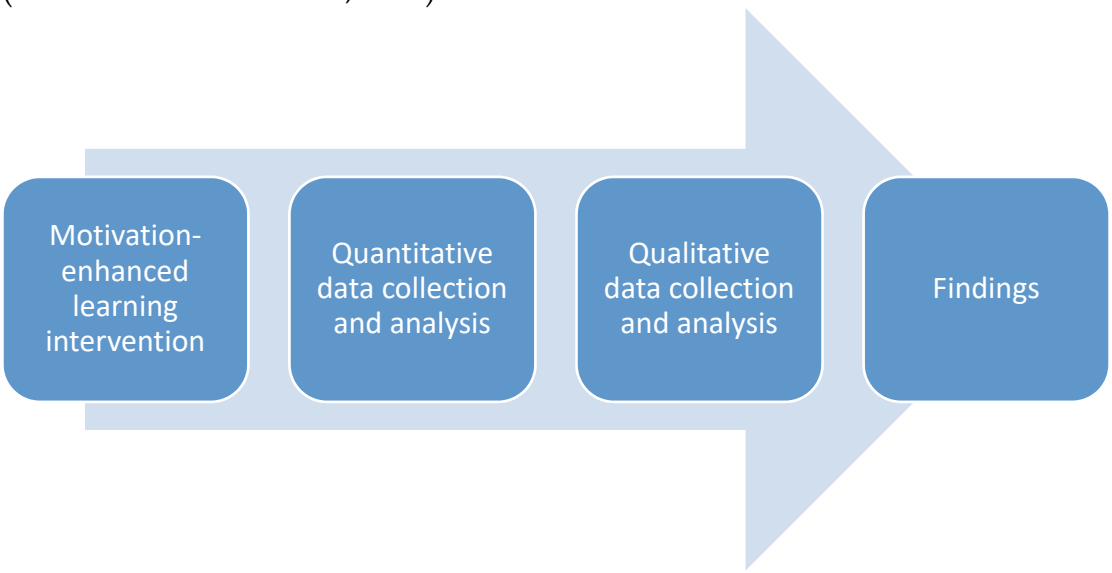


FIGURE 2 Mixed methods sequential explanatory design strategy

3.2.2 Survey

A survey is a method that collects data utilizing instruments such as questionnaires (Pinsonneault & Kraemer, 1993). It allows researchers to collect data and information cost-effectively and in a short amount of time from large numbers of respondents. One strength of the survey is that researchers can ask many questions in the same exact form to all participants without direct contact with them. Anonymous participation in surveys facilitates the expression of true opinions and safeguards the honesty of answers. Potential limitations of surveys are the low degree of participation and the ambiguous formulation of questions that lead to misunderstandings (Czaja & Blair, 2005). Therefore, researchers must be very careful in the formulation of questions as they constitute the basis of the research. Three relevant aspects are the number of questions, the total length of the questionnaire and the necessary answering time of the questionnaire; if a questionnaire is too long and the task of participating in a survey becomes a burden, then respondents could skip questions or answer without the appropriate consideration.

A questionnaire contains items that are usually categorized into open-ended and close-ended questions. Open questions give respondents the opportunity to express their opinions freely, without any verbal constraints. Close-ended questions have a set of defined answers and each respondent is called to

choose the one option that represents his or her view. Closed questions offer exact information on the specific studied phenomenon. Closed questions can have the form of a rating scale called Likert-type where participants are invited to express their level of agreement or disagreement on a statement (Albaum, 1997).

For this research, we designed questionnaires according to guidelines by Cohen et al. (2013). We used questionnaires to capture participants' opinions, goals, attitudes, experiences, knowledge and skills. The questionnaires contained both close-ended and open questions to collect complementary quantitative and qualitative data. The questionnaires were pretested and peer reviewed prior to being sent to respondents.

3.2.3 Interview

Another data collection method used in this research was semi-structured interviews. The interview is defined by Cannell and Kahn (1968) as

> *…a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused by him on content specified by research objectives of systematic description, prediction, or explanation.*

The interview is a flexible tool for qualitative data collection through multisensory verbal and non-verbal channels. The interview is an interpersonal coconstructive transaction between the interviewer and the interviewee based on trust and curiosity (Powney & Watts, 1987). Interviews have strengths and weaknesses. One key strength of interviews is that they enable researchers to follow-up observations and explore issues in depth. On the other hand, interviews can be time-consuming and generate large amounts of potentially inconsistent data. Also, the personal involvement can be a potential factor for subconscious bias introduction in the data (Knox & Burkard, 2009). Cohen et al (2007) suggest the consideration of several factors such as interviewer's tendencies and linguistic or interpretative misunderstandings.

Interviews can be categorized as structured, semi-structured or unstructured (Gill, Stewart, Treasure, & Chadwick, 2008). In the structured interview, all procedures and questions are pre-determined and the same for all participants. Unstructured interviews in contrast grant full freedom and flexibility to the researcher on how to organize and conduct the conversation. Semi-structured interviews take place within a specific context and thus have an agenda with some key questions but are also accompanied by open-ended questions.

In this research we used semi-structured interviews to collect data about intangible aspects of the studied phenomena and also explore personal reasons and explanations behind quantitative data, observed behaviors and attitudes. We organized individual conversations over the internet using voice-over-ip software with audio and visual communication. These interviews took place after the completion of any formal course or programme so as to minimize intimidation factors and biases from behalf of the participants. They were recorded, transcribed and analyzed using content analysis methods (Hsu et al., 2012).

3.2.4 Quasi-experiment design

The quasi experimental pretest-posttest design is a quantitative research method that is used to compare the status of a phenomenon in the form of the arithmetic value of a dependent variable before and after an intervention individually for each participant (Cohen et al., 2007). Quasi experiments record measurements before a treatment to assess potential confounds. After the field experiment, testing is repeated. The comparison can reveal the effect of the treatment (Morgan, Gliner, & Harmon, 2000).

In the presented research, we devised an exploratory one-group pretest-posttest design to estimate quantitatively the effect of a novel learning intervention. We measured the existing participants' knowledge in a subject already studied before and right after they were subjected to the treatment using the exact same test. The analysis of measurements depicted the eventual learning gains as well as the deepening of understanding as a result of the treatment.

3.2.5 Systematic literature review

A Systematic Literature Review aims to summarize all existing information in a thorough and unbiased manner and make sense on the studied topic. According to Kitchenham (2004), the systematic literature review is conducted in a three-step process including the following stages:

- Planning
- Conducting
- Reporting

In the planning phase, the review need and objectives are identified; these inform the research questions formulation and the development of the review protocol. The review protocol contains all information and processes that are necessary for conducting the review. More specific, the components of the review protocol include the following: rationale for the review; research questions; search strategies; inclusion and exclusion criteria; quality assessment procedure; data extraction and coding process.

The conducting stage consists of the following activities (Kitchenham, 2004):

1. Identification of research
2. Selection of primary studies
3. Study quality assessment
4. Data extraction and monitoring progress
5. Data synthesis

The first activity is the definition of search strategies to locate in an unbiased manner as many primary studies as possible to address the formulated research questions. In the second activity, criteria for inclusion and exclusion are applied. Next, the initially included studies are appraised for their quality according to

the set criteria. The output of this activity should be the final list of primary studies to be coded and reviewed. The fourth step is the data extraction from the included articles. In the final activity, the extracted data is summarized and synthesized in an appropriate manner. After the first round of search, additional manual branching searches can be conducted by searching the references and citations of the already included studies. Combining automatic and manual search strategies ensure the discovery of most, if not all, relevant studies. In the final reporting stage, the review processes, results, analysis, discussion and conclusion are published, disseminated and evaluated (Mystakidis et al., submitted).

4 MAIN RESEARCH FINDINGS

In this section, we introduce eight original publications that were authored and published in peer-reviewed conferences and journals. The goal of this research was to explore the effects of game-based motivation-enhancement methods in e-learning and open education. Research questions were defined so as to discover the implications of motivation-enhancement methods in e-learning. The entire articles are presented in their original form at the end of this thesis.

4.1 Article I: The case of literacy motivation: Playful 3D immersive learning environments and problem-focused education for blended digital storytelling

Mystakidis, S., & Berki, E. (2018). The case of literacy motivation: Playful 3D immersive learning environments and problem-focused education for blended digital storytelling. *International Journal of Web-Based Learning and Teaching Technologies*, *13*(1), 64–79.

Hypothesis

Playful, game-informed learning experiences in 3D Virtual Immersive Environments or social virtual reality environments (SVREs), enriched with (digital) storytelling and problem-focused education concepts can have a positive impact in facilitating primary education students' learning.

This paper is a pilot study that was conducted and authored in 2014 and was ultimately published in 2018 due to administrative issues related to the organization of the special issue it was included. It explores the effect of Storytelling using 3D immersive learning environments in a playful learning experience offered to primary and secondary school students by the University of Patras' Library Services. The first author designed and implemented the pilot educational program "*From the Ancient to the Modern Tablets*", featuring immersive multimedia learning experiences about the book history. The pilot program consisted of

three stages: a playful library tour, followed by an interactive game-based digital storytelling activity with game elements, and a collaborative, creative, reflective hands-on activity. Utilizing the avatar psychology power, the visualization and simulation affordances of SVREs and the appeal of storytelling and game-based learning, the gamified blended narrative on the book evolution enabled learning as problem-focused, embedded and context-generated.

Main findings

This informative educational student-centred programme has been popular among schools. The programme's high engagement level created enthusiastic students' responses and positive learning behaviours. This project also became known and well-accepted among teachers. More than 1,500 students have participated in innovative learning ways and advanced their knowledge and skills through active edutainment (education + entertainment).

Teachers' perceptions regarding the effectiveness of the 3D Virtual Immersive Environments were very positive. They agreed that learners acquired new skills. They also affirmed that the learning experience added to the students' positive mentality towards books and reading. 3D Virtual Immersive Environments were regarded very useful for facts recalling and history understanding. Teachers also noted the high emotional involvement of students; the experience captivated their attention and evoked high levels of interest that lead to high engagement and performance in the final collaborative activity. The overall result was high satisfaction, and positive motivation towards book reading, learning, and literacy.

4.2 Article II: Addressing the retention gap in MOOCs: Towards a motivational framework for MOOCs instructional design

Herodotou, C. & Mystakidis, S. (2015). Addressing the retention gap in MOOCs: Towards a motivational framework for MOOCs instructional design. In *16th Biennial EARLI Conference for Research on Learning and Instruction Proceedings*. Limassol, 25–29 August 2015.

Main findings

One of the most crucial problems of E-learning courses is their high drop-out rate. The average completion rates of Massive Open Online Courses (MOOCs) is around 10% or less. Existing MOOC design schemes usually focus on pedagogy, assessment and technology and rarely take into account learners' experience, emotions and motivation. Drawing from the success of quest-based initiatives, gamified web platforms, and multi-user digital games, this paper introduces the first version of an innovative motivational framework for MOOCs instructional design coined as Open Quest Framework (OpenQuest). The framework is grounded on established motivational theories such as the Self-Determination

Theory and Situated Motivational Affordance. OpenQuest aims to enhance learners' engagement and reduce attrition rates in MOOCs.

4.3 Article III: OpenQuest: Designing a motivational framework for MOOCs instruction

Mystakidis, S., & Herodotou, C. (2016). OpenQuest: Designing a motivational framework for MOOCs instruction. In *MOOCs in Europe* (pp. 141–145). European Commission.

Main findings

This paper continues the conceptual and procedural construction of the innovative motivational framework OpenQuest for Massive Open Online Courses (MOOCs) instructional design. OpenQuest aims to improve user learning, engagement, performance and motivation in MOOCs by drawing lessons from the success of quest-based initiatives, gamified web platforms, and massive-multiplayer online games (MMOs). It supplements existing MOOCs design schemes that usually focus on pedagogy, assessment and technology by addressing learners' incentives and emotions.

It features specific motivational mechanisms including quests and narration, reputation systems, progression mechanisms, multiple learning pathways, well-designed feedback and social elements, that can be used to enhance learners' engagement and personalize learning. The OpenQuest framework proposes the creation of personalized learning paths through a series of processes relying on users' profiles and learning analytics (Figure 3).

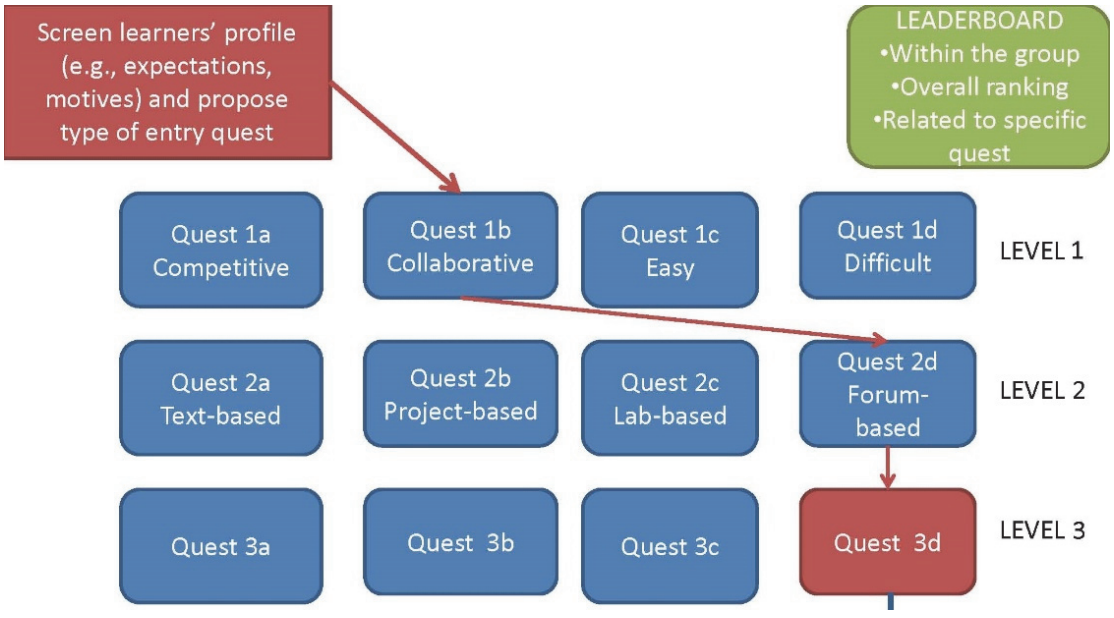


FIGURE 3 OpenQuest learning path with game elements

4.4 Article IV: Designing and implementing a big Open Online Course by using a 3D Virtual Immersive Environment – lessons learned

Mystakidis, S., Berki, E., & Valtanen, J. (2017a). Designing and implementing a big Open Online Course by using a 3D Virtual Immersive Environment – lessons learned. In *9th Annual International Conference on Education and New Learning Technologies (EDULEARN17) Proceedings* (pp. 8070–8079). Barcelona, 3-5 July 2017.

Hypothesis

A motivation-enhanced 3D immersive learning environment has a positive effect on completion rates and the quality of learning in a Big Open Online Course.

This paper focuses on the experience of using 3D immersive learning environments or social virtual reality environments (SVREs) for synchronous formal and informal collaborative learning in an innovative Open Online Course. Open Education is a distance learning approach that was strategically proposed by the European Commission to encourage cost-effective training, upskilling and reskilling of large population groups and workforce with speed and flexibility. Institutions and businesses can design and offer Open Online Courses (OOCs) to address skill gaps, organizational and societal needs. OOCs and especially Massive Open Online Courses (MOOCs) are suffering from high rates of attrition, which is attributed to various factors such as learner isolation and lack of motivation to complete the course.

Main findings

The University of Patras in Greece organized an innovative, motivation-enhanced Big Open Online Course (BOOC), the first of its kind in Greece according to our knowledge, with title "Open Workshop on Information Literacy". The instructional approach was based on Problem-Focused Education (PFE) and Game-Based Learning (GBL). PFE is a variation of Problem-Based Learning. During the course, over three hundred thirty participants acquired information literacy skills using web-based open learning platforms and the social virtual reality environment (SVRE) Second Life.

Course participants achieved sustainable high completion rates, namely over thirty percent, three times higher than the average MOOC. This result is comparable to empirical evidence from a MOOC with a different motivation-enhancement method, namely a serious game demonstrating that the novel pedagogical model deployed with motivation enhancement methods was able to address and overcome common pitfalls of MOOCs, such as anonymity, learner isolation and lack of feedback (Thirouard et al., 2015).

The participants achieved their set learning outcomes, experienced a community of practice atmosphere, expressed high degree of satisfaction and appreciated the variety of active learning methods. The open publication mode of most learning activities facilitated social agency that lead to increased motivation. The

course demonstrated that the effective use of SVREs for rich, synchronous learning, both formal and informal, can enhance significantly Open Online Courses.

4.5 Article V: Toward successfully integrating mini learning games into Social Virtual Reality Environments – Recommendations for improving Open and Distance Learning

Mystakidis, S., Berki, E., & Valtanen, J. (2017b). Toward successfully integrating mini learning games into Social Virtual Reality Environments – Recommendations for improving Open and Distance Learning. In *9th Annual International Conference on Education and New Learning Technologies (EDULEARN17) Proceedings* (pp. 968–977). Barcelona, 3-5 July 2017.

Hypothesis

Game-based learning in social virtual immersive environments can have a positive impact on the quality of learning.

We inquired if online learning can be enhanced using mini games and playful elements. What would be the reaction of postgraduate students, accustomed to traditional e-learning platforms when exposed to a new environment with game-based learning activities? Our research aim was to capture their level of satisfaction of all components of the course as means to evaluate the pedagogical potential and effectiveness of the employed instructional method.

Main findings

We designed and deployed two mini serious games as proof of concept for the supplement of a postgraduate course on Cybersecurity in the University of Washington, USA. These social learning experiences were constructed taking into account various game mechanics and components designed to increase their appeal to most game player types and styles (explorers, achievers, socializers). The games featured narrative, rules, team collaboration, competition, challenges, achievements, surprises, levels, rewards, choice, feedback, scoring, time-pressure, exploration.

The participants in this distance education course think that playful experiences in 3D social virtual reality are beneficial for their learning. They also value learning activities based on active participation and social interaction. The immersion into a virtual environment and the ability to be embodied in a moving avatar and occupy a virtual space were the most valued components of the virtual environment. Some participants reported that the game had a positive effect on their learning. They noted that the game was a memorable experience, it stimulated their senses and emotions and it enhanced their learning. Several also noted that they were motivated to experiment with these characteristics.

SVREs enable educators to create interactive exhibits and 3D content as well as entertaining social experiences of learning value in order to illustrate and visualize real Cybersecurity practices. Programming in virtual reality environments

helps participants experience intangible notions such as malware and behavioral patterns with the help of storytelling and visual metaphors.

We also confirmed that the steep learning curve of new users in 3D virtual immersive environments is an obstacle for learning that needs to be addressed meticulously. Results revealed the emergence of two user groups we called techno-enthusiasts and techno-challenged. The first group participated smoothly and valued the experience. The second group faced serious technical issues in technology access or software use and this fact had a negative impact on their overall experience.

4.6 Article VI: The Patras blended strategy model for deep and meaningful learning in quality life long distance education

Mystakidis, S., Berki, E., & Valtanen, J. (2019). The Patras blended strategy model for deep and meaningful learning in quality life long distance education. *The Electronic Journal of E-Learning, 17*(2), 66–78.

Hypothesis

A blended, deep and meaningful learning focused quality strategy model has a positive effect on participants' perceptions and experiences in distance life-long learning programmes.

In this study we identify, propose and evaluate preconditions, criteria and strategies to achieve high quality blended learning online courses based on the relevant experience of the University of Patras.

Main findings

To facilitate the life-long learning project of the University of Patras, we designed the Patras blended strategy model for quality e-Learning. The model is realized through the fostering of a mixed culture of quality attributes, self-evaluation and innovation components.

The University of Patras' blended quality strategy had an overall positive effect. All aspects of learning quality regarding design, development, content, personnel, media, platforms, organization, implementation and communication were confirmed. Teachers in both synchronous and asynchronous settings performed at a very high level considering the respective environments' affordances. Participants expressed their high satisfaction in KEDIVIM's distance lifelong learning programmes that met their expectations.

The perceived quality in the eyes of University of Patras' distance lifelong learning programme participants was high, possibly higher than those experienced from other institutes. This can also be attributed to the successful use of peer and active learning methods, and general commitment to other essential elements striving for realizing deep and meaningful learning to achieve high learning quality, learner satisfaction, confidence, and self-efficacy. The courses' participants also appeared to be more confident and optimistic both by recognizing

factors for learning quality improvement (process improvement, in particular) and not being intimidated by potential obstacles in peer collaboration.

4.7 Article VII: Deep and Meaningful E-learning with Social Virtual Reality Environments in Higher Education: A Systematic Review

Mystakidis, S., Berki, E., & Valtanen, J. (Submitted). Deep and Meaningful E-learning with Social Virtual Reality Environments in Higher Education: A Systematic Review. *Australasian Journal of Educational Technology*.

Hypothesis

The goal of this study is to assess the potential of Social Virtual Reality Environments (SVREs) for deep and meaningful e-learning in higher education. The following research questions were formulated: What aspects of deep and meaningful learning have been studied in higher education in the context of distance education with the use of SVREs? What instructional design methods seemed to influence DML support in the context of distance education with the use of SVREs in higher education? What is the effectiveness of SVREs in distance education according to existing research? What factors influence DML support in the context of distance education with the use of SVREs in higher education?

Main findings

Deep and meaningful learning has not been widely studied in conjunction with SVREs in distance education. The main subjects of the included studies were the following: Business and Economics (n=5), Computer Science (n=4), Education (n=4), Science (n=3), Languages (n=3), Health and Medical Education (n=3). In total, 24 studies focused on the cognitive domain, 24 on the affective and 14 on the social. The most common research design was the cognitive and affective domain combination (n=13). These studies researched the effect of SVREs on student learning and also recorded aspects of their emotional states and perceptions. Eight studies researched all three DML dimensions, cognitive, social and affective. Regards the studied learning outcomes, most studies in the cognitive domain focused of cognitive knowledge (n=11), while a significant minority studied procedural knowledge (n=7). The big majority of studies with an affective focus researched Learner Perceptions (n=21), with Motivation (n=5) being the second preferred studied construct. In the social domain, qualities and characteristics of Collaboration (n=5), along with Social Presence (n=5) were the prime studied outcome.

Studies used a wide range of learning methods and techniques, most prominent being collaborative problem-based learning (n=8), collaborative project-based learning (n=8) and collaborative learner-centered learning (n=4). Analyzing the level of DML support, we can discern three categories of educational practices in SVREs. There is the top-tier of innovative practices (n=7) that support

four or five attributes of meaningful learning. These studies apply proven methods such as simulations, problem-based learning and game-based learning with positive results. Several of them observed and report directly greater depth of student learning and thinking, e.g. Drake-Bridges, Strelzoff, & Sulbaran (2011). In the second tier, 15 studies deployed elaborated constructionist, constructivist or socio-constructivist practices that supported three attributes of meaningful learning. The most frequently occurring combination of three supported attributes were Active, Authentic, Cooperative (n=4). Finally, in the third tier, 10 studies supported two or less attributes of meaningful learning. In these studies, several researchers applied research designs with emphasis on the control and comparison of specific aspects of the educational experience and not on learning innovation itself that takes into account the full spectrum of SVRE's affordances. However, even these interventions, when well designed and implemented, can lead to deeper levels of learning and thinking (Hearrington, 2010).

Synthesizing the above findings, the recorded degree of support of SVREs for deep and meaningful learning was overwhelmingly positive as 85% of included studies (n=23) reported high or medium support for DML. It is worth noting that most studies classified as achieving a medium level of DML support only studied and reported favorable results in two of the three DML domains. In other words, it is possible that they actually achieved positive results also in the third, missing DML domain but this fact wasn't recorded or reported.

The four most commonly recorded learning effects were the following:

1. Positive impact on learning performance (14 studies)
2. Positive impact on perceptions and satisfaction (11 studies)
3. Positive impact on collaboration (7 studies),
4. Positive impact on motivation (5 studies).

Articles researching cognitive aspects of learning concluded that distance learning interventions in SVREs can improve students' declarative and procedural knowledge (Wang et al., 2012), retention (Downey, Mohler, Morris, & Sanchez, 2012), and higher order thinking and problem-solving skills (Rogers, 2011). When learners are active in a SVRE, they become engaged and experience learning gains that improve their performance (Hornik & Thornburg, 2010). Studies examining social phenomena, behaviors and concepts confirmed that SVRE platforms are mature media for rich social peer-to-peer and teacher-student interactions and activities. Students were able to engage in effective collaboration such as the co-creation of digital artifacts (Drake-Bridges et al., 2011) and team-building activities (Keskitalo, Pyykkö, & Ruokamo, 2011). Also studies suggested that SVREs enable high social presence and co-presence (Burgess, Slate, Rojas-LeBouef, & LaPrairie, 2010). In the affective dimension of learning, students' perceptions influenced engagement, motivation and performance (Noteborn, Bohle Carbonell, Dailey-Hebert, & Gijselaers, 2012). Learners felt comfortable and relaxed in a virtual, simulated environment in contrast to a physical environment which was perceived as stressful (Vrellis, Avouris, & Mikropoulos, 2016). Even shy remote students were encouraged to participate actively in an avatar-mediated SVRE (Beltrán Sierra, Gutiérrez, & Garzón-Castro,

2012) as scaffolding and constructionist activities in SVREs can have a positive effect on learner self-efficacy (Wiecha, Heyden, Sternthal, & Merialdi, 2010). In the context of distance education and e-learning with SVREs, higher motivation and engagement lead to lower attrition rates (Dickey, 2005; Mystakidis, Berki, et al., 2017a). SVREs can facilitate sustained high levels of motivation in e-learning courses with longer duration (Beltrán Sierra et al., 2012).

Finally, we identified and distinguished the classes of factors and antecedents that mediate deep and meaningful learning with SVREs in distance education settings and integrated them into a comprehensive model. Analyzing the reviewed studies, we classified conditions and factors across two dimensions; (i) according to the acting entity or person and (ii) in relation to the time of the educational intervention. First, there are (a) individual learner factors, and (b) contextual factors related to technology, learning design and implementation. These categories of factors can be mapped before, during, and after learning. All factor categories compose a Blended Model for Deep and Meaningful E-learning in Social Virtual Reality Environments that is depicted in Figure 4. The model incorporates the essential interactions between teachers, students and content in prior models for deep and meaningful learning (Anderson, 2003) and constructive alignment for quality learning experiences (Entwistle & Peterson, 2004).

4.8 Article VIII: Enter the serious e-scape room: A cost-effective serious game model for deep and meaningful e-learning

Mystakidis, S., Cachafeiro, E., & Hatzilygeroudis, I. (2019). Enter the serious e-scape room: A cost-effective serious game model for deep and meaningful e-learning. In *Proceedings of the 10th International Conference on Information, Intelligence, Systems and Applications (IISA 2019)*. Patras, 15-17 July 2019. IEEE.

Hypothesis

Playing a serious virtual game leads to a significant understanding increase in test performance. Students enjoy the experience and increase their motivation.

Main findings

In this paper we present a new and cost-effective model for designing serious games in virtual reality environments for deep and meaningful learning, a virtual escape room.

Playing the game improved significantly high school students' motivation and understanding, despite the fact that the topic was taught and supposedly already known to them. Students generally enjoyed the game and playing increased their interest in the subject and motivation albeit facing some technical challenges. They were very positive towards using such learning environments and methods to reinforce their understanding in their formal education.

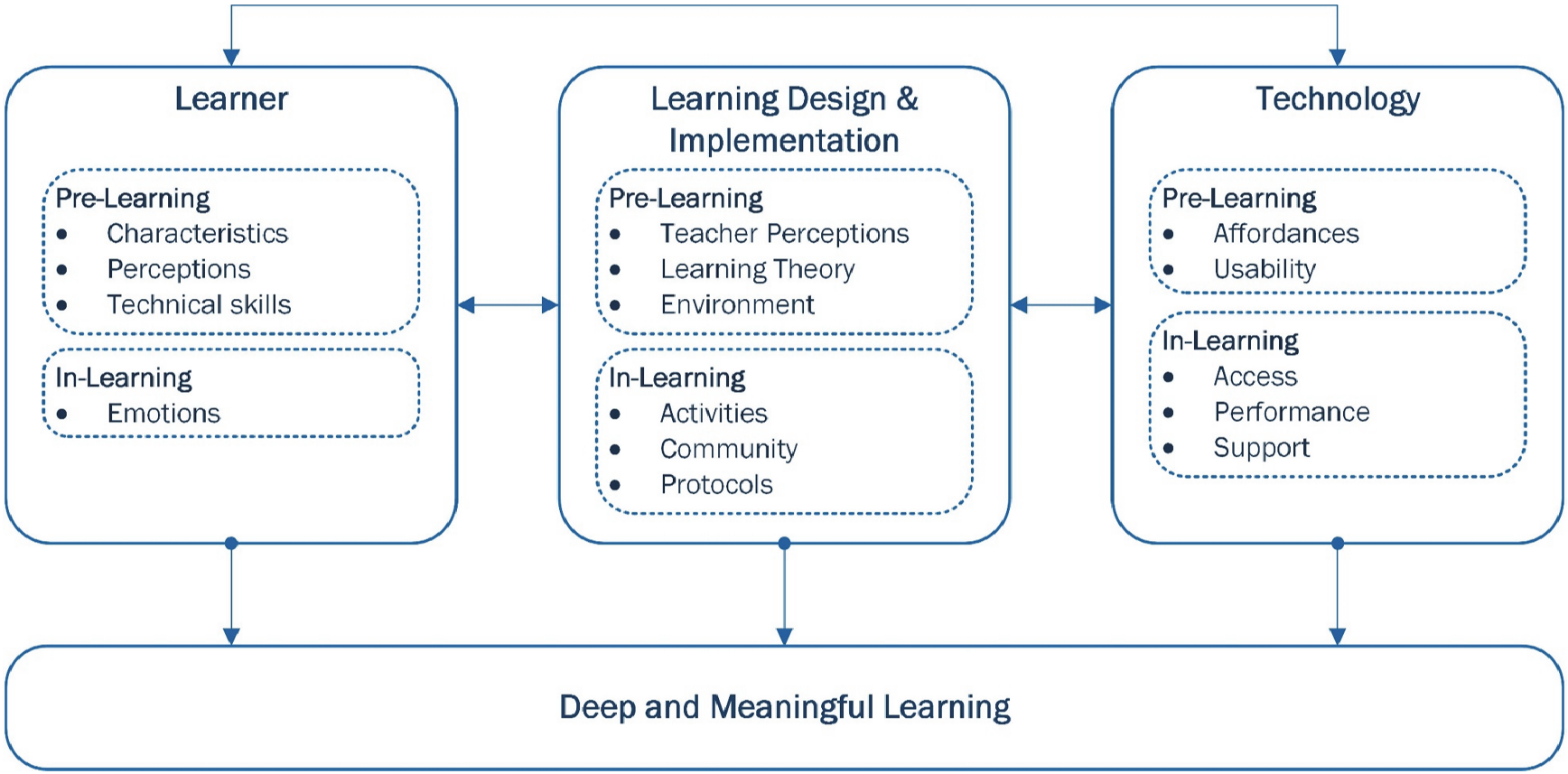


FIGURE 4 Blended model for deep & meaningful E-learning in social virtual reality environments

4.9 Contribution to collaborative research

Article I is an extended journal paper based on a published, peer reviewed conference paper (Mystakidis, Lambropoulos, Fardoun, & Alghazzawi, 2014). It was prepared in collaboration with Prof. Eleni Berki. After the early planning stage, the author prepared the first full manuscript of the paper which was rewritten in close collaboration with Prof. Eleni Berki.

Articles II and III are derivatives from two published peer-reviewed conference position papers (Mystakidis & Berki, 2014, 2015). Article II is a published, peer-reviewed conference paper that was presented by Dr. Christothea Herodotou at the 16th European Conference for Research on Learning and Instruction (EARLI 2015) in Limassol, Cyprus. Article III is a published, peer-reviewed position paper that extends the previous article and was presented by the author at the "Higher education Online: MOOCs the European way" conference in Rome, Italy. Articles II and III were co-authored with Dr. Christothea Herodotou. The described OpenQuest framework was developed by both authors in a gradual dialogic process in synchronous and asynchronous communication mode. Then, the first author of each publication wrote the outline and first draft of the respective manuscript and the second author contributed and participated in the rewriting process. More specific, in article II, the author co-authored sections "A motivational framework for MOOCs instructional design" and "Theoretical and educational significance" and contributed to sections "Introduction", "Aim/research questions" and "Conceptual rationale".

Articles IV and V were peer reviewed, published conference papers that were presented virtually by the author at the 9th annual International Conference on Education and New Learning Technologies (EDULEARN17) in Barcelona, Spain. Article IV builds on author's work on the intersection of open education and MOOCs with SVREs (Kostopoulos, Giannopoulos, Mystakidis, & Chronopoulou, 2014; Lambropoulos et al., 2012; Mystakidis, 2012b, 2014). Article V presents one facet of the author's work in distance education with SVREs and the Certificate programme in Virtual Worlds at the University of Washington, Seattle, USA (Brock-Richmond, Hill, Mystakidis, & Hayes, 2012; Hill & Mystakidis, 2012; Mystakidis, 2012a; Mystakidis & Gadler-Pratt, 2012). Article VI was an extended journal paper based on a published, double-blind peer reviewed conference paper (Mystakidis et al., 2018) that the author presented at the 17th European Conference on e-Learning in Athens, Greece and on previous work (Mystakidis, Kostopoulos, & Amanatides, 2017). Articles IV, V & VI were authored in a collaborative process with Prof. Eleni Berki and Dr. Juri Valtanen as follows: the author initiated the process and communicated the main ideas and design concepts proposing an authoring plan. Upon the received feedback from the co-authors, the author prepared a full manuscript of each paper. The papers were completed with critical comments and additions of co-authors.

Article VII was co-authored with Prof. Eleni Berki and Dr. Juri Valtanen. The author performed the search strategies, examined all included studies, extracted data and compiled the results. Berki and Valtanen analyzed and coded samples of the included papers to establish inter-rater reliability. Upon receiving feedback from the co-authors, the author prepared a full manuscript, developing among others the Blended Model for Deep & Meaningful E-learning in Social Virtual Reality Environments. The paper was completed with critical comments of co-authors.

Article VIII is a double-blind peer reviewed and published conference paper that was presented by the author at the 10th International Conference on Information, Intelligence, Systems and Applications in Patras. It was authored entirely by the author except from the Case Study, Evaluation and Results sections that were co-authored with Enrique Cachafeiro. The model was developed by the first author. Prof. Ioannis Hatzilygeroudis provided critical reflection comments on paper's organization and layout.

5 DISCUSSION

5.1 Article I

Storytelling can be used to develop and demonstrate educational aims in practice. Modern digital media can complement traditional ways of learning by creating new ways for learners to experience and remember stories and associated information and knowledge.

Tools for team collaboration can provide an assisted to learning environment for early age learners. Online games and other information communication technologies, such as those used in our pilot project can digitalise innovative learning through interactive fiction or participative storytelling. They can further enhance curiosity and stimulate learning by involving the user in interesting virtual worlds that resemble real facts, events and other knowledge.

Overall, social virtual reality environments combined with engaging pedagogical methods such as scaffolding enabled the production of a cost effective and yet rich learning experience in cyber-space, a gamified, narrative-driven relay of virtual field trips; and engage students from local schools, which could not otherwise have because they would not afford to travel to the actual physical places. Utilizing the socio-psychological power of the avatar image, the visualization and simulation affordances of SVREs and the appeal of storytelling and game-based learning, we designed and developed a gamified blended narrative on the evolution of the book, where learning is embedded and context-enabled focusing on students' learning and thinking skills in the socio-cognitive, psychomotor and affective domain.

The overwhelming positive reactions of teachers, as well as the observed engagement, feedback, passion, imagination, initiative and performance of learners confirmed the potential of SVREs for deep and meaningful learning, especially in game-informed learning activities and scenarios.

5.2 Articles II and III

The proposed theoretically-driven MOOCs design framework, OpenQuest, tackles the need for motivating learners towards MOOC completion by considering learners' initial motives for participation and the reasons justifying their exit from a MOOC. OpenQuest extends suggestions to add motivational design elements to existing design frameworks.

OpenQuest adds an additional sophistication layer in MOOC design. This complexity can be addressed by incorporating existing applications into the existing MOOC virtual learning environments and platforms, e.g. in the form of plugins and APIs. Second, we propose an iterative process of design starting with a simple version of the learning environment with only basic characteristics such as two different pathways of learning.

MOOC design is currently focused on cognitive and technical aspects of learning. The OpenQuest framework aims to transform learning in a MOOC from an isolated solitary task into a social, enjoyable experience and engage massive numbers of learners. By engaging the affective and social domain of learning, the framework proposes a motivational approach that monitors and rewards learning and embraces learning flexibility, personalization and self-directed learning.

These two articles mark the beginning of a theory-grounded design and creation process toward a highly structured, systemic MOOC platform solution for gamification in an asynchronous learning environment to facilitate open education purposes. The nature, requirements and implications of such an endeavor - that still remains an open possibility- lead the author to explore additional game-based methods and alternative implementations to enhance motivation based on relative propositions (Mystakidis & Berki, 2014, 2015).

5.3 Article IV

The Big Open Online Course "Open Workshop on Information Literacy" (OWIL) provided an opportunity to derive valuable lessons for open online courses' design and implementation. First, SVREs are instrumental for the creation of a warm, motivating learning atmosphere and the facilitation of informal learning. In the virtual space each participant had an individual and representative presence, thus breaking the anonymous, distant, isolated feeling of participants in MOOCs. Therein teachers and organizers appeared as "equals", they did not have –visible- privileges over course participants; sometimes tech-savvy participants often assisted the instructors. Additionally, the pervasive character of the environment, the fact that they could enter, leave and move in the virtual space created and enhanced the sense of agency.

Second, synchronous activities in the SVRE Second Life supplement well courses with social constructivist emphasis on active learning and creation of

content. Meetings became quickly the weekly reminder of the course and meeting point of fellows. It also offered a chance to solve any questions related to the course with the organizers, an informal office hour. The SVRE enhanced the live participants' interactions and user experiences beyond the standard classroom experience, through the availability of multiple communication channels such as voice, private voice sessions, public and private chat, movement, apparel and gestures of the avatar.

The interdisciplinary composition of the team of educators and participants was an unprecedented experience for all the involved parties. This resulted in the cross-fertilization of the collective learning process through the creative exchange of experiences, views, knowledge and competences.

The current trend of combining fun and learning emphasizes the production of entertaining learning materials and activities. Recommendations to address the retention gap in MOOCs include adopting a participation-driven approach, using game design techniques in the courses' pedagogical design and supplementing the predominant asynchronous learning paradigm in MOOCs with synchronous learning activities and virtual meetings. However, this might increase the learners' expectations that learning must be always fun and enjoyable. Thus learners might be developing a new attitude toward learning at the expense of content and process while emphasizing fun and enjoyment. In addition, gameful experiences in virtual immersive environments might be expensive to produce, and access and accessibility might not be guaranteed; the latter bring obstacles in the full use of virtual reality and MOOCs in education.

5.4 Article V

This study confirmed the hypothesis that mini serious games in a social virtual reality environment (SVRE) can have a positive impact on the quality of learning in an e-learning course. One of the major concerns of educators is how to increase the quality of learning for all students. New technologies such as SVREs have attempted to offer some answers. A 3D SVRE, especially if it interconnected or part of a larger, open-ended virtual world, can be an environment where students can feel ownership. They can be given the opportunity to have an impact and contribute to its construction -on equal footing with their educators- or at least have a collective space with the freedom to take initiatives, experiment and express their agency. Also SVREs offer visual and auditory representative fidelity that evoke genuine feelings of immersion. There they can meet people and collaborate with peers from all over the world, share their thoughts and demonstrate the product of their work and creativity. Hands-on training activities that might be too hazardous, costly, unethical or inconvenient to orchestrate in the physical world can be replicated with great detail in the virtual. Abstract concepts, notions and environments of the micro- or macrocosm can be visualized and experienced for the first time. The participants of this study appreciated the variety of active learning modes and acquired new skills for virtual team work. The course

demonstrated that the effective use of SVREs for rich, synchronous formal and informal learning can enhance distance education.

However, the findings of this study also confirmed that the steep learning curve of new users in SVREs is an obstacle for learning. This issue needs to be addressed meticulously. On one hand, the question is about time and effort that is needed in order to achieve an appropriate technical skill level for using SVRE for increasing the quality of learning. That is, the students must be trained. On the other hand, the question is about technical fluency. These put unnecessary obstacles while trying to improve learning by using the tools and environments as well as running smoothly the course. Moreover, the continuous facing of technical challenges can be a very frustrating experience particularly for non-technically oriented persons. This negative experience can evoke emotions and feelings such as anger, anxiety, boredom, hopelessness and even shame, which can decrease learning and performance and reduce interest and increase task irrelevant thinking. However, the same negative emotions and feeling can improve for example persistency, which is a valuable feature for learning, if one chooses to carry on regardless difficulties.

The findings of this study showed that participants considered playful experiences in SVREs beneficial for their learning. There has been an increasing trend to personalise the learning process by using new technology. Particularly designed learning games or serious games are thought to assist people's learning process and achieve their current learning needs. Playful activities can produce enjoyment and fun which can have positive influence for learning. Nevertheless, by overemphasising the fun part of learning might lead to the development of an attitude that learning must always be fun and enjoyable, and if learning does not feel like it, then a person might think that he/she is not learning.

The findings of this study showed that participants valued learning activities which were based on social interaction and active participation. Games users can experience an essential impact on their social development which can have a positive impact on the quality of learning. By embedding social content within the games, such as caring of something or of someone, through characters, plots and themes, players can experience decision making with the real consequences. By presenting a system of rules and act on it, such as facing an ethical dilemma, can have a positive influence upon players' social development and social learning. In addition, discussing and debating about the game and its content online and offline can have a positive impact on developing players' argumentation, elaboration and reasoning.

Recommendations on the effective use of game-based instructional approaches such as serious games, gamification and play in virtual immersive environments for educational purposes include the following; Game-based learning experiences should be crafted in close conjunction with the course's learning outcomes. A course-wide narrative can help overall participants' engagement and content retention. The thinking styles of the participants and their learning

preferences should also influence rapid tweaking of game parameters in programming and general curricula design decisions in order to accommodate epistemological needs and particular knowledge desires.

Games and simulated experiences can help students transfer conceptual understanding and skills to real situations in their future professional roles. SVREs enable educators to create interactive exhibits and 3D content in order to illustrate and visualise abstract concepts, tacit knowledge and practices. Learning by doing, learning with others and learning through problem finding as well as resolving can be considered as benefits of games.

The educational context can be considered relatively traditional as a nature. That is, every new educational idea must be very convincing to become a norm. This is for very good reason since education is not a random activity. The use of SVREs and games are still relatively uncommon ways of improving the quality of learning. Many worries might exist such as how to align SVREs and games to the existing curriculum or course, what if students use the limited time not for learning from the game but spend the time learning the game itself, and how expensive, time consuming and labour intensive it is for designing, developing and testing games for educational purposes. One appropriate way to start can be by using mini serious learning games for educational purposes i.e. in SVREs. They can be developed relatively quickly and cost-effectively.

5.5 Article VI

The utilization of Technology Enhanced Learning and more specifically of Distance Education for Life-Long Learning and Continuous Professional Development are at the epicenter of national and European policies for the improvement of the delivery of Vocational Education and Training. In this context, one of the important challenges is the design of versatile quality assurance strategies for training; providers that can guide the development of e-learning programs that achieve real impact in the participants' lives. Distance education when designed, planned and implemented with an appropriate blend of pedagogical approaches, methods and technological means can be equally effective and in some specific cases more effective than classroom-based instruction.

The provision of life-long learning and continuous education services is of growing importance for the information society and knowledge-based economy. Training providers need to find effective ways to integrate meaningfully technologies that enhance quality of education while at the same time guarantee the educators' commitment that can lead to deep and durable learning. The latter can be achieved by actively encouraging the emergence of a learner-centric involvement and pedagogic culture that aligns the assessment of learning through its outcomes in a more natural and pragmatic manner with flexible curricula. For example, technology enhanced natural assessment methods focus on students' competences to synthesize knowledge and apply skills in contextual, realistic,

simulated settings. This can be achieved by engaging learners in authentic experiences. This strategic priority needs to be nurtured and underpinned by a sustainable quality learning model. We argue that trainers should be at the heart of this model and be empowered to be the main motivating drivers of change towards digital transformation and innovation.

This study describes the results of an attempt to transfer and apply lessons learned on deep and meaningful learning in previous studies in the institutional strategy level with very different contextual parameters in terms of aims, structure, technology, resources and personnel. There, game-informed motivation enhancement methods were embedded mainly in the training and mentoring of new e-learning trainers.

5.6 Article VII

Several studies that focused on the cognitive domain of learning in SVREs distinguish between descriptive or declarative (Erlandson, Nelson, & Savenye, 2010) and procedural knowledge (Vrellis et al., 2016), others examine retention (Downey et al., 2012), skills acquisition (Girvan, Tangney, & Savage, 2013), and comprehension (Drake-Bridges et al., 2011). Reported success in any of these outcomes and measures however doesn't equate or lead automatically to DML. Virtual worlds have been found to be suitable of knowledge-based, abilities-based, or skill-based learning outcomes achievement (Merchant et al., 2014).

However, deep and meaningful learning (DML) hasn't been researched widely in the context of distance education with the use of SVREs. Our search yielded just one study with an explicit focus on deep or meaningful learning (Keskitalo et al., 2011). There are several factors that could explain this phenomenon. First, the topic of DML in itself is quite complex and not fully developed. Assessing deep learning with validity and reliability in any educational setting can be challenging. One common instrument to estimate deep learning is using questionnaires. However self-reporting has limitations (Rourke & Kanuka, 2009). Actual student behavior and performance could differ from their self-perceptions (Dolmans, Loyens, Marcq, & Gijbels, 2016). Assessment of meaningful learning should aim at higher order processes and can be therefore daunting.

3D virtual learning environments - SVREs - can serve multiple purposes within an e-learning programme (Steils et al., 2015). Trainees participating in desktop virtual reality experiences achieved superior outcomes in declarative knowledge, procedural knowledge, and retention than the control groups (Sitzmann, 2011). The element of immersion in a situation, a problem or a professional competence allows educators to reorient the depth of learning outcomes of online educational experiences from learning *about* a subject to learning by doing and by emulating a role, and thus build deep conceptual and procedural knowledge *of* a discipline, far superiror than a superficial declarative knowledge *about* the content area (Scardamalia & Bereiter, 2006).

Elaborating on the importance of teacher perceptions and learning theory in relation to technical aspects of the learning environment, as Mikropoulos & Natsis (2011) point out, "carefully designed learning activities are more important than an exotic interface that contributes to intuitive interaction". One general classification of learning activities in SVREs is the following: content creation, content exploration and interaction with content, social interaction, gaming, participation in representations of real life events and situations (Mantziou, Papachristos, & Mikropoulos, 2018). Indeed, a meta-analysis of desktop-based virtual reality instruction found no difference between high and low research design quality, an indicator of the robustness of their benefits for learning (Merchant et al., 2014). Moreover, high degree of sensed presence in SVREs is correlated with learning performance (Mikropoulos & Natsis, 2011). More importantly this affordance of the medium and the induced sense of presence wasn't influenced by the design of the educational environment (Mantziou et al., 2018).

Game-based experiences in SVREs have been effective in eliciting intrinsic motivation and student satisfaction in distance education (Berns, Gonzalez-Pardo, & Camacho, 2013). Students in gameful or playful environments were intrinsically motivated, working to solve problems, tasks and challenges (Hornik & Thornburg, 2010; Mystakidis, Berki, et al., 2017a). Game-based curriculum studies in blended K-12 settings have demonstrated the superiority of gamified experiences in terms of learning gains and complex skills construction in comparison to teacher-centered methods (Barab, Pettyjohn, Gresalfi, Volk, & Solomou, 2012; Metcalf et al., 2018). Simulated, game-informed role-play experiences are perceived to be free from the fear of failure (Berns et al., 2013) as failing in a virtual environment doesn't carry harmful consequences, and repetitive practice is a viable path towards mastery (August et al., 2016).

The developed Blended Model for Deep and Meaningful E-learning in Social Virtual Reality Environments can assist involved stakeholders identify and take into account all interlinked factor categories (individual, design-related and implementational, technological) that mediate deep meaningful learning. Learning experiences in Social Virtual Reality Environments that engage learners' cognitive, social and affective domains can facilitate deep and meaningful learning. SVREs can be used as platforms to provide authentic, realistic, cognitively challenging experiences in engaging, motivating environments for open-ended social, collaborative interactions and intentional, purposeful, self-directed learning. In other words, they can embrace all three dimensions for deep and meaningful learning; mind, emotions, and community for mastery, autonomy and connectedness. In this way, SVREs can increase student satisfaction and enjoyment, factors that influence performance and academic success in distance education. SVREs can also support effectively knowledge application through project-based experiential learning, and complex, simulated problem-based activities.

5.7 Article VIII

Educational practices should be in dialogic sync with societal trends and practices. Topics of debate in the public sphere and emerging behaviors can inspire educators to develop enjoyable interventions that energize learners mentally and socially. The proposed model of Serious E-scape Room enables educators to create virtual escape rooms for deep and meaningful learning by engaging the cognitive, emotional and social domains of learning.

This model is also an attempt to democratize immersive education and make VR learning apps an attainable aim for educators from all fields and levels, without special technical skills (Gaspar et al., 2019). Thus, it can be beneficial both for educators and VR developers. Educators can use creatively the established, popular yet fully customizable template of escape rooms to develop virtual immersive experiences that engage learners. Similarly, VR developers can partner with subject-matter experts and deliver robust, compelling and scalable serious games that demonstrate the immersive affordances of VR platforms for education.

This article is an attempt to build upon the recommendations of article V and systematize a serious games learning solution in immersive environments. It constitutes also the first step in the direction of embracing also new SVREs and headset-based VR systems.

6 CONCLUSION

In this research presented, various motivation-enhancement methods such as game-based learning, problem-focused education, playful design, gamification, and serious games showed to play a positive role in e-learning quality and for deep and meaningful learning. Article I constituted a pilot study to evaluate the potential of SVREs for game-based instructional methods for learning. In the following two articles (Articles II and III) a new theoretical gamified model for Open Education instructional design was developed. The next articles (Articles IV, V, and VIII) extended the epistemological assumptions and hypotheses behind the model. More specific, after focusing on gameful design in Articles II and III, in Article IV we applied playful design, building on the findings of Article I, and then in Articles V and VIII we studied serious games. We applied and evaluated the effects of the above mentioned methods at the *nano* (learning activity) and *micro* level (course design) of distance and blended education. In Article VI we explored and described the ramifications and the impact of the studied methods at the *meso* level of institutional e-learning policy and quality strategy. In Article VII we analyzed systematically the literature on deep and meaningful learning and social virtual reality environments so as to deduce useful and practical findings to guide our future research plans that started with Article VIII and are presented further in Section 6.3.

6.1 New frameworks and models

One goal of this research was to build new models and frameworks that will address policy challenges and assist e-learning and blended learning practitioners. Therefore, this study is intentionally closely related to educational e-learning and blended learning practices.

6.1.1 OpenQuest framework

The OpenQuest framework adds a layer of narrative, personalization and freedom of choice in an existing online course to facilitate motivation enhancement in asynchronous e-learning. This instructional design sophistication can be implemented using motivational mechanisms including, quests and narratives, reputation systems, progression mechanisms, multiple learning pathways, well-designed feedback and social elements (Mystakidis & Herodotou, 2016).

This new motivation enhancement layer can be used to enrich learners' engagement, motivation and personalize learning. OpenQuest suggests the transformation of learning in a MOOC from an isolated, individual solitary task into an engaging, social enjoyable experience. By addressing the affective and social domain of learning along with the cognitive, the framework introduces a motivational approach that monitors and rewards learning and embraces learning flexibility, personalization and self-directed learning with the help of systems such as learning analytics and machine learning (Herodotou & Mystakidis, 2015).

6.1.2 The Patras blended strategy model

The University of Patras has launched a project for the provision of short, accessible, certified distance life-long learning programmes. The main pillars of this project are Quality, Deep Learning and Innovation. To facilitate the life-long learning project of the University of Patras, we designed the Patras blended strategy model for quality e-Learning. The model is realized through the fostering of a mixed culture of quality attributes, self-evaluation and innovation components in the following ways: i) Active commitment to quality and excellence empowerment on and for all levels (executive/top, managerial/middle, operational/low), processes and personnel; ii) the establishment of flexible/agile frameworks with clear procedures for all the life-cycle stages of the programmes; iii) resolution to seek and willingness to accept feedback for improvement from various internal and external actors/stakeholders; iv) identification and dissemination of good practices, internally and externally (Mystakidis & Berki, 2019). More specifically, the model includes the following processes in four stages:

Stage I Analysis, Initiation & Preparation
Stage II Design & Development
Stage III Marketing & Implementation
Stage IV Evaluation

In Stage I, one essential evaluation criterion for candidate programmes is their sustainability and correspondence to existing or anticipated learning or certification needs (Mystakidis et al., 2018). In Stage II, course leaders or instructors without experience in professional e-learning are expected to prepare themselves by completing an e-trainers' crash-course. Another essential quality measure in this phase is safeguarding the selection, formulation and commitment to adequate and achievable learning outcomes with an effective mix of learning activities for deep and meaningful learning achievement (Mystakidis et al., 2019).

6.1.3 Blended model for deep and meaningful E-learning in social virtual reality environments

The Blended Model for Deep & Meaningful E-learning in Social Virtual Reality Environments consists of three interconnected factor categories or layers that influence the level of support of deep and meaningful learning in SVREs: individual, student factors; learning design and implementation factors, and; technology-related factors (Mystakidis et al., submitted).

First, the layer of student pre-learning factors includes their inherent *characteristics*, *perceptions* and relevant *technical skills* (Pellas, 2014). The learner characteristics encompass personality attributes such as cognitive ability, values, beliefs and behavior orientation e.g. introvert vs extrovert personality. Perceptions contain situative attitudes towards a specific learning intervention. They include conceptions of studying and learning, interest, self-efficacy and motivation to learn (Okita, Turkay, Kim, & Murai, 2013). These variables are not static and are connected to the emotions experienced during learning; design and implementation can enhance or diminish learners' interest and motivation towards DML. Equally impactful in e-learning is the level of technical competence related to the used systems. Several studies have confirmed that this factor can obstruct learning when neglected (Ozonur, Yanpar Yelken, & Sancar Tokmak, 2017; Wiecha et al., 2010); in other words, prior to learning teachers should confirm learners' skills adequacy and provide ample opportunities for them to familiarize themselves with new tools and platforms so as to ensure that "technology doesn't get in the way of learning".

In regards to the classes of technology and learning design & implementation in a computer-mediated system such as an immersive virtual world, the dynamic has been partly described by Duncan, Miller, & Jiang (2012). The technological system *affordances* and level of *usability* by non-technical users define the constraints of what is possible within the platform (Burgess et al., 2010). Also, during learning, user access, robustness of *performance* and existence or lack of user *support* are decisive enabling or inhibiting factors for DML (Mystakidis, Berki, et al., 2017a).

Next, in the category of learning design & implementation, teacher *perceptions* and the adoption of a certain *learning theory*, philosophy or pedagogic framework -or the lack thereof- dictate functional and aesthetic decisions on characteristics of the 3D learning *environment* prior to learning (Girvan et al., 2013; Ward et al., 2015). These inform in turn teaching and learning *activities* in the pursuit of specific learning outcomes.

Two additional, interconnected factors in-learning include the establishment and maintenance of a sense of social presence in a *community* of inquiry or practice where learners can build and navigate personal connections (Burgess et al., 2010; Dickey, 2005), and the establishment of clear *protocols* of collaboration and communication, especially in less structured environments and activities (Schiller, Mennecke, Nah, & Luse, 2014).

The proposed model can be used by educators to reflect upon and optimize their practice in SVREs towards deep and meaningful learning. Two examples

related to cognitive load theory (Kirschner, 2002; Sweller, 1994) are presented. Cognitive overload as a result of the limited capacity of the human mind is a potential threat for distance learning quality especially in rich, open, interactive SVRE platform where learning doesn't take place in a confined digital space and there are multimodal stimuli. One technology affordance and one learning design decision lead to positive effects on learning by decreasing cognitive load; the addition of communication over voice in SVREs (Erlandson et al., 2010) and a structured collaborative environment in comparison to an unstructured (da Silva & Garcia, 2013).

6.1.4 Serious E-scape room model

The proposed model of serious E-scape room unites virtual escape rooms with deep and meaningful learning theories. Serious E-scape rooms are educational game-based and problem-solving experiences in virtual online environments with a special focus on deep and meaningful learning. Serious e-scape rooms provide learners with challenging activities and puzzles they can undertake autonomously from a distance in an authentic context, narrative or theme. Participants are invited to act, explore, identify, think, experiment, solve problems, communicate, discuss, coordinate, distribute roles, collaborate and reflect, so as to build mental connections between new and existing knowledge. Additionally, these experiences when designed effectively can attract the attention, ignite interest and create a pleasurable atmosphere that excite and enables intrinsic motivation. Hence, serious e-scape rooms can address the cognitive, emotional and social domains of learning in a potentially cost-effective manner.

6.2 Recommendations for practice

For deep and meaningful learning in SVREs especially for distance education the following recommendations are proposed: meaningful context, purposeful activation, learner agency, intrinsic emotional engagement, holistic social integration, 360^0 obstacles removal and sufficient duration (Mystakidis et al., submitted).

Technology alone cannot cause learning to happen but its affordances can make specific activities possible where learning takes place (Dalgarno & Lee, 2010). Learning environments and activities in a SVRE have to be designed in an *appropriate context*, aligned with the programme's learning outcomes and learners goals (Nussli & Oh, 2014). This context can be authentic, realistic or completely fictional but cognitively related to learning outcomes e.g. through metaphor or storytelling (Mystakidis & Berki, 2018). It should serve a specific need and purpose that learners will embrace voluntarily to be active and work towards a goal or challenge. *Active learning* enhances metacognition and helps students build mental models of the studied discipline (Sitzmann, 2011). Therefore, they must

be emotionally engaged; being in the SVRE should be a positive, desirable experience, not an obligation. Educators will be instrumental in cultivating the ethos of the shared environments towards trust building (Kostiainen et al., 2018). Learners should be encouraged to exercise *agency*, freedom to make choices in their engagement with content, objects, artificial intelligence entities such as non-player characters (NPCs) in the environment and especially with teachers and peers. Exercising control on their experience is beneficial for students' learning (Mikropoulos & Natsis, 2011).

The SVRE should not be just the 'virtual classroom' where course meetings take place. Different spaces can be students' locker rooms, cafés, workshops, alternative places for online social formal *and* informal *peer interactions* (Mystakidis, Berki, et al., 2017a) but not to the detriment of learning. Creating the conditions for students to discuss and exchange their opinions enable them to explore and encourage an investigative attitude (Pellas, Kazanidis, Konstantinou, & Georgiou, 2017). Finally, in the operational level, one prerequisite is that all technological, psychological or other *obstacles should be removed*. A good practice is providing ample time and resources for training, preparation and experimentation with eventually unfamiliar SVRE platforms so that technology is not a barrier but an enabler.

Another linked implementation factor for meaningful learning experiences in SVREs is the duration of learning experiences. SVREs as complex systems generally take time to master, although new platforms are improving the learning curve. More importantly, the emotional connection to the digital representation of the self, the mastery of complex trained skills through repeated practice, as well as the effective acquaintance, communication and collaboration with other avatars take time especially in distance education (Merchant et al., 2014). Although short interventions can demonstrate learning gains and positive emotional results, deep and meaningful learning requires space and time for commitment, activation, and interaction. Shorter interventions run higher danger of suffering by the novelty effect, users being enthused with the VR platform due to its newness (Hew & Cheung, 2010). Therefore, we advocate the design of e-learning experiences spanning across *longer time-spans*, unless the experience is very intense and structured or directed at experienced VR users.

6.3 Future research

In this presented research, the connection between game-based motivation enhancement methods and deep & meaningful learning has been shown. This calls to pay attention to the potential of this phenomenon in future e-learning design and planning while also improving existing platforms, systems or courses. Addressing the affective and social domains of learning improves the learner experience and has a positive effect on learning satisfaction and quality. To future develop the described models, it is important to seek opportunities further refine, apply, test and expand them so as to become more useful to practitioners. This is

important because theory-grounded, well-researched, application-tested and adequately-documented models and frameworks can democratize learning innovation by facilitating the massive adoption of SVREs by a large audience of educators of all disciplines in institutions and businesses. Indeed, facilitating the creative and pedagogical needs of non-technical users has been proposed as one of the top research priorities for the field of immersive learning technology (Gaspar et al., 2019).

Deep and meaningful is a theoretical framework that can be further developed to accommodate the requirements of an increasingly knowledge-based digital economy and society where learning is a central, vital process. In this direction, one option would be to focus on three essential dimensions that involves learning; cognitive, social and affective aspects. Especially as life-long learning and continuous education throughout our entire professional life will be a necessity for most adults, more research can be conducted on how technology enhanced learning and especially SVREs can help educators and providers overcome emotional and social obstacles such as motivation, commitment, and isolation to adult education, professional training and especially life-long e-learning courses.

Information seeking and finding in creative collaboration ways and inquiry-based/problem-focused education approaches have been encouraging pedagogical frameworks and proved to be very fruitful in combination with game mechanics in 3D Virtual Immersive Learning Environments (Mystakidis & Berki, 2019). A further future research and development target is to accommodate these pedagogical concepts within an epistemological framework that considers social inclusion and promotes deep learning strategies. There are different requirements for the latter, and access to these new media, both within and between countries would highlight the differences in the learning process and learning outcomes. Any inequalities, often referred to by the term "digital divide", involve both questions of access and representation (Mystakidis & Berki, 2018). In the future of this research and development, we prioritized our investigation on issues of inclusion and digital divide, digital learning identities and multicultural representation and deep/surface learning comparison within the framework of problem focused education (Mystakidis & Berki, 2019).

In the future, we also feel compelled to address another relevant, important issue; competence-based deep and meaningful learning assessment in distant education and 3D virtual immersive environments. We need new instruments and for reliable deep and meaningful learning evaluation in e-learning and SVREs. We are aware that formal education is to a large extend evaluation-driven; the evaluation method dictates and shapes studying and learning approaches of students. Therefore, it is critical to link directly deep and meaningful learning outcomes with authentic assessment methods that emphasize students' competence to identify, analyze and solve problems in ill-defined settings that resemble real-life situations. Existing learning activities frameworks and categorizations in

SVREs can be mapped across deep learning skills scales such as the SOLO taxonomy levels. In that way educators will be able to use appropriate combinations of activities to help learners achieve specific levels of knowledge depth.

Another line of research links deep and meaningful learning with enhanced degrees of freedom and self-directedness of learners' participation in SVREs 'liquid' learning (Steils et al., 2015). Liquid curricula are characterized by active course co-design, democratization, emancipation, reflexivity and flexibility. Liquid learning is suitable for higher education in a rapidly changing world with a high degree of uncertainty. SVREs enable flexible e-learning design with fluid content, natural assessment and strong emphasis on community interactions, open-ended discussions and tasks that facilitate deep and meaningful learning.

6.4 Limitations of the study

The presented research in this study has some limitations that need to be acknowledged and addressed. First limitation regards the generalizability of findings beyond the context of the specific studied systems and experiences. For this particular study we researched the effects of learning interventions in specific yet heterogeneous educational organizations in different countries with participants with various nationalities. Further empirical studies are needed to test and replicate findings in different populations, contexts and situations in various institutions in other platforms and systems. These studies would provide a more solid basis of findings that could be generalizable to wider population groups.

Another limitation is related to the application area of the presented tentative models and frameworks. Different approaches were applied in various blended and fully online learning settings. However, in future research the current models could be expanded to new areas such as mobile learning, augmented reality (AR), mixed reality (MR) and extended reality (XR) applications in conjunction with sensor input and the Internet of Things.

Also, despite the benefits of adding game elements in learning environments, we recognize that motivation enhancement methods and techniques such as gamification, serious games and playful design might have certain limitations and points of criticism. These points include the control and power opposed to learners by the designers and the normalization of behavior when people have to play by the rules to learn. This might limit the autonomy and agency of learners to negotiate and creatively engaged with content (Mystakidis & Herodotou, 2016).

6.5 Contribution of the research

The mixed research in this thesis focused on the value of game-based motivation enhancing methods that facilitates deep and meaningful learning for quality e-learning. It approached the area of study holistically and with a practice-anchored attitude. It unified findings from the nano, micro, and meso levels of e-learning practice. I started from the design and study of modular learning activities and interventions (nano level) that together build cumulatively entire courses or programmes (micro level). A portfolio of courses is developed, informed and guided by institutional or enterprise strategies and policies (meso level). Thus, experiences and lessons learned at the latter levels can in turn provide practical insights, inspire respective updates and adaptations to national and international European policies (macro level).

Taking a macroscopic look at the outputs of the Ph.D., the OpenQuest framework is a solid foundation for researchers to build upon, expand apply and test in open education and e-learning practice. The Serious E-scape Room is a practical model to unleash the potential of serious games by bringing them closer to the mainstream educational practice. The Blended Model for Deep & Meaningful E-learning in Social Virtual Reality Environments can assist practitioners orient their practice towards powerful, high quality learning. The Patras Blended Strategy Model can help institutional and business leaders fine-tune and scale up all process towards deep and meaningful e-learning.

The research outputs and findings can be useful, be applied and expanded in other disciplines with distributed systems that users have the choice to use or not such as such as e-Government, e-Health and e-Business. This research is also highly relevant to the adoption of other and future technologies in education, especially experience-centered technologies such as augmented, mixed and extended reality as they intersect with machine learning and artificial intelligence. Deep and meaningful learning was, is and will be an important educational goal regardless of learning mode or used technological medium. Lessons learned in social virtual immersive environments can inform practice and research with adjacent technologies and platforms.

This research reaffirms the importance of affecting computing, the role of emotions and social interactions in virtual reality and e-learning. Many past and current educational policies, practices and lifelong learning systems focused solely on the cognitive side and only gradually took the social aspect into account. However, they often ignore the emotional dimension or attempt to manipulate emotions and motivation using external financial or administrative incentives. Both practices, ignoring or hacking human emotions, are inhibiting the emergence of a learning atmosphere conducive to deep and meaningful learning with true transformative potential.

For mass quality digital education in the knowledge economy we need to enable and encourage teaching and learning approaches that facilitate deep meaningful learning in distance education. SVREs can support sufficiently deep

and meaningful learning combining a variety of student-centered learning methods that engage them cognitively, socially and affectively. As research findings indicate, apart from the content side, we need to put equal emphasis, on the social and emotional aspect of the e-learning process. One suggested course of action is to enhance motivation and social interaction by using appropriate methods such as problem-based learning, project-based learning, inquiry-based learning, game-based learning, playful learning, gameful learning (gamification) or serious games.

EPILOGUE

The proliferation of digital technologies in education and economy enable a profound transformation of work, teaching and learning. The traditional higher education study cycle system (undergraduate, graduate, doctoral) will be supplemented with new models of continuous, flexible work-based life-long learning. The unbundling of degrees with the emergence of modular international and transdisciplinary credentials, linked with internet-based degree programmes, and flexible online learning, such as MOOCs will test the adaptability and agility of traditional institutions and give more choices than ever to learners.

In this dynamic educational landscape of a knowledge-driven economy and society, learning effectiveness will be essential. Effective teaching and learning approaches in distance and blended educational settings are expected to engage learners cognitively, socially and affectively. High quality education will be experience-driven instead of content-centered. It will facilitate durable, deep and meaningful personal learning emphasizing robust understanding, knowledge application and construction, higher-order critical thinking, creativity, ethics, and moral values. In this context, ethical motivational enhancement methods and emotional support will be crucial for learning perseverance and successful completion. Also technologies such as extended and social virtual reality will be essential for providing meaningful formal and informal online interpersonal interactions and human experiences based on social presence and co-presence.

YHTEENVETO (FINNISH SUMMARY)

Verkko-oppimisesta ja avoimesta koulutuksesta on tulossa yleisiä koulutusmuotoja, joilla voidaan vastata lisääntyneisiin koulutustarpeisiin korkea-asteen koulutuksen ja elinikäisen oppimisen aloilla tietoyhteiskunnassa. Nykyisillä verkko-opetuksen ja –oppimisen käytännöillä on merkittäviä rajoituksia etäopetuksen laadun ja tehokkuuden suhteen. Syvän ja mielekkään oppimisen teorioissa asetetaan yhtäläinen paino oppimisen kognitiiviseen, sosiaaliseen ja affektiiviseen näkökulmaan osallistamalla henkilö kokonaisvaltaisesti. Syvälle ja mielekkäälle verkko-oppimiselle tarvitaan uusia malleja ja viitekehyksiä, jotka kehittävät ja ylläpitävät oppijoiden korkeaa motivaatiota, kognitiivista sitoutumista ja tyytyväisyyttä.

Tämän tutkielman keskipisteessä ovat motivaatiota lisäävät menetelmät syvälle ja mielekkäälle oppimiselle e-oppimiskursseilla. Yleisenä tavoitteena on selvittää sosiaalisen virtuaalitodellisuusympäristön avulla motivaatiota lisäävien lähestymistapojen vaikutus verkko-oppimisen ja avoimen koulutuksen yhteydessä. Peleihin pohjautuvia sisäistä motivaatiota kasvattavia lähestymistapoja ovat leikkisä suunnittelu, pelillistäminen ja hyötypelit. Aikaisempi osallistumisperusteisten, sulautuvan oppimisen ja verkkoympäristöjen yhteydessä tehty empiirinen tutkimus on osoittanut lupaavia tuloksia. On kuitenkin tarpeen tutkia motivaatiota lisäävien menetelmien vaikutuksia verkko-oppimisessa ja avoimessa koulutuksessa oppimisen laatuun nähden. Voimmeko parantaa oppimisen laatua ja auttaa oppijoita saavuttamaan syvän ja mielekkään oppimisen, kun luontainen motivaatio on painopisteenä suunnittelussa ja opettamisessa? Motivaation lisäämisen vaikutuksen ymmärtämiseksi on kirjoitettu kahdeksan artikkelia, jotka kuvaavat tuloksia pääasiassa laadullisia ja määrällisiä menetelmiä yhdistäneistä tutkimusasetelmista.

Tutkimus esittää neljä alustavaa viitekehystä ja mallia syvää ja mielekästä e-oppimista varten. OpenQuest tarjoaa perustavan viitekehyksen, jonka avulla tutkijat voivat rakentaa, laajentaa, soveltaa ja testata pelillistämistä avoimen koulutuksen ja e-oppimisen käytännöissä. Serious E-scape Room on käytännöllinen malli, joka vapauttaa hyötypelien potentiaalin tuomalla ne lähemmäksi valtavirtaa edustavia opetuskäytäntöjä. Blended Model for Deep & Meaningful E-learning in Social Virtual Reality Environments voi avustaa opettajia orientoimaan toimintansa kohti vaikuttavaa, laadukasta oppimista. Patras Blended Strategy Model voi auttaa instituutioiden ja yritysten johtajia hienosäätämään ja skaalaamaan kaikkia prosesseja kohti syvää ja mielekästä e-oppimista.

Tämän tutkimuksen tulokset ja opit voivat nopeuttaa verkko-oppimisen laadun parantamista vastaamaan kiireellisiin yhteiskunnallisiin ja taloudellisiin koulutustarpeisiin, jotka vaikuttavat korkea-asteen koulutuksen ja elinikäisen oppimisen tulevaisuuteen. Syvän ja mielekkään oppimisen helpottaminen verkkokoulutuksen avulla tarjoamalla laadukasta, joustavaa, henkilökohtaista ja muuttuvaa oppimista suurelle yleisölle voisi avata uusia koulutusalueita ja auttaa saavuttamaan uusia virstanpylväitä talouskasvussa, sosiaalisessa kehityksessä ja hyvinvoinnissa.

ΣΥΝΟΨΗ (GREEK SUMMARY)

Η ηλεκτρονική μάθηση και η ανοικτή εκπαίδευση καθίστανται βασικοί μέθοδοι εκπαίδευσης για την αντιμετώπιση των αυξημένων αναγκών μάθησης και κατάρτισης στην τριτοβάθμια εκπαίδευση και τη δια βίου μάθηση στην κοινωνία της γνώσης. Οι τρέχουσες πρακτικές διδασκαλίας και εκμάθησης στην εξ αποστάσεως εκπαίδευση αντιμετωπίζουν σοβαρούς περιορισμούς ως προς την ποιότητα και την αποτελεσματικότητα. Η θεωρία της βαθιάς και ουσιαστικής μάθησης μπορεί δυνητικά να αντιμετωπίσει αυτές τις προκλήσεις, δίνοντας έμφαση στη γνωστική, κοινωνική και συναισθηματική πτυχή της μάθησης, εμπλέκοντας ολιστικά το άτομο. Στο πεδίο της εξ αποστάσεως εκπαίδευσης απαιτούνται νέα μοντέλα και πλαίσια για βαθιά και ουσιαστική ηλεκτρονική μάθηση που θα οδηγούν σε υψηλά επίπεδα παρακίνησης, γνωστικής ενασχόλησης και ικανοποίησης των μαθητών.

Η παρούσα διατριβή εστιάζει στις μεθόδους ενίσχυσης της παρακίνησης για βαθιά και ουσιαστική μάθηση στην ηλεκτρονική εκπαίδευση. Ο πρωταρχικός στόχος είναι να διερευνηθεί η επίδραση των προσεγγίσεων ενίσχυσης της παρακίνησης με τη χρήση κοινωνικών περιβαλλόντων εικονικής πραγματικότητας στην ηλεκτρονική μάθηση και την ανοιχτή εκπαίδευση. Προσεγγίσεις για εγγενή παρακίνηση που βασίζονται στην παιγνιώδη μάθηση περιλαμβάνουν τον παιγνιώδη σχεδιασμό, την παιχνιδοποίηση και τα παιχνίδια σοβαρού σκοπού. Προηγούμενες εμπειρικές έρευνες στην παραδοσιακή διά ζώσης, την υβριδική και την πλήρως εξ αποστάσεως εκπαίδευση έχουν αποφέρει ενθαρρυντικά αποτελέσματα. Ωστόσο, είναι αναγκαία η διερεύνηση της επίδρασης των μεθόδων ενίσχυσης της παρακίνησης στην ηλεκτρονική μάθηση και την ανοικτή εκπαίδευση όσον αφορά την ποιότητα της μάθησης. Μπορεί να βελτιωθεί η ποιότητα της εκπαίδευσης και οι εκπαιδευόμενοι να βιώσουν βαθιά και ουσιαστική γνώση, όταν το επίκεντρο του εκπαιδευτικού σχεδιασμού και της διδασκαλίας είναι τα εγγενή κίνητρα; Για να κατανοήσουμε την επίδραση της ενίσχυσης των κινήτρων, συντάχθηκαν οκτώ ερευνητικά άρθρα, τα οποία περιγράφουν τα ευρήματα ερευνών με τη χρήση κυρίως μεικτών, ποιοτικών και ποσοτικών μεθόδων.

Η διατριβή προτείνει τέσσερα πλαίσια και μοντέλα υπό σχεδιασμό για βαθιά και ουσιαστική γνώση. Το πλαίσιο OpenQuest παρέχει μια βάση για την ανάπτυξη, εφαρμογή κι αξιολόγηση εφαρμογών παιχνιδοποίησης στην ανοικτή εκπαίδευση και την ηλεκτρονική μάθηση. Το Ηλεκτρονικό Δωμάτιο Απόδρασης Σοβαρού Σκοπού είναι ένα πρακτικό μοντέλο για την αξιοποίηση του δυναμικού των παιχνιδιών σοβαρού σκοπού από μεγάλο αριθμό εκπαιδευτών. Το Μικτό Μοντέλο για Βαθιά και Ουσιαστική Γνώση σε Κοινωνικά Περιβάλλοντα Εικονικής Πραγματικότητας μπορεί να βοηθήσει επαγγελματίες της εκπαίδευσης να στρέψουν τον τρόπο διδασκαλίας τους προς τη δυναμική μάθηση υψηλής ποιότητας. Το Μοντέλο Μικτής Στρατηγικής της Πάτρας δύναται να υποστηρίξει ηγέτες σε ιδρύματα και επιχειρήσεις να συντονίσουν και κλιμακώσουν όλες τις σχετικές εκπαιδευτικές και διοικητικές διαδικασίες προς τη βαθιά και ουσιαστική ηλεκτρονική μάθηση.

Τα αποτελέσματα και τα συμπεράσματα από την έρευνα αυτή μπορούν να επιταχύνουν τη βελτίωση της ποιότητας της ηλεκτρονικής μάθησης για την αντιμετώπιση των επειγουσών κοινωνικών και οικονομικών αναγκών εκπαίδευσης που επηρεάζουν το μέλλον της τριτοβάθμιας εκπαίδευσης και της δια βίου μάθησης. Η διευκόλυνση της βαθιάς και ουσιαστικής μάθησης στην ηλεκτρονική εκπαίδευση για την παροχή ποιοτικής, ευέλικτης, εξατομικευμένης, μετασχηματίζουσας μάθησης για μεγάλο πλήθη συμμετεχόντων μπορεί να ανοίξει νέους εκπαιδευτικούς ορίζοντες και να οδηγήσει σε νέα επιτεύγματα οικονομικής ανάπτυξης, κοινωνικής προόδου και ευημερίας.

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ORIGINAL ARTICLES

I

THE CASE OF LITERACY MOTIVATION: PLAYFUL 3D IMMERSIVE LEARNING ENVIRONMENTS AND PROBLEM-FOCUSED EDUCATION FOR BLENDED DIGITAL STORYTELLING

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The Case of Literacy Motivation:
Playful 3D Immersive Learning Environments and Problem-Focused Education for Blended Digital Storytelling

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ABSTRACT

The University of Patras' Library Services designed and offered to primary and secondary schools the pilot educational program "From the Ancient to the Modern Tablets", featuring immersive multimedia learning experiences about the book history. The pilot program consisted of three stages: a playful library tour, followed by an interactive game-based digital storytelling activity with game elements, and a collaborative creative reflective hands-on activity. Utilizing the avatar psychology power, the visualization and simulation affordances of 3D immersive learning environments and the appeal of storytelling and game-based learning, the "gamified" blended narrative on the book evolution enabled learning as problem-focused, embedded and context-generated. An additional research study was conducted to investigate teachers opinions regarding the effectiveness of the 3D Virtual Immersive Environment(s); this focused on students' learning and thinking skills in the socio-cognitive, psychomotor and affective domain. This work exposes the pedagogical design, presents the socio-technical development and reflects on the initial research findings.

KEYWORDS

3D Virtual Immersive Learning Environments (3D VLE), Digital Storytelling, Gamification, Library, Multi-User Virtual Environments (MUVEs), Problem-Focused Education (PFE), Second Life

1. INTRODUCTION

At times libraries have been criticized for becoming increasingly outdated or irrelevant in the age of ubiquitous access to knowledge and information. We argue that in the era of lifelong learning, libraries can become places and spaces, which host learning opportunities that are accessible to all. Beyond fulfilling their traditional role of offering information and knowledge, libraries can be transformed and evolve to critical and reflective knowledge providers, can offer creative workshops and develop innovative, open learning spaces for any age. Universal access can be achieved with the help of educational technology specialists and learning innovators design thinking.

As an integral part of its mission the Library and Information Center (LIC) of the University of Patras considers that to stay accessible to and collaborate with schools so as to support school teachers and students in their learning ventures. This approach is aligned with the function of Libraries in the 21st century as "third places" (Montgomery & Miller, 2011) that facilitate learning in multiple ways. "A third place is an open accessible area or space where citizens can congregate voluntarily

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and interact to produce social value." (Oldenburg, 1999). The two other places where people spent their time daily are workplace and home.

In 2012, the University of Patras decided to launch a new institution-wide initiative called "Schools go to the University", (University of Patras, 2014), and invited all interested departments to design and offer short educational programmes suitable for primary and secondary education schools. All programmes were communicated to schools of the Prefecture of Achaia. Interested schools could arrange visits for one or several class to any programs during a specified spring open-door two-week period.

Responding to this invitation, LIC designed the pilot educational project "From the Ancient to the Modern Tablets", (University of Patras Library Services, 2014), an immersive playful multimedia learning experience about the history and future of books. The programme combines digital storytelling, 3d virtual immersive learning environments, and gamification, utilising the concepts of problem-focused education.

The current work is an extended version of the work presented in a conference publication forum, co-authored by Mystakidis, Lambropoulos, Fardoun, and Alghazzawi (2014). The extended work elaborates more on the pedagogical design, the socio-technical development principles and the formative assessment results of the educational programme.

2. THEORETICAL BACKGROUND

In this section, there is an exposure of our main theoretical terms and pedagogical design concepts. Thus sections 2.1-2.4 outline the conceptual essence and personal motivation to aim at constructing this type of pedagogical instrument that mainly targets at historical events' finding and understanding. The whole research study has been carried out in an experimental, rather unusual, but yet innovative and effective way, which revealed interesting conceptual pedagogical aspects of problem-focused education and enquiry-based learning.

2.1. Digital Storytelling

Storytelling is a universal and diachronic medium for knowledge and wisdom transfer across cultures (Bruner, 1991). Storytelling is the socio-cultural activity of sharing stories, often with improvisation, theatrics, or changing the emphasis on different aspects. Historically, various stories and plots have been shared by humans as a means of entertainment, education, cultural preservation and instilling values and cultural norms. Crucial elements of storytelling are the plot, the characters and the narrative points of view. The term 'storytelling', however, has rather been used in a narrow sense to refer specifically to oral storytelling and also in a looser sense to consider techniques used in other media to unfold or disclose the narrative of a story (Wikipedia, 2017). Further digital storytelling uses contemporary technologies, such as digital media to utilize the ancient form of communication through stories. Moreover, digital storytelling utilizes visual and auditory elements to compose and deliver valuable meanings and messages. Music and sound effects can accompany the narrative to add atmospheric tension to the experience. This type of storytelling is a rather compelling method to construct and organize learning both for children and adults (Ohler, 2006). It can be used both as a teaching and learning strategy, for example as a vital component in an organized student (individual or group) project. Van Eck argues that narration and storytelling are two of the most powerful instructional strategies (Van Eck, 2007). "Stories allow us to learn from the experience(s) of others without having to face another person's personal consequences…" (Baer, 2013). McAdams has argued that the human behavior is being guided by narrative construction (McAdams, 2006). Storytelling has also been found to be an effective method to increase information retention. Adval and Wyer (1998) have demonstrated that adults tend to remember facts and other pieces of knowledge more accurately if they encounter them in a story rather than reading them in a list or simple text format (Adaval & Wyer, Robert S., 1998).

Digital storytelling has been used world-wide in classroom education with excellent pedagogical results (Clarke & Adam, 2012; McDrury & Alterio, 2003; Moon, 1999). More specifically, digital storytelling has been found to improve 1) student comprehension, 2) logical thinking, 3) literacy, written and oral language skills, 4) student memory, 5) cross-curriculum learning (Haven, 2007). In most instances, however, digital storytelling has been used as a student activity for the design and production of digital artifacts, usually as a part of an assigned project or as the means of individual or group reflection. In the context of our study, we chose digital storytelling as an enquiry-based and problem-focused education framework to construct an overarching narrative for the achievement of selected, pre-defined teaching aims and learning objectives.

2.2. Increasing Commitment through Game, Gamification and Play

A recent (revisited) addition to the educators' arsenal is the target of increasing interest in playful activities and commitment to learning through games, that is gamification and playful design. During well-designed immersive games children and adult learners could experience the state of a problem, enquiry, or simple fact flow as an immersive learning experience. Otherwise stated the latter state of flow can be evidenced as the optimal state where between boredom and anxiety a potential learner can utilize an ever-changing learning identity through achievement of balance between learning challenges and skills to be acquired (Csikszentmihalyi, 1990). Such games can be used as appropriate learning experiences according to Vygotsky's zone of proximal development (Lambropoulos et al., 2012). A plethora of games have frequently been used to initiate, enhance and facilitate learning (Gee, 2004; Squire, 2005). Story and digital storytelling is a game mechanic in games to provide a compelling narrative. One common form of digital storytelling applied in games is, for instance, "the hero's journey" (Goldstein, 2005), which focuses on adventures and values. Gamification is the incorporation of game mechanics and elements in a non-gaming context (Deterding, Dixon, Khaled, & Nacke, 2011). Schiller already in 1875 pointed out that play is the expenditure of exuberant energy. Gamification, games and play as such are distinct strategies to incorporate the element of fun in the learning process, so students' commitment would increase.

2.3. Problem-Focused Education (PFE) and Manifold Thinking Skills

Problems are challenges in real-life situations that have been used as primary building blocks to design socio-cultural, situated student-focused learning experiences for attendance-based and distance learning programs (Margetson, 2001). Problem-based learning (PBL) orchestrates student learning as a process of apprenticeship on solving real-life problems (Margetson, 2001). The aim of problem-based learning is to provide a bridge between learning and real life and encourage manifold thinking. Manifold thinking includes four types of thinking skills: creative, critical, caring and reflective thinking (Valtanen, Berki, Kampylis, & Theodorakopoulou, 2008).

Proponents of problem-focused education (a variation of PBL) argue that learning, should be structured around meaningful, complex real-life problems instead of isolated subjects and self-contained courses. Problem-focused education (PFE) follows a more flexible than PBL approach: PFE 1) begins with a problem, 2) presents the problem as a real-life situation, 3) supports students' manifold thinking and working in a group, 4) encourages students to identify their own learning needs and take responsibility of their own learning processes, and 5) encourages assessment and evaluation of the learning process and its learning outcomes (Valtanen, Berki, Georgiadou, Ross, & Staples, 2011).

In this context, we adopted the principles of problem-focused education and combined them with digital storytelling in 3D virtual immersive learning environments. In so doing, we designed learning activities to 1) facilitate students' independent/individual or/and group learning, 2) increase the responsibility of own learning processes; 3) develop manifold thinking and other skills and, finally, 4) advance deep learning strategies in the educational designs of the future.

2.4. 3D Virtual Immersive Learning Environments

3D Virtual Immersive Learning Environments (3D VIEs), also called 3d Virtual Worlds or multi-user virtual environments - MUVEs are three-dimensional computer-generated virtual spaces that enable educators to enhance both attendance-based teaching (Nussli & Oh, 2014) and distance learning (Endicott-Popovsky, Hinrichs, & Frincke, 2013; Hill, 2011) by applying socio-constructivist instructional methods such as situated and experiential learning (Dede & Dawley, 2014; Liz Falconer, 2013). More specifically, 3D VIEs are flexible learning tools for utilizing approaches of storytelling to create simulated (L. Falconer & Frutos-Perez, 2009) and game-based learning experiences (Hill & Mystakidis, 2012).

The Library and Information Center (LIC) of the University of Patras offered the first open course series in 3D VIEs in Greek higher education in the frame of a project called "Open Workshop on Information Literacy". As a result, the creators of the programme received a national seal of good digital teaching practice (Mystakidis & Tsakonas, 2012).

In this instance, we used 3D VIEs as a digital medium to narrate a transmedia story, by visiting various virtual environments and directing immerse learners into different historical times and ancient civilizations. Transmedia storytelling expands the content delivery of a story across multiple platforms and media such as television, internet, social media, mobile applications etc. (Jenkins, 2006)

3. RESEARCH QUESTION AND RESEARCH METHODOLOGY

3D virtual immersive learning environments and digital storytelling have not been introduced into Greek primary and secondary education as teaching tools and learning methodologies. Notwithstanding the underlying technologies are expected to be familiar to some students, primarily through computer games in 3D environments. Thus, our initial intention was to provide teachers and students with the opportunity to experience different teaching and learning approaches.

Secondly, we wanted to find out about the local school teachers' perceptions on the short-term impact of the learning experiences of their students. Our research aim was to capture the initial teacher evaluation of the pedagogical potential and effectiveness of the employed instructional method for literacy motivation in their class students. The teachers had the opportunity to observe their students' behaviour during all stages of the programme. Teachers were especially encouraged to observe and interact with the students during the final part of the programme, which was considered to be the stage of the creative collaboration and reflection.

More specifically we aimed at tackling and answering the following research question:

Could enriched with (digital) storytelling and problem-focused education concepts 3D Virtual Immersive Environments have a positive impact in facilitating primary education students' learning?

To address the above, we used a mixed research methodology approach, which is also found at the work of (Venkatesh, Brown, & Bala, 2013). The approach comprised the following components:

A. a teacher survey (quantitative research) in combination with
B. unstructured interviews (qualitative research).

First, the teachers were informed about the research study through the Library's pilot project and were invited to voluntarily evaluate the students' reactions by completing an anonymous online questionnaire that is our main research instrument. The questionnaire was designed according to Cohen et al's (Cohen, Manion, & Morrison, 2007) principles of questionnaire designing. The final questionnaire consisted of twenty-nine questions organized in three sections, focusing on the:

- Overall formative assessment of the experience;
- Assessment of the impact of used technologies on students' in the cognitive, affective and psychomotor domain;
- Teacher demographics.

Second, after the completion of the educational pilot programme, we conducted short unstructured oral interviews with volunteering teachers. During these interviews, we invited teachers to comment on the programme's design (e.g. educational aims/aspects), implementation (e.g. appearance, interface issues), as well as their students' reactions, interactions and performance, as well as raise issues and make further suggestions for improvement. Their answers were recorded by writing notes.

Finally, during the realization of the pilot project, we were able to collect further data and combine data with anecdotal encounters, reactions and spontaneous comments and questions from the students, by observing students behaviour and learning attitudes.

4. PEDAGOGICAL DESIGN AND RESULTS APPRAISAL

After a series of unstructured interviews and consultations with primary school teachers, the following learning objectives were identified for the "From the Ancient to the Modern Tablets" programme:

- To motivate extracurricular reading and promote earlier, historical events and knowledge literacy;
- To develop socio-cognitive links among books reading, writing, and knowledge acquisition through information and communication technologies;
- To acquire an introductory set of user skills through a tablet; and
- To practice team collaboration and collective knowledge sharing.

An important challenge was to avoid and overcome the passivity and compliance (and sometimes conformity and boredom!) that students face when they are merely presented with events and facts. So, we regarded active user engagement as a critical success factor. Thus, to maximize the students' excitement and engagement while targeting at a project with high problem-focused education quality and learning value, we decided to construct the educational programme around selected game mechanics. The learning experience consisted of three components and stages:

A. A playful library tour (Figure 1),
B. An interactive game-based digital storytelling activity with playful elements, followed by
C. A collaborative creative hands-on group reflection activity.

At the first stage and upon arriving at the Library, students participated in a 30-minute playful tour. The latter features various problem-focused education concepts and game mechanics incorporated and built-in this introductory learning component; such concepts and features are: team play, competition, challenge, information seeking, quests, choices, surprise, curiosity, and expression.

At the second stage, in the Library's seminar room, the students participated in an interactive playful digital storytelling experience. They were invited to assist a digital agent, in the form of an avatar, like an online tutor, on the quest through a series of 3D Virtual Immersive Learning Environments (3D VIEs). The display was visible by all students via a video projector. With the help of this tutor-avatar, which was controlled by a LIC instructor, children traveled back in time and visited simulated 3D virtual environments. The realistically constructed virtual environments allowed students to immerse themselves experiencing aesthetics, architecture, clothing and the culture of that time. Moreover, the students explored cyber-spaces, observed online historical samples and experimented with interactive objects related to the respective studied technological advancement

Figure 1. Playful Library Tour: Students searching for books

or milestone. At the same time, appropriately timed soundtrack was woven into the story to enhance the emotional depth and feeling of immersion. This particular activity highlighted the following milestones about the history of the book:

- Storytelling and ancient cave drawings ca. 32000 BC
- The invention of writing and ancient clay tablets ca. 3500 BC
- Linear A & B script ca. 1450 BC
- The invention of the alphabet ca. 1200 BC
- Papyrus and the Great Library of Alexandria ca. 200 BC
- Byzantine/Roman Scriptorium and the systematic copy of manuscripts in monasteries ca. 600 AD
- The invention of the movable type ca. 1040 AD
- Modern Library ca. 1980 AD
- Tablets and e-books ca. 2014 AD

Herein, concepts and principles from the Problem-Focused Education paradigm played an important role to form a learning innovation: In order to motivate students learning we particularly used contextualized problems and designed interactive elements in the learning activity. At each stop, students were encouraged to demonstrate their (updated) knowledge, conceptual understanding, and critical, creative and reflective thinking skills related to each milestone through age-specific questions and quizzes. For example, in the Ancient Greece stop, the students of the second and third grade played a mini-game, where they had to guess the modern equivalents of the ancient Phoenician alphabet letters. Also in the Space Age stop we challenged the students of fifth and sixth grade to find a solution for the storage of the ever-increasing volume of books and knowledge production.

The students were divided into two groups so as to actively participate in the game that required two teams. Each team scored a point when they were able to answer questions or make valid and useful observations around each milestone. The duration of the storytelling activity was 45 minutes.

An example of the above game activity was the Phoenician Alphabet Challenge, designed for students of 2-6th grade. The two student teams were challenged in turns to identify the correct temporary letter by observing a matrix of selected Phoenician letters.

During the third project stage, students were divided into small groups of three to five pupils. After a brief demonstration of the tablet's use, each group had the challenge to demonstrate their reflective and creative thinking; discuss, experiment with the tablet's software, decide and collaboratively create digital artifacts inspired by the previous book history experiences (see Figure 3). The creative task had duration of 30-40 minutes. These groups used simple multimedia and image editing software of a modern tablet to produce completely diverse digital artifacts (see Figures 2 and 4). The tablets were leased to LIC temporarily by the University of Patras' Human - Computer Interaction Group. The best drawings from each school were showcased on LIC's website.

5. SOCIO-TECHNICAL DEVELOPMENT AND LEARNING MOTIVATION

For the second project stage, we needed to use appropriate 3D virtual immersive environments (3D VIEs) that we either designed and produced or adapted from existing 3D VIEs in the platform of Second Life. The new 3D VIEs were developed at a cost-effective manner in-house by the LIC's 3D Virtual Worlds Expert and first author of this paper in the University of Patras' space in Second Life. The existing 3D VIEs were used and adapted temporarily with permission by their creators and administrators. In total, the following 3D VIEs were used during the experience:

- Lascaux France prehistoric cave (see image 3)
- Ancient Babylon & Mesopotamia

Figure 2. Students' drawing (2th grade): "Phaistos Disk", the first typography system in history

Figure 3. Collaborative creative group reflection activity using tablets

- Ancient Greece
- Ancient Egypt
- Byzantine monastery
- Typography machine
- Space age

The visited 3D VIEs were placed in or adapted from the following islands in Second Life:

- University of Washington's Museum of Virtual Media
- Museum Island
- Alice Academy
- Ancient Alexandria
- International Spaceflight Museum

The 3D VIEs essentially contributed to the students' learning experiences in the following ways, since there was evidently clear that they:

- Depicted the civilization's architecture, natural environment and aesthetics
- Showed clothing and appearance of a representative of each milestone (through the avatar's clothing and skin)

Figure 4. 3D VIE Ancient Egypt & avatar appearance in Second Life

- Visualized objects and notions not available in the physical life, e.g. the arrangement of scrolls in the Great Library of Alexandria
- Demonstrated through programming how inventions worked (e.g. movable type)
- Included objects to be used as prompts during the game (e.g. the Phaistos disk)

The role of the avatar (Yee & Bailenson, 2007) was also equally crucial to the design of the learning experience as it contributed to an additional playful element beyond its functional role in the 3D VIEs and influenced interaction and motivation positively and evidently. Through the use of appropriate animations, the digital agent responded to students' questions and answers, action suggestions or other surprise events in the storyboard, demonstrating emotions and sound effects. This rather non-anticipated behaviour was a surprising element that understandably entertained the students widely and provided a flair style of an interactive show during the motivated learning experience (see also Figure 5).

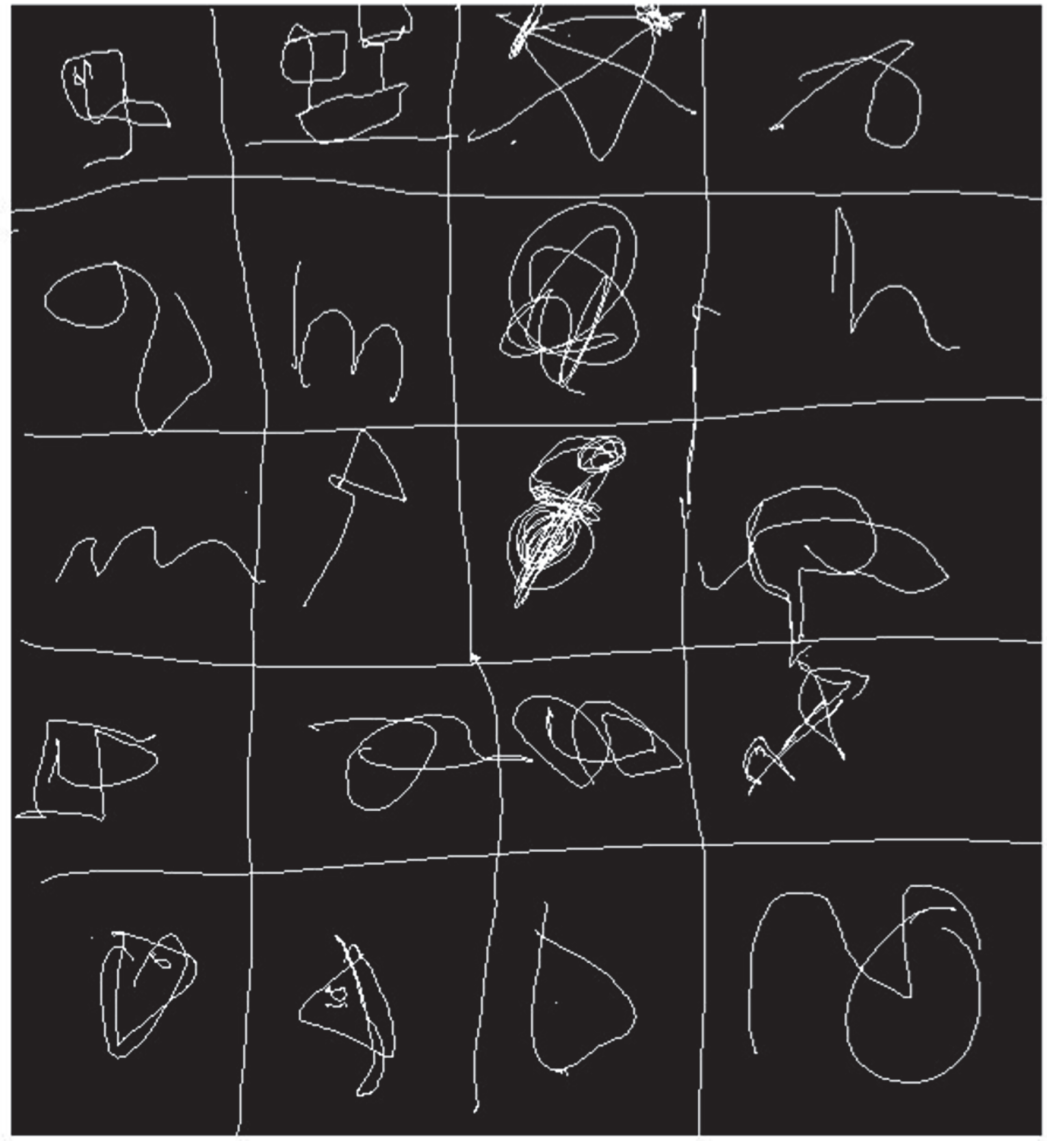
6. CONCLUSION AND FUTURE RESEARCH AND DEVELOPMENT

Storytelling can be used to develop and demonstrate educational aims in practice. Modern digital media can complement traditional ways of learning by creating new ways for learners to experience and remember stories and associated information and knowledge.

As this was a pilot, but also an ongoing research project, we hereby only present and reflect on some initial findings and outline research limitations, general skepticism and future steps.

Tools for team collaboration can provide an assisted to learning environment for early age learners. Online games and other ICTs, such as those used in our pilot project can digitalise innovative learning through interactive fiction or participative storytelling. They can further enhance curiosity and stimulate learning by involving the user in interesting virtual worlds that resemble real facts, events and other knowledge.

Figure 5. Students' digital artifact (4th grade): "Ancient Mesopotamian tablet with symbols"



At the end of the project's last stage, the teachers were called upon to evaluate the learning experience's design, layout and activities, as well as the interaction, reactions, behaviour, emotions and performance of their students. For this data collection, the teachers first completed an online questionnaire. The questionnaire was designed considering the 5 responses-preferences of Likert scale (Cohen et al., 2007).

There were twenty-eight (28) teachers who participated in the current evaluation study and responded to the questionnaire. In summary, the initial findings from this questionnaire's data collection suggested the following: 81% of the teachers confirmed that children acquired new skills (with answers: 'agree' and 'fully agree'); 85% affirmed that the learning experience added to the students' positive mentality towards books and reading; 85% of the teachers estimated that the learning

experience helped children to assume a positive attitude towards books and reading (answers: agree & fully agree); 98% found 3D VIEs useful for facts recalling and history understanding.

During the qualitative research evaluation phase, through the unstructured interviews (Cohen et al., 2007), among other comments (Mystakidis et al., 2014) the teachers expressed, among other, the following opinions, which range from the very optimistic and positive to more skeptical ones:

I have never seen my class so quiet and concentrated as when they attended this program.
You exceeded teachers' and students' expectations; you have captivated children's interest and they enjoyed the program greatly. The whole visit to the Library was so alive.
I am not sure if the use of technology will increase my students' desire to read books.

Overall, 3D Virtual Immersive Environments combined with engaging pedagogical methods such as scaffolding (Chase & Scopes, 2012) enabled LIC to produce a cost effective and yet rich learning experience in cyber-space; and engage students from local schools, which could not otherwise have because they would not afford to travel to the actual physical places. Utilizing the socio-psychological power of the avatar image, the visualization and simulation affordances of 3D virtual immersive learning environments and the appeal of storytelling and game-based learning, LIC designed and developed a "gamified" blended narrative on the evolution of the book, where learning is embedded and context-enabled.

The "From the Ancient to the Modern Tablets" programme was a pilot educational project intended to serve as a proof of concept and the first step towards the formulation of a new pedagogical framework design with the essential and tried epistemological concepts for a full-scale project implementation.

Due to resources scarcity it was not possible to organize a true random sampling (Cohen et al., 2007) by inviting truly representative school classes to participate in the project. However, the geographical distribution of the visiting schools was representative enough as it included classes both from urban and rural areas, but also from areas of high and low income. In any case, the results could be skewed when we take into account the degree of interest and initiative by teachers and head teachers to provide optional learning opportunities by participating in the pilot study programme.

In the next phase of our research and development project we intend to conduct a research study in the form of an experiment or quasi-experiment so as to capture in greater detail the effectiveness of 3D Virtual Immersive Environments on students' skills in the socio-cognitive, psychomotor and affective domains. Also, a notable contribution to this study would be the immediate (just after the experiment), short-term (a few days/weeks after) and long-term (a few months/years) feedback from the students-learners themselves; this feedback aspect is missing, at the moment. The collection of this data could provide invaluable insights for the personal learning processes and self-organised learning skills.

This informative educational student-centred programme has been popular among schools. The programme's high engagement level created enthusiastic students' responses and positive learning behaviours. This project also became known and well-accepted among teachers. More than 1,500 students from twenty (20) schools (ages: 7-15) have participated in and learned about typography and the history of the book and its future, in innovative learning ways and advancing their knowledge and skills through edutainment (education + entertainment).

Critically speaking, the gap between those who enjoy the learning environments with the benefits of new technologies and those who do not is a major societal concern, often associated with phenomena of social exclusion. New media technologies, if accessed, have the (not yet fully realized) potential to assist people facing unequal learning opportunities often because of economic inequality, geographic and social discrimination and cultural misrepresentation (Reed, 2017).

Information seeking and finding in creative collaboration ways and enquiry-based/problem-focused education approaches have been encouraging pedagogical frameworks and proved to be very fruitful in combination with game mechanics in 3D Virtual Immersive Learning Environments.

A further future research and development target of this ongoing project is to accommodate these pedagogical concepts within an epistemological framework that considers social inclusion and promotes deep learning strategies. There are different requirements for the latter, and access to these new media, both within and between countries would highlight the differences in the learning process and learning outcomes. Any inequalities, often referred to by the term "digital divide", involve both questions of access (who is online) and representation (what is online and how truly does it reflect the diverse digital world cultures (see e.g. Reed, 2017). In the future of this research and development project we prioritized our investigation on issues of inclusion and digital divide, digital learning identities and multicultural representation and deep/surface learning comparison within the framework of problem focused education.

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II

ADDRESSING THE RETENTION GAP IN MOOCS: TOWARDS A MOTIVATIONAL FRAMEWORK FOR MOOCS INSTRUCTIONAL DESIGN

by

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Addressing the Retention Gap in MOOCs: Towards a Motivational Framework for MOOCs Instructional Design

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Abstract

Existing design schemes of Massive Open Online Courses (MOOCs) usually focus on pedagogy, assessment and technology and rarely take into account learners' experience and motivation. Drawing from the success of quest-based initiatives, gamified web platforms, and multi-user digital games, this paper introduces an innovative motivational framework for MOOCs instructional design coined as Open Quest Framework (OpenQuest). The framework is grounded on established motivational theories such as the Self-Determination Theory and Situated Motivational Affordance. It features specific motivational mechanisms including, quests and narration, reputation systems, progression mechanisms, multiple learning pathways, well-designed feedback and social elements, that can be used to enhance learners' engagement and reduce attrition rates in MOOCs.

Extended summary

1. Introduction

Theoretical frameworks outlining the pedagogical and technical aspects of MOOCs design have been proposed in the past (e.g., MOOC canvas, Mazaro's taxonomy design framework). This paper proposes a new design dimension to existing approaches which relates to MOOCs motivational design. It introduces a theoretical framework which details how specific game mechanisms can benefit MOOCs instructional design by enhancing learners' engagement. When applied to practice, this framework is envisioned to minimize the retention gap in MOOCs (Clow, 2013).

2. Aim/research questions

The aim of this paper is to present the first, theoretically-driven, motivational framework on MOOCs design, called OpenQuest. Specifically, it reviews a number of motivational theories and their applicability to the case of MOOCs design, it analyses literature on quest-based learning, gamified web-platforms and multi-user games to provide evidence-based recommendations on how specific game mechanisms can work motivationally in the case of MOOCs, and discusses implications for future research.

3. Conceptual rationale

Amongst the reasons explaining high dropout rates in MOOCs is the lack of motivation, interactivity, time and skills (Khalil & Ebner, 2014). Speculations are made as to whether module completion should be a requirement for MOOCs, for learners may enrol due to curiosity and have no intention to complete a course (Clow, 2013). The proposed framework tackles the need for

motivating learners towards MOOCs completion considering for learners' initial motives for participation and the reasons justifying their exit from a MOOC.

OpenQuest is grounded on established motivational theories. Self-determination theory postulates that intrinsically motivating actions can be enacted in environments that exhibit choices, direct feedback, optimal challenges, self-directed interaction and social connectedness (Ryan, Rigby, & Przybylski, 2006). The theory of Situated Motivational Affordance (Deterding, 2011) stresses the need for a meaningful integration of game elements in a system, including understanding users (expectations, skills) and the organizational context of learning (e.g., CPDs acquisition, curiosity), if it is to work motivationally. Flow theory is a 'classic' approach for designing optimal learning experiences. To become absorbed in an activity requires a match between a person's capabilities and level of difficulty (Csikszentmihalyi, 1990). Learning should be flexible for learners to customize and self-direct it based on their own learning needs. Web 2.0 technologies could also be beneficial for engagement since increasing popularity results in increasing adoption (Catline-Groves, 2012). Overall, the centre of the proposed framework is the learner; user-centred design is proposed as the key to a meaningful MOOCs motivational design.

4. A motivational framework for MOOCs instructional design

OpenQuest consists of gaming and social mechanisms emerging from either the previously discussed theories or online applications that successfully engaged users. (1) Delivering the content of a MOOC in the form of *quests* where learning comes out as a natural characteristic of play are found effective in terms of learning performance, persistence and engagement in initiatives such as the Quest to Learn (http://mitpress.mit.edu/books/quest-learn) and the 3D GameLab (http://works.bepress.com/chris_haskell/19/). Quests can be arranged in the form of a *story/narration* where learners' responses contribute to the story's progression. (2) *Reputation systems* provide rewards to learners. For example, badges, social and scientific scores contributed to iSpot's creation and maintenance of a large community of users (Clow, 2013). (3) Adaptable *leaderboards* increased behavioural change towards social and business objectives (Abadi et al., 2014). Contrasting learner's performance to meaningfully-related others (e.g., teammates) increases intrinsic motivation. (4) Collaborative mechanisms are the motivational cornerstone of successful multi-user games explaining persistence in gaming (Herodotou et al., 2014). Course participation can be enhanced by performance responsibility towards peers in team coursework. (5) Well-designed feedback through timed triggers and unexpected rewards can reinforce learners' participation (Fogg, 2009).

5. Theoretical and educational significance

MOOCs design is currently focused on cognitive and technical aspects of learning. Less emphasis is given to the affective realm of design (Mystakidis & Berki, 2014). With the aim to address this gap and engage massive numbers of learners, we propose a motivational approach that monitors and rewards learning and embraces learning flexibility, personalization and self-directed learning. Our intention is to empirically examine the validity of the proposed framework through the design of a MOOC featuring the above characteristics. Although evidence favour the effectiveness of the proposed mechanisms, engagement may not be long-term but due to a novelty effect. Factors including initial motivations for MOOC registration, learners' characteristics and ways of engagements in MOOCs (e.g., Hamari et al. 2014) may mediate the success or failure of the proposed framework. Subsequent studies will consider those factors and systematically monitor participants engagement with a MOOC (e.g., learning analytics) in order to inform and refine the design of the proposed framework.

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III

OPENQUEST: DESIGNING A MOTIVATIONAL FRAMEWORK FOR MOOCS INSTRUCTION

by

Mystakidis, Stylianos & Herodotou, Christothea 2016

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OpenQuest: Designing a Motivational Framework for MOOCs Instruction

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Abstract

This paper introduces an innovative motivational framework for Massive Open Online Courses (MOOCs) instructional design coined as Open Quest Framework (OpenQuest). OpenQuest aims to improve learning and user engagement in MOOCs by drawing lessons from the success of quest-based initiatives, gamified web platforms, and massive-multiplayer online games (MMOs). The framework is grounded on established motivational theories such as the Self-Determination Theory and Situated Motivational Affordance. It supplements existing MOOCs design schemes that usually focus on pedagogy, assessment and technology. It features specific motivational mechanisms including, quests and narration, reputation systems, progression mechanisms, multiple learning pathways, well-designed feedback and social elements, that can be used to enhance learners' engagement and personalize learning.

Keywords

MOOC, gamification, motivation, pedagogy, learning

1 Introduction

This paper proposes in brief a new theoretical motivational framework which describes how game elements can benefit MOOC instructional design by enhancing learners’ engagement. It builds upon the work of design frameworks that outline the pedagogical and technical aspects of MOOCs design such as MOOC canvas (Alario-Hoyos et al., 2014) and Mazaro's taxonomy design framework. The aim is to present the first, theoretically-driven, motivational framework on MOOCs design, called OpenQuest. Specifically, it reviews a number of motivational theories and their applicability to the case of MOOCs design, it analyses literature on quest-based learning, gamified web-platforms and multi-user games to provide evidence-based recommendations on how specific game mechanisms can work motivationally in the case of MOOCs.

2. Theoretical background

The proposed framework tackles the need for motivating learners towards MOOC completion by considering learners' initial motives for participation and the reasons justifying their exit from a MOOC. OpenQuest extends suggestions to add motivational design elements to existing design frameworks (Mystakidis & Berki, 2014) and is grounded on the following motivational theories. Self-determination theory postulates that intrinsically motivating actions can be enacted in environments that exhibit choices, direct feedback, optimal challenges, self-directed interaction and social connectedness (Ryan, Rigby, & Przybylski, 2006). The theory of Situated Motivational Affordance (Deterding, 2011) stresses the need for a meaningful integration of game elements in a system, including understanding users (expectations, skills) and the organizational context of learning (e.g., CPDs acquisition, curiosity), if it is to work motivationally. Flow theory is a ‘classic’ approach for designing optimal learning experiences. To become absorbed in an activity requires a match between a person's capabilities and level of difficulty (Csikszentmihalyi, 1990). Learning should be flexible for learners to customize and

self-direct it based on their own learning needs. Overall, the centre of the proposed framework is the learner; user-centred design is proposed as the key to a meaningful MOOCs motivational design.

3. A motivational framework for MOOCs instructional design

OpenQuest consists of gaming and social mechanisms emerging from either the previously discussed theories or online applications that successfully engaged users. (1) Delivering the content of a MOOC in the form of quests where learning comes out as a natural characteristic of play are found effective in terms of learning performance, persistence and engagement in initiatives such as the Quest to Learn[1] and the 3D GameLab[2]. Quests can be arranged in the form of a story/narration where learners' responses contribute to the story's progression. (2) Reputation systems provide rewards to learners. For example, badges, social and scientific scores contributed to iSpot's creation and maintenance of a large community of users (Clow, 2013). (3) Adaptable leaderboards increased behavioural change towards social and business objectives (Abadi, H. K. Mandayam, C., Yue, J. S., Zhu, C., Merugu, D., Prabhakar, 2014). Contrasting learner's performance to meaningfully-related others (e.g., teammates) increases intrinsic motivation. (4) Collaborative mechanisms are the motivational cornerstone of successful multi-user games explaining persistence in gaming (Herodotou, Kambouri, & Winters, 2014). Course participation can be enhanced by performance responsibility towards peers in team coursework. (5) Well-designed feedback through timed triggers and unexpected rewards can reinforce learners' participation (Fogg, 2009).

[1] http://mitpress.mit.edu/books/quest-learn

[2] http://works.bepress.com/chris_haskell/19/

4. OpenQuest Learning Path

OpenQuest proposes the creation of personalized learning paths through a series of processes relying on users' profiles and learning analytics (figure 1). More specific, the initial screening of users' profile including their expectations, skills, motivation and preferences will determine the best suited learning activity (entry level quest). Each level features alternative quests based on different learning approaches (Laurillard, 2002) that map to learners' interaction preferences (Bartle, 1996). Based on their performance, OpenQuest will propose the completion of additional quests in the same level or the optimal quest in the next level. Levels increase in complexity and difficulty corresponding to the course's progress towards the achievement of the set learning objectives matching user skills with learning challenges (Csikszentmihalyi, 1990). Additional mechanisms such as adaptive leaderboards related to a given quest and overall performance provide additional motivation for learning.

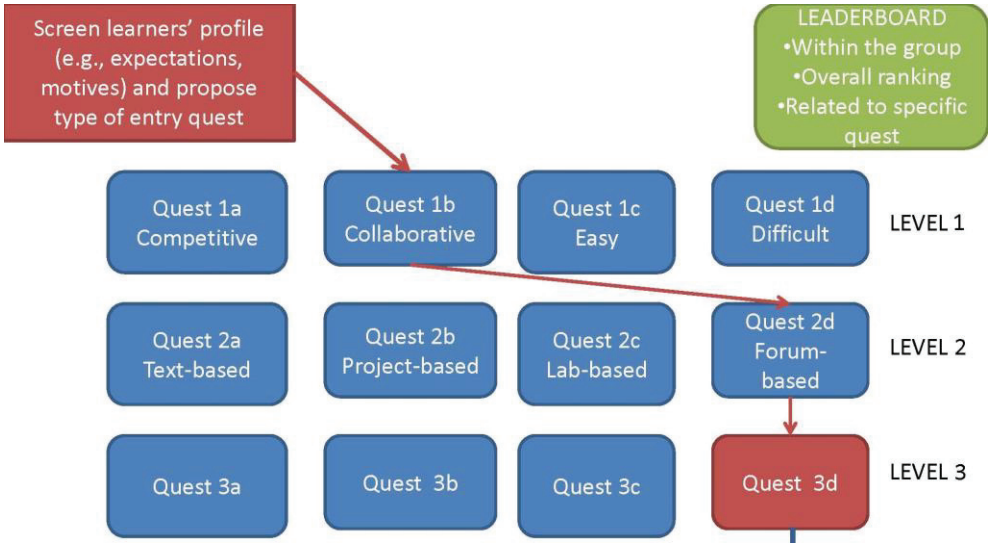

Figure 1 OpenQuest Learning Path

5. Conclusion

MOOC design is currently focused on cognitive and technical aspects of learning. With the aim to transform learning in a MOOC from an isolated solitary task into a social, enjoyable experience and engage massive numbers of learners, we propose a motivational approach that monitors and rewards learning and embraces learning flexibility, personalization and self-directed learning.

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IV

DESIGNING AND IMPLEMENTING A BIG OPEN ONLINE COURSE BY USING A 3D VIRTUAL IMMERSIVE ENVIRONMENT – LESSONS LEARNED

by

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DESIGNING AND IMPLEMENTING A BIG OPEN ONLINE COURSE BY USING A 3D VIRTUAL IMMERSIVE ENVIRONMENT – LESSONS LEARNED

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Abstract

Open Education (OE) is a distance learning approach that was strategically chosen by the European Commission (EC) to encourage cost-effective training, upskilling and reskilling of large population groups and workforce with speed and flexibility. Institutions and businesses design and offer Open Online Courses (OOCs) to address skill gaps, organizational and societal needs. OOCs and especially Massive OOCs (MOOCs) are suffering from high rates of attrition, which is attributed to various factors such as learner isolation and lack of motivation to complete the course. Recommendations to address the retention gap in MOOCs include adopting a participation-driven approach, using game design techniques in the courses' pedagogical design and supplementing the predominant asynchronous learning paradigm in MOOCs with synchronous learning activities and virtual meetings.

The University of Patras (South Greece) organized an innovative, motivation-enhanced Big Open Online Course (BOOC), the first of its kind in Greece, with title "Open Workshop on Information Literacy". During the course, over three hundred (300) participants acquired information literacy skills using available open learning environments and the three-dimensional virtual immersive learning environment Second Life. In this paper, the authors describe the instructional approach based on Problem-Focused Education (PFE) and Game-Based Learning (GBL), the participants' results and the course outcomes, and the necessary pre-requisites for successful outcomes. Further, the participants' feedback, evaluation outcomes and lessons learned are discussed.

In summary, the participants achieved their set learning goals, experienced a community of practice atmosphere and appreciated the variety of active learning modes. The open publication mode of most learning activities facilitated social agency that lead to additional motivation. Finally, the course demonstrated that the effective use of virtual immersive learning environments for rich, synchronous learning, both formal and informal, can enhance OOCs.

Keywords: E-Learning, Virtual Immersive Environments, Open Education, MOOC, Second Life, Gamification, Problem-based Learning (PBL), Problem-Focused Education (PFE), Game-Based Learning (GBL)

1 INTRODUCTION

Open Education (OE) is a learning approach that emerged from the need for open access and distance mode learning that was initially provided by Open Universities. Recently Open and Distance Education (ODL) aspired some of the values and culture of Free/Libre Open Source Software (FLOSS) [1] to facilitate the access of all to education and social learning. Initially the movement for openness in education was focused on content, namely Open Educational Resources (OER) [2] and Open Courseware [3]. Next, the attention was shifted to Open Educational Practices (OEP), such as Open Access (OA) to research results and/or publications and the Open Online Courses (OOCs), educational programmes that are mostly free and accessible for all via the Internet. Especially after 2011 one evidences the emergence of Massive Open Online Courses (MOOCs) as the means to help thousands of people all over the world learn online. Notably, universities, organizations and business companies design and offer OOCs to address skill gaps and organizational and societal needs while policy makers encourage the adoption of OE and MOOCs. For instance, the European Commission chose OE as an official strategy to encourage rapid, flexible, cost-effective training, upskilling and reskilling of large population groups and workforce [4] [5].

Currently MOOCs are considered as the vehicle of training innovation and as a de facto efficient channel for dissemination of educational content. As a result, more MOOCs are being produced and offered by an increasing number of providers and attract millions of enrolments [6]. However, MOOCs are suffering from extremely high drop-out rates [7], [8], a phenomenon which is attributed to various factors such as *low quality of instructional design, learner isolation* and *lack of motivation* to complete the courses [9]. This is a phenomenon with serious implications for learners and MOOCs providers as it affects the learners' lives negatively and impacts the business model of MOOC providers, to mention but a few stakeholders. Already, major MOOC providers are transforming "common", free MOOCs into courses with entrance fees or limit the access to courses to "view-only" [10]. Failure to the sustainability challenge of Open Education could mean a significant backlash in the development of the learning subject fields.

Recommendations to address the retention gap in MOOCs include adopting a participation-driven approach [11], using game design techniques in the courses' pedagogical design for the enhancement of participants motivation [12] and supplementing the predominant asynchronous learning paradigm in MOOCs with synchronous learning activities and virtual meetings [13].

In this paper the authors will describe how they designed and organized an OOC for a higher education institution implementing among others the three above-mentioned advanced pedagogical approaches to overcome the pitfalls of OOCs and achieve a high quality learning experience. Next we present the design and results of a research study.

2 LEARNING DESIGN

The staff and collaborators of the Library & Information Center of the University of Patras, Peloponnese (South Greece), designed and implemented the Open Online Course "Open Workshop on Information Literacy" (OWIL). This was a collaboration project with other interested in the delivery results parties. The OWIL course emphasised the focus on learning outcomes and active hands-on learning. It was the first Big Open Online Course (BOOC) that was organized in Greece [14]. That is, the "Big" means less than 500 participants, while the "Massive" means hundreds, thousands, tens of thousands and more participants [15]. The OWIL course was designed by the following three approaches:

2.1 Socio-constructivism for Deep Learning

Humans are socially curious beings. Humans' learning is considered to occur mostly within and through social interaction with others. Thus, learning is considered as a cultural and social process. It occurs in the context of human relationships and activities rather than just in the minds of individual learners. Hence the socio-cultural context affects what is learned and how people learned. Deep learning emphasizes more durable learning than surface learning. That is, a learner using deep learning approaches attempts to understand the learning content and process. Deep learning can lead to transformation of current understanding rather than confirming it. However, excessive workload and cognitive overload can put a learner in a position to choose a surface learning approach in order to survive. Nonetheless, deep learning occurs when students are actively involved in the learning process and are given opportunities to construct meaning [16]. In so doing, they should be able to transform the course's concepts to personal (learning) experiences. This also suggests a competence-based design approach [17].

2.2 Motivational Design through Game-Based Learning (GBL)

Motivation is one of the most important aspects of learning. There is no, however, general agreement about the nature of motivation. One framework emphasises that motivation is determined by environmental conditions while another framework emphasises that the learners control motivation through active self-regulation strategies. The third way has been presented by social cognitive theory by asserting that the level of motivation is a result of the interaction between the learner and environment. Motivation enhancement strategies [18] are essential to engage participants in active learning experiences. Strategies such as Game-based learning (GBL) and Gamification [19] have been applied in education [20] and e-learning [21] with various degrees of success. There is a great deal of commonality between the characteristics of games and the characteristics of effective learning experiences such as challenging, goals, outcomes, interaction, exploration and safe environment. Yet, the aspect of competition might shift the focus from learning to winning, which might not be motivating for some learners. In the OWIL course we utilized playful design in 3d Virtual Immersive Environments

(3d VIEs) with the purpose to create a friendly, playful and inviting atmosphere for learning. 3d VIEs can enable rich social interactions empowered by the role of the digital self [22] for formal and informal learning leading to the creation of virtual communities of practice [23].

2.3 Problem-Focused Education in E-learning

Problem-based learning (PBL) is a form of active learning that supports the idea of learning from problems with collaborative ways. It first became popular during the 1960s as a response to the mainstream approach of content-transmitting teaching practices [24]. Organizing learning around real-life problems and problem finding and resolving activities and processes has apparent value and interest for vocational training and adult education. One promising variation of PBL [25] is problem-focused education (PFE) [26]. While PBL focuses on skills and employability, PFE adopts a wider and more flexible view by stressing manifold thinking (critical, creative, caring and reflective thinking) and wisdom [27]. That is, the focus is more on the problems of living rather than the problems of knowledge. PBL has successfully been used in Higher Education through the assistance of 3d Virtual Immersive Environments [28].

2.4 Designing the Open Online Course

The scope of the OOC was to create a learning experience, tailor-made on the needs of advanced academic library users, including postgraduate students, doctoral candidates and researchers. The course was designed with two fundamental objectives in mind: a) to encourage participants to acquire useful knowledge and skills for their academic evolution and professional career, and b) to provide authentic, enjoyable and effective learning through the effective use of e-learning technology.

Embracing an open attitude, the workshop's curriculum was designed after detecting and analysing the learning needs of the target audience. The learning needs detection was carried out through an online questionnaire and by selective unstructured interviews. The course's modular scheme included the following five modules (learning units): Research Innovation & Creativity; Information Literacy; Research Methodology; Authoring, Publishing & Presentation of Scientific Papers; Professional Career Development.

In OWIL we used a blended learning approach combining asynchronous and synchronous e-learning activities. For the asynchronous part we used an open and collaborative learning web-based environment, a wiki. Again, the choice of an open environment over a traditional "closed" learning management system was deliberate to stress the democratic character of the course, since the course instructors and participants had equal rights to modify the course pages and create content. In the wiki unit leaders uploaded all resources and learning materials and the participants posted openly their individual and group assignments.

OWIL also featured one weekly 2-hours synchronous, online meeting that took place in the 3d VIE platform Second Life. The 3d VIE was selected over 2d platforms owing to its enhanced capabilities for playful learning techniques. Each session took place in a suitable environment that facilitated the character of the module i.e. with the use of metaphors. For example the Research Methodology module took place in the steampunk lab of a virtual renaissance castle. There participants had the capability to communicate via multiple channels: chat, instant messaging), voice and virtual kinesthetic communication (avatar movement, clothing, gestures etc.) The sessions were also broadcasted simultaneously live over the web using streaming technologies so as to accommodate users with mobile devices. Each session was organized on the premises of problem-focused education. It featured a series short 10-minute individual and group learning activities based on real-life problems to engage participants. The activities were based on prepared questions of comprehension of the educational material as well as short case studies. The weekly meetings were recorded and made available later in the wiki. For the management of the OOC and the support of participants, we used a blog and a Facebook page as communication channels. Prior to the beginning of the course, we organized training sessions to help participants and faculty to use the platforms effectively.

Figure 1. Playful group activity in OWIL's virtual steampunk lab

The course was voluntary, open for anyone interested. It had a duration of 18 weeks, and it was delivered with the synergy of collaborators and faculty from the University and other institutions such as the University of London, the University of Helsinki and the University of Washington. Each of the six sequential modules had a duration of 4-6 weeks without breaks apart from public holidays and exam periods. The order of the modules followed the life of a research project; inception of an idea – literature study – research – authoring – presentation – professional development. In order to complete successfully the Open Workshop each participant had to produce assignments or create artifacts related to the learning outcomes of each session and module. The assignments were posted openly in the wiki. Participants were encouraged to comment on their peers' assignments, post questions and share resources. The participants that completed the course successfully received a certificate of attendance and completion from the university.

3 RESEARCH METHODOLOGY

The purposes of this mixed methods research [29] were i) to identify if academic community members would be interested in participating in Distance Education and Open Online Courses, which are not a mainstream learning option in Greek higher education at the moment, and ii) to understand about the effect of motivation enhancement in open education. For this there was a need for designing and implementing a course of 18 weeks duration: "Open Workshop on Information Literacy" (OWIL). The course was delivered twice during the subsequent academic years and we called them as OWIL I and OWIL II. A rather long course could probably demonstrate the potential drop out rate of the course. The high rate of drop out is considered as one of the main negative trends in MOOCs. For this reason, our additional aim was to understand the ways of helping to sustain the course participants' engagement for achieving their learning goals. That is, capturing their level of satisfaction from the course and its components. Thus, we could subsequently evaluate the effectiveness of the employed instructional method and its pedagogical potential. More specifically we aimed at answering the following research questions:

> RQ1. Can a motivation-enhanced environment in an Open Online Course have a positive impact on completion rates?
>
> RQ2. Can a motivation-enhanced environment in an Open Online Course have a positive impact on the quality of learning?

The hypothesis for RQ1 is that a playful, relaxed learning environment, friendly atmosphere and communication will help to maintain the interest of students throughout the course. Similarly, we assumed that the same approach will motivate the students positively for learning more and better.

The majority of the participants in this study were female (60%). Concerning their level of education, postgraduate (31%) was the predominant category followed closely by Phd candidates (26,2%) and undergraduates (14,3%). As far as age is concerned, the two main categories were 25-34 years (66,7%) and 35-44 (19%). Participants were from 23 departments of the University of Patras. The strongest representation came from the departments of Chemistry (6 participants), Primary Education, Mathematics and Biology each with 4 participants.

We used a sequential strategy for data collection/fact finding. First, we collected data through an online questionnaire, which was designed by one of the authors. It consisted of 56 question items organized in three sections: The overall evaluation of the participants' experience, assessment of the impact of the used methods, and participants' demographics. We used predominantly closed, five-level Likert scale questions such as what is your degree of agreement with the following statement: I acquired new knowledge?, What is your degree of satisfaction with the following aspect: Asynchronous E-learning (wiki)?. Participants (N=73) completed anonymously and voluntarily the online questionnaire; 25 in OWIL I and 48 in OWIL II. The results were analyzed statistically [30]. Second, two to three weeks after the course's completion, we collected data by using semi-structured interviews. One of the authors interviewed 27 course participants either in person or over the phone; 8 interviewees were from OWIL I and 19 from OWIL II. Each interview lasted around 10 minutes and it was held in the author's office room. During the interview notes were taken. The interview focused on participants' views and experiences about the design and implementation of the course, their learning and performance, notable incidents, and suggestions for improvement. All the 27 interviews were done in 2 weeks. The results were further processed utilising content analysis' techniques. All interviews were held in Greek and the questionnaire was written in Greek language. The translation into English was carried out by one of the authors.

4 RESULTS

4.1 Survey results

The survey generated an ordinal dataset that was analysed using non-parametric statistics [29]. For each question item we calculated the median, the mode, the interquartile range (IQR) and the variation ratio. The median and the mode are expressions of the central tendency of data while IQR and variation ratio measure the dispersion of responses. Also, for the final interpretation of the responses we clustered similar question items to solidify and test their consistency.

The participation and completion rates appear in Table 1.

Table 1. OWIL participation and completion rate

	Participants (Admitted)	Participants (Completed)	Completion rate
OWIL I	92	30	32,61%
OWIL II	219	71	32,42%
Total	311	101	32,48%

The completion rate of both iterations of the OOC remained steady and significantly higher than average MOOC success rates that according to various reports fluctuates below or slightly over 10% [30].

Table 2. OWIL learning impact

	Median	Mode	IQR	Variation Ratio
Q3.1 I liked it	4	4	1	0,57

Q3.2 I acquired new knowledge	3	3, 4	2	0,77
Q3.3 I acquired new skills	4	5	2	0,68
Q3.4 I will apply what I've learned	4	4	2	0,61
Q3.5 I found the course useful	5	5	1	0,70
Q3.6 I would recommend the course to my friends	5	5	1	0,71

Table 3. Overall satisfaction with OWIL components

	Median	Mode	IQR	Variation Ratio
Q8 Open Workshop Overall Quality	4	4	1	0,46
Q6 (aggr.) Open Workshop Sessions Quality	4	4	1	0,45
Q7 (aggr.)Teaching Quality	4	4	1	0,49

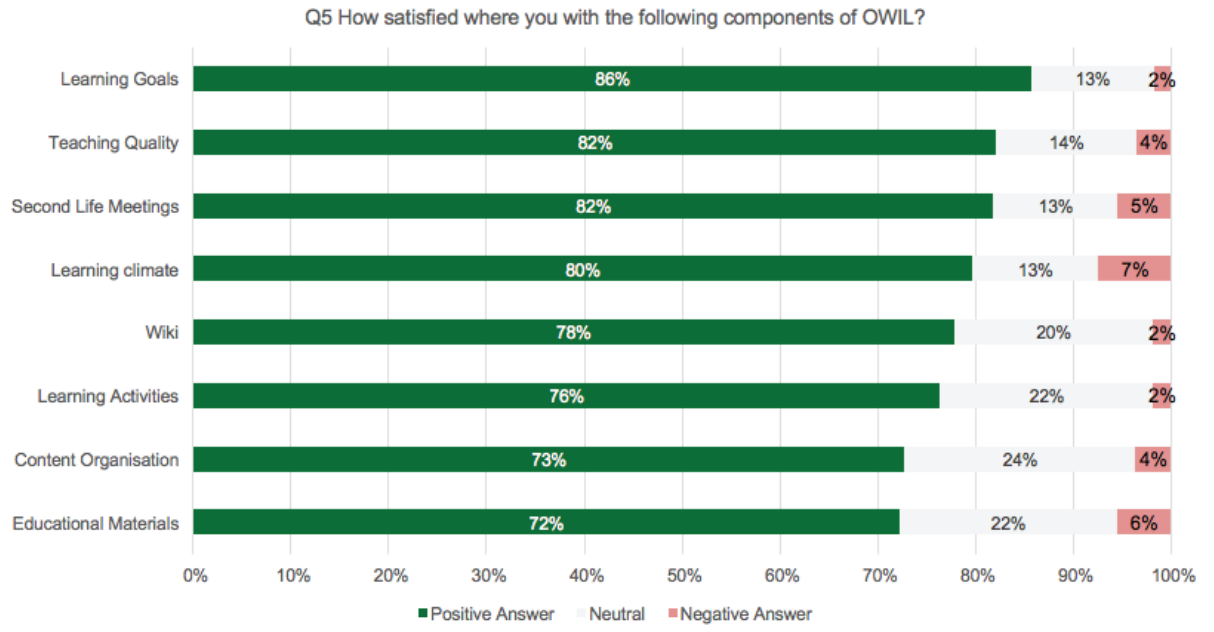

Figure 2. Satisfaction level of participants with OWIL components

High overall satisfaction with the course design and delivery was shown in Tables 2, 3 and Fig. 2. The quality of the course, of teaching and sessions (table 3) was graded as very good. More impressive are the self-assessment results (table 2) reporting the acquisition of new skills and the willingness to apply them in practice. The strong fluctuation in Q3.2 can be attributed to the following factors, as qualitative comments in interviews suggested: weak curriculum focus on theoretical data, high degree of participant heterogeneity and high level of participants especially in OWIL I. (OWIL II: Mdn=4, IQR=2, VR=0,70). More importantly, the fact that over 80% of the responding participants expressed very high satisfaction with all factors that are associated with the synchronous component of the course (Second Life meetings, teaching quality, and learning climate) support the hypothesis for RQ2.

Another notable side product of OWIL was the significant impact of its resources for informal learning. The open nature of the course led to the production of a significant number of open educational resources (OER). The quality of the digital content and its free access resulted in remarkable dissemination and popularity on the Internet, beyond the boundaries of the University of Patras and of

the course. More specifically, the presentation files of the course attracted a number of visits that was twice the size of the total university students' population within 6 months of the end of the course.

4.2 Interview results

The interviews were further processed by content analysis' techniques deployment. The participants' responses were grouped into four predefined categories, which are shown in Table 4.

Table 4. Predefined interview categories

Technology / technical	Design / Organization	Teaching / Learning	Other
8	6	15	2

Concerning technology/technical issues, participants mentioned difficulties they faced related to either the platforms used or their equipment and Internet access.

> *I found Second Life difficult to use at first but delightful later, especially modifying and moving my avatar and flying! (P9)*
>
> *My computer was too slow to run Second Life but I was able to watch the live stream and participate via chat (P17)*

Concerning design/organization issues participants appreciated the playful approach and the open nature of the course and confirmed the acquisition of new skills.

> *I enjoyed the weekly meetings, they were informative and fun even though I couldn't always attend. The video recordings were very helpful. (P2)*
>
> *Being able to stop at times when I was busy and catch-up helped me continue with the course. (P11)*

Concerning teaching/learning issues, the participants raised many different points of view. First, the participants' experiences about the group work and its quality vary a lot.

> *One complaint I have is that two team members didn't join us in time for the group assignment so me and another girl had to do almost all the work. (P21)*
>
> *I had great conversations with my team members with different studies than mine. (P10)*
>
> *I appreciated the enthusiasm of everyone in the course, professors, and participants. (P5)*

Apparently, the modules that emphasized group work led to higher engagement and satisfaction with peer learning. In contrast, there were cases where group members were not committed to their role and participation and this led to frustration of the remaining, active members and to the potential dysfunction of the team.

Second, the participants realized that they were introduced to a plethora of new tools.

> *Posting my assignments openly so that everyone could see them pushed me to spend more time to produce something of high standard. (P15)*

Third, the participants raised the request for more study materials.

> *Study materials were ok but I wanted more to learn about statistical analysis methods with SPSS. (P18)*

In summary, regarding RQ1, the course achieved sustainable high completion rate, comparable to empirical evidence from a MOOC with a different motivation-enhancement method [31], demonstrating that the novel pedagogical model deployed with motivation enhancement methods was able to address and overcome common pitfalls of MOOCs, such as anonymity, learner isolation and lack of feedback. Thus, we can deduce that the hypothesis is confirmed. Regarding RQ2, participants achieved their learning goals, experienced the working atmosphere of a virtual community of academic practice. They appreciated the variety of active learning modes and acquired new skills for virtual team work. The open publication mode of most learning activities facilitated social agency that led to additional motivation. Finally, the course demonstrated that the effective use of virtual immersive learning environments for rich, synchronous learning, both formal and informal, can enhance OOCs. Therefore, the hypothesis for RQ2 was also confirmed.

The potential explanations for the high completion rate and for achieving the learning goals could be: i) the OWIL course was long enough and ii) it was held in the participants' mother tongue; iii) the use of virtual reality brought a sense of newness, iv) emphatic engagement through role-playing and v) the course met the participants' initial expectations.

5 LESSONS LEARNED, RELATED WORK AND CONCLUSIONS

Although there are several proposals to integrate games and gamification structure or elements into MOOCs [32]–[34], so far there is little empirical evident to assess their effectiveness [35]. One MOOC that used serious games achieved higher than average completion rates of 31% [31]. OWIL provided an opportunity to derive valuable lessons for open online courses' design and implementation. First, 3d VIEs are instrumental for the creation of a warm, motivating learning atmosphere and the facilitation of informal learning. In the virtual space each participant had an individual and representative presence, thus breaking the anonymous, distant, isolated feeling of participants in MOOCs. Therein teachers and organizers appeared as "equals", they did not have –visible- privileges over course participants; sometimes tech-savvy participants often assisted the instructors. Additionally, the pervasive character of the environment, the fact that they could enter, leave and move in the virtual space created and enhanced the sense of agency.

Second, synchronous activities in the 3d VIE Second Life supplement well courses with social constructivist emphasis on active learning and creation of content. Meetings became quickly the weekly reminder of the course and meeting point of fellows. It also offered a chance to solve any questions related to the course with the organizers, an informal office hour. The playful design of the course; surprises, virtual gifts, games, change of meeting locations, virtual excursions and other elements of playful design helped to maintain an academically defined space that was relaxed and warm with a friendly community atmosphere. 3d VLE enhanced the live participants' interactions and user experiences beyond the standard classroom experience, through the availability of multiple communication channels such as voice, private voice sessions, public and private chat, movement, apparel and gestures of the avatar.

The interdisciplinary composition of the team of educators and participants was an unprecedented experience for all the involved parties. This resulted in the cross-fertilization of the collective learning process through the creative exchange of experiences, views, knowledge and competences.

The current trend of combining fun and learning emphasizes the production of entertaining learning materials and activities. However, this might increase the learners' expectations that learning must be always fun and enjoyable. That is, learners might equate learning so strongly with fun and enjoyment that if they feel that they are not enjoying themselves, they are not learning. Thus learners might be developing a new attitude toward learning at the expense of content and process while emphasizing fun and enjoyment.

New technologies to assist the learning process have constantly been sought by researchers. Virtual reality has been identified as one of them. Virtual reality is a unique computerized technology which may be of great value since the physical counterpart may be unavailable, too dangerous, or too expensive. That is, it can overcome the traditional limitations of learning-by-doing. It offers a truly new way to engage learners and provides unique experiences which are consistent with successful pedagogical strategies. However, virtual reality might be expensive to produce, and access and accessibility might not be guaranteed; the latter bring obstacles in the full use of virtual reality and MOOCs in education.

6 LIMITATIONS AND DIRECTIONS FOR FUTURE STUDY

To some extent, the highly noticeable satisfaction level of the participants could be attributed to the opportunity alone to learn and study for free and from distance, a new experience for most of them. They, in turn, would be satisfied with the given chance regardless of shortcomings in some areas of delivery. Additionally, this pedagogical model was applied in a smaller scale of a BOOC instead of a MOOC with thousands or tens of thousands participants. Another important potentially limiting factor could be the longer (compared to average) duration of the course and its modules. Safer conclusions about the effect of the applied pedagogical approach could be deduced by comparing the results of two simultaneous iterations of an OOC with audiences of comparable characteristics: one standard (control group) versus another iteration gamified/playful interventions. Other problematic aspects of MOOCs that influence the participants and might intervene in their motivation (enhancement) should

also be researched; such issues are the reasons for giving up the courses and modules and the attendance rates.

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V

TOWARD SUCCESSFULLY INTEGRATING MINI LEARNING GAMES INTO SOCIAL VIRTUAL REALITY ENVIRONMENTS – RECOMMENDATIONS FOR IMPROVING OPEN AND DISTANCE LEARNING

by

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TOWARD SUCCESSFULLY INTEGRATING MINI LEARNING GAMES INTO SOCIAL VIRTUAL REALITY ENVIRONMENTS – RECOMMENDATIONS FOR IMPROVING OPEN AND DISTANCE LEARNING

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Abstract

Social virtual reality environments, also known as 3D virtual immersive environments, are three-dimensional computer-generated virtual spaces that are increasingly used in attendance-based and distance education. Thanks to their unique characteristics that separate them from two-dimensional virtual learning environments, social virtual reality environments can enhance distance education efficacy when used in combination with applying instructional methodologies such as situated learning, experiential learning and game-based learning.

The authors of this paper describe the design and findings of a research study on game-based learning in social virtual immersive environments. The research methodology of the study incorporated a mixed approach for evaluation; the participants answered to a survey and participated in semi-structured interviews.

More specifically, the paper exposes the design and the implementation of two mini serious games as proof of concept for the supplement of a postgraduate course on Cybersecurity in the University of Washington, USA. These social learning experiences were constructed taking into account various game mechanics and components designed to increase their appeal to most game player types. The games featured narrative, rules, team collaboration, competition, challenges, achievements, surprises, levels, rewards, choice, feedback, scoring, time-pressure, exploration.

The findings of the study showed that the participants in distance education programmes i) think that playful experiences in 3d social virtual reality are beneficial for their learning and ii) they value learning activities based on active participation and social interaction. The findings from the study also confirmed that the steep learning curve of new users in 3d virtual immersive environments is an obstacle for learning that needs to be addressed meticulously.

The paper authors illustrate how social virtual reality environments enable educators to create interactive exhibits and 3d content as well as entertaining social experiences of learning value in order to illustrate and visualize real Cybersecurity practices. In addition, it is explained how programming in virtual reality environments helps participants to experience intangible notions such as malware and behavioral patterns with the help of storytelling and visual metaphors. Overall, the authors offer recommendations on the effective use of game-based instructional approaches such as serious games, gamification and play in virtual immersive environments for educational purposes. Game-based learning experiences should be crafted in close conjunction with the course's learning outcomes. A course-wide narrative can help overall participants' engagement and content retention. The thinking styles of the participants and their learning preferences should also influence rapid tweaking of game parameters in programming and general curricula design decisions in order to accommodate epistemological needs and particular knowledge desires.

Keywords: Open and Distance Learning (ODL), serious games, virtual immersive environments, e-learning, gamification, game-based learning.

1 INTRODUCTION: VIRTUAL REALITY AND EDUCATION

Virtual reality (VR) is a technological field with origins in the 1960s [1], but has re-emerged in recent years with the promise to offer sensory immersion [2] into virtual environments. VR environments are currently used mainly for entertainment [3] but also for educational purposes [4]. So far most new VR platforms offer environments for single-player experiences. A new generation of sensor-based Social

VR Environments (SVREs) are expected to arrive in the coming years [5]. Regards education, developers often do not take into account the long experience in immersive education [6] and tend to "reinvent the wheel" or present already well-documented characteristics as novelties [7]. It is wise and practical to remember that text-based social VR environments had been used successfully for educational purposes decades ago [8]. The next desktop-based SVREs, also known as 3D virtual immersive environments (3D VIEs) or multi-user virtual environments (MUVEs) or 3D virtual worlds, are three-dimensional computer-generated virtual spaces that offer social immersion, and are increasingly used in attendance-based and distance education [9]. SVREs offer unique characteristics that separate them from two-dimensional virtual learning environments; they feature a superior sense of self since the participant controls his or her embodied representation or agent, the avatar [10]. This creates the sense of being in a space experiencing a prevalent power of co-presence when meeting with other avatars [11]. The identification with one's avatar in a virtual environment can have profound psychological impact on behavior and learning [12]. However, just like other novel systems, desktop-based SVREs faced early the trap of routinization [13], the tendency to use new tools to replicate old, existing methods instead of striving for new solutions.

In this paper, the authors describe how they designed and implemented mini serious games in a SVRE so as to accompany virtual lectures and improve the quality of learning for a postgraduate university course. In the next sections the paper includes the presentation of the design and results of a research study on the quality of learning.

2 IMMERSIVE EDUCATION

Immersive Education is the use of SVREs for teaching and learning, targeting to facilitate the social and psychological immersion of participants into a compelling, realistic learning experience that engages multiple senses. Immersive educational experiences in SVREs can act as a synthesis of learning activities that can help participants achieve learning outcomes in multiple domains. In each domain, one can pursue the attainment of skills and abilities in various levels of sophistication and mastery organized in a taxonomy. As described in the Cybergogy Blended Taxonomy for Learning Domains model [14], immersive educational experiences can be used to facilitate the enhancement of competences in four intersecting domains [15]: Cognitive (intellectual); ranging from remembering and understanding up to creating [16]; Emotional (perceiving, integrating and managing emotions and feelings); ranging from perceiving to influencing; Dextrous (virtual kinesthetic skills such as doing, being, moving, organizing, communicating); ranging from imitating to mastering; Social (fostering the sense to community, collaboration); ranging from personalising to channeling.

More specifically, SVREs enable educators to enhance the quality of both attendance-based teaching [17] and distance learning [18], [19]. Some approach to achieve this is the application of socio-constructivist instructional methods such as situated and experiential learning [20], [21], simulated [22] and game-based learning experiences [23] to achieve deep learning [24]. Deep learning occurs when students are actively involved and are given opportunities to construct meaning [24], [25] and metacognitive skills in deep levels of processing [26]. In so doing, students should be able to transform the course's concepts to personal (learning) experiences and competences.

2.1 Learning Motivation through Games and Play

In the quest for deep learning in education, motivation enhancement strategies [27] can be used to engage participants in active learning experiences. Strategies such as Game-based learning (GBL), Playful Design, Serious Games and Gamification [28] have become popular elements and concepts for teaching and learning innovation for classroom-based and distance education [29]. These methods have successfully been applied in education [30] and e-learning [31]. Games, in particular, have been frequently used to enhance and facilitate learning [32], [33] by increasing students' intrinsic motivation [34]. Nonetheless, the value of game and play for learning is not new. Plato argued in favor of the value of play and positive motivation and voluntary participation in education: "Do not, then, my friend, keep children to their studies by compulsion but by play" [35]. Serious (or epistemic) games comprise a set of meaningful choices with a primary educational purpose [36]. Serious games can be used as appropriate learning experiences according to Vygotsky's zone of proximal development [37]. Studies have shown that serious games can be very effective learning tools in multiple fields [38]. Mini games in education are 'bite-sized' activities with limited learning purposes and of short duration that can be played in the context of a broader course [39]. Otherwise, mini serious games are sophisticated, interactive learning experiences.

The design of games should consider players' (learners') preferences and favourite styles of thinking and play. Early studies have identified four basic player types and styles: explorers, achievers, socializers and killers [40]. Explorers value freedom and discovery, achievers strive for completion and high scores, socializers focus on collaboration and communication, while killers prefer competition.

3 DESIGNING THE MINI SERIOUS GAMES

The *Foundations of Organizational Information Assurance (IMT 551)* was a course module offered as part of the Information Security Specialization, one of the six paths of study in the University of Washington (UW), at the MSc in Information Management (MSIM) degree programme. The course took place fully online with weekly lectures. For the premises of lecture 9 on Security in Social Media, the class session was scheduled to take place in the UW's island in the social virtual reality platform Second Life.

Aspiring to showcase the potential of Social Virtual Reality in this domain, we proposed as a proof of concept the development of a mini serious game to supplement the scheduled class. "Cybersecurity Challenge Game Level I" was developed rapidly and had an average playing time of 30 minutes. After the successful implementation of the game, we added the sequel, "Cybersecurity Challenge Game Level II". These mini serious games were constructed as social learning experiences taking into account various games' mechanics and components to increase their appeal to most game player types. The games featured a narrative, rules, team collaboration, competition, challenges, achievements, surprises, levels, rewards, choice, feedback, scoring, time-pressure, and exploration. Level I was a role-playing team competition that required group collaboration. The participants as cadets had the task to earn their gear, a shield and a sword by facing hostile animals they could locate by exploring the surrounding environment. The animals would ask them content-related questions and if answered correctly, players received the awards and earn points. The team with the most points were the game winners.

Figure 1. Snapshots from Level I and Level II mini serious games respectively

In Level II both teams received a mandate, the disarmament of a huge bomb set to explode in 50-60 minutes. The members of each team had to disperse and collect evident, maintain group communication, navigate a maze to find a hidden passage, and solve puzzles related to the course's content. Meanwhile, they faced unforeseen surprises that emulated online behaviours related to cyber safety; e.g. clicking on appealing 'malware' objects caused their avatars to become disfigured and they had to find the cure in healing waters. This level took place in the Cybersecurity island, an environment designed and developed by graduates of the University of Washington's Virtual Worlds certificate program [41].

> *Breaking News! The University of Washington has just been the target of a large scale cyber-attack! Homeland Security located the suspects who are currently on the run. Before escaping they placed a huge time-bomb in the central of the island! [] You are a member of one of two elite Cybersecurity teams that are deployed to find clues about the attack, their techniques and the hidden Steganography keep before the bomb explodes! []*
>
> (Exerpt from the Cybersecurity Challenge Game Level II initial briefing)

Figure 2. Scenes from Level II serious game (disfigured avatar and maze exploration respectively)

4 RESEARCH METHODOLOGY

As ODL and Open Education are becoming mainstream in all levels of Education worldwide, there is a constant quest to improve and safeguard learning quality [42]. Our initial intention was to see if online teaching can be enhanced using mini games and playful elements. What would be the reaction of postgraduate students, accustomed to traditional e-learning platforms when exposed to a new environment with game-based learning activities? Our research aim was to capture their level of satisfaction of all components of the course as means to evaluate the pedagogical potential and effectiveness of the employed instructional method.

More specifically we aimed at tackling and answering the following research question:

> RQ1. Can a mini serious game in a 3d VIE have a positive impact on the quality of learning in an e-learning course?

The hypothesis is that playing the games would have been instrumental for students' learning and motivation (enhancement).

Fifty-six (56) students in total participated in the particular learning experience. The participants in this study were balanced in terms of gender (male 53,8%), and belonged mainly to the age categories 25-34 (61,5%), 18-24 (14,3%) and 55-64 (14,3%). Almost all participants had never used SVREs (85,7%) before, only 14,3% had experienced them occasionally in the past. The large majority (84,6%) had no or few experience with computer games in 3D environments such as Multiplayer Online Games (MMOs). They were very familiar with web-based communication software such as Skype and e-learning platforms such as Adobe Connnect (85,7% respectively). The weekly classes in their distance programme took place in Adobe Connnect.

To address the research question, we used a mixed research method approach [43] in a sequential manner to collect data and find facts. First, participants (N=28) were invited to evaluate the intervention by completing an anonymous online questionnaire whose results were analyzed statistically. The questionnaire, designed by one of the authors, consisted of 21 question items focusing on the overall assessment of the experience and participants' demographics. The survey used predominantly closed five-level Likert scale questions according to the following format: 1-Disagree totally, 2-Disagree, 3-Neutral, 4-Agree, 5-Agree totally such as how would you evaluate 3d virtual world Second Life? I prefer it over 2d synchronous learning tools, how would you evaluate the mini Learning Game "Cybersecurity Challenge"? Playing it improved my learning. The questionnaire was sent to the participants two weeks after the session took place accommodating their study schedule. Students had one week to complete the survey voluntarily. Second, after an initial analysis of the survey results, one of the authors interviewed 14 volunteering students for further exploratory research issues. The interviews had an average duration of 10 minutes; they were planned and took place four weeks after the intervention via Skype. All interviews took place in a two week-period. Notes were kept from each interview. During these interviews, the students were invited to voice their views on the experience freely, as well as comment on their participation and learning.

5 RESULTS

5.1 Survey results

The survey generated an ordinal dataset that was analysed using non-parametric statistics [44]. For each question item we calculated the median, the mode, the inter-quartile range (IQR) and the variation ratio (VR). The median and the mode are expressions of the central tendency of data while IQR and variation ration measure the dispersion of responses.

In the evaluation of their experiences, the participants expressed which components of the environment were more and less advantageous to them (Fig. 3 and 4). The immersion into a virtual environment and the ability to be embodied in a moving avatar and occupy a virtual space were the top responses (Fig. 3). In contrast, most participants had to overcome technical shortcomings either from the software or their configuration and internet connection (Fig 4). The findings confirm the main affordances and barriers of SVREs for teaching and learning in past studies [45].

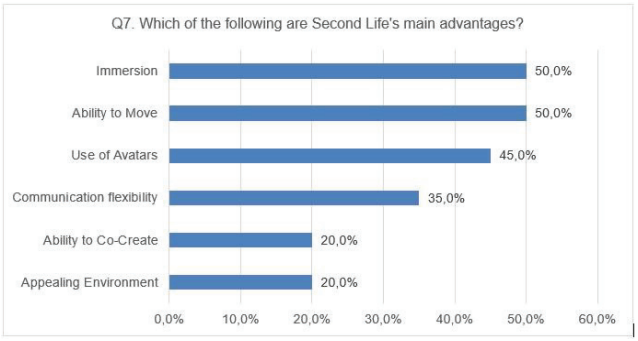

Figure 3. Perceptions on SL advantages

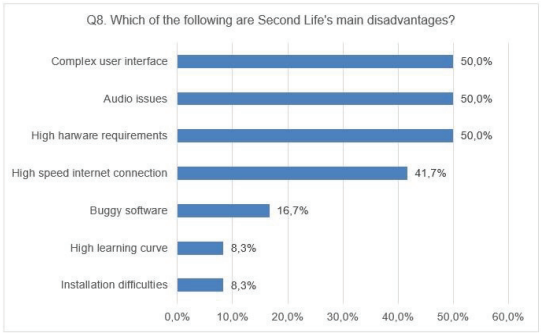

Figure 4. Perceptions on SL disadvantages

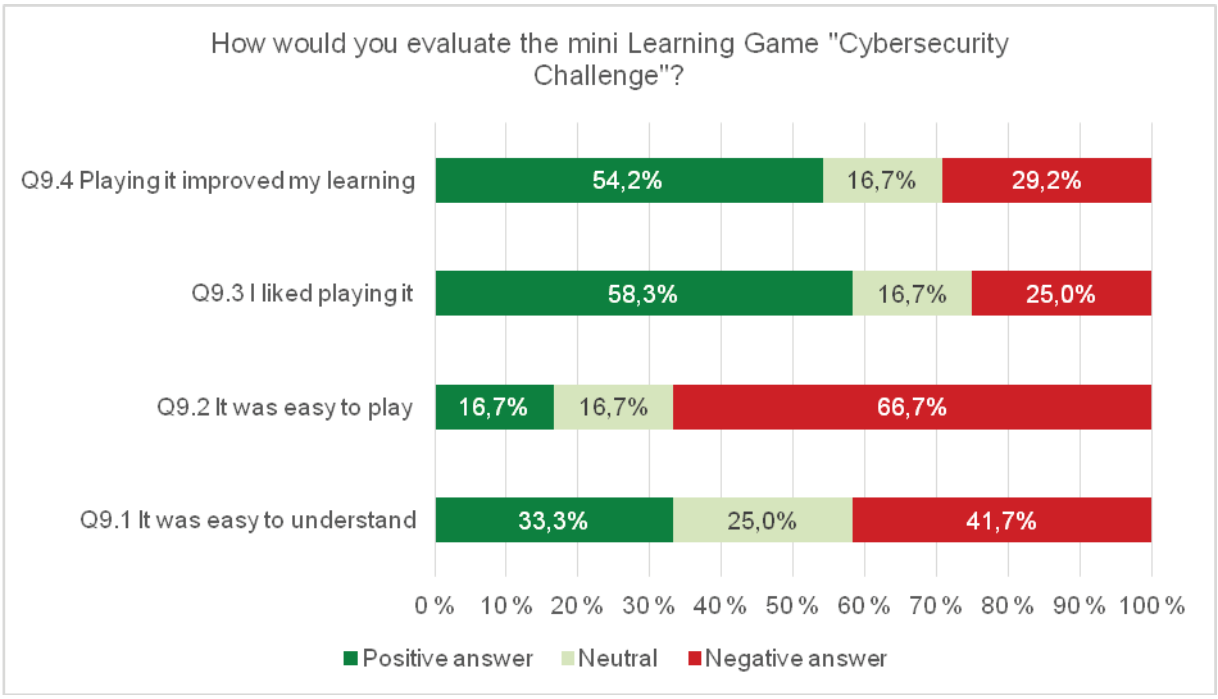

Figure 5. Participants' evaluation of the mini serious game

Despite the fact that the onboarding process to the games was not smooth, Fig. 5 and Table 1 suggest that there was a high barrier for most to understand and play the game, the outcome was rewarding for the majority of participants. This finding is in line with the results by Falconer et al and De Freitas that students appreciate playing games and conducting projects for learning [21], [46].

Table 1. How would you evaluate 3d virtual world Second Life?

	Median	Mode	IQR	VR
Q6.1 It was easy to use	2	4	3	64,3%
Q6.2 It was easy to learn	2,5	4	2	64,3%
Q6.3 I prefer it over 2d synchronous learning tools	2	2	2	64,3%

The high variation of responses in Table 1 and Fig. 5 suggests that there was a dichotomy among participants; we labeled the groups as techno-enthusiasts and techno-challenged. The first group participated smoothly and valued the experience. The second group faced serious technical issues in technology access or software use and this fact had a negative impact on their overall experience.

5.2 Interview results

We conducted interviews seeking to explore further and investigate some of the early findings of the survey. After the interviews, we analyzed and grouped the responses in four common predefined topics: technology (technical issues), organization, game play, and learning.

We confirmed that one cluster of participants faced technical difficulties of varying severity. As we found out, this happened partly due to the fact that many students accessed the class lecture session over corporate, firewall-protected lines with heavy port-blocking services that prevented Second Life's software components such as voice/audio communication to function properly.

> *I had technical difficulties periodically and was unable to hear the lecture, which made it difficult to play the game. (P2)*

> *Our network security policy didn't allow all necessary ports for Second Life to be open so I couldn't play, I just watched it in Adobe. (P4)*

This is confirms experiences and observations by other researchers, especially in projects with an international dimension [47].

On the organization aspect, we discovered some flaws in the implementation. The fact that the course had a tight weekly schedule was another stress factor; some participants had to step out of their weekly comfort zone to participate. Those who were unable to do so, e.g. attend the preparatory practice session to learn the basics of using the SVRE, they faced the challenge of self-learning or rapid onboarding; understand how to perform necessary in-world actions and communicate so as to play the game within minutes.

> *I was unable to attend the extra practice session - I was not able to find it - I did not get a message about where to go - that might have helped me. (P7)*

> *I didn't attend the practice meetings. I did go out to second life and practice on my own - but because I was a novice on the site, I found that the game went faster than I could manage - maybe extra time for people who were novices or an avatar to help people that got lost during the game would have been helpful. Now that I have had this experience, I would like an opportunity to play additional games like this in second life. (P13)*

This confirms the suggestion by previous studies that as Second Life wasn't designed for education, providing support and guidance prior and during classes is essential for learning success [48].

However, when technology was removed as inhibiting factor, participants appreciated the new active participation possibilities, the game play and capabilities of serious games in social VR.

> *It was hard to orientate myself at first and understand what to do in the environment. When I finally got going, I needed more time to find the objects and get the rewards. (P5)*

> *Because this is such a new environment for me; even though I did 'practice' a little, the environment tended to be distracting. I hadn't mastered all of the moves, and when I started to, flying in the virtual world was intoxicating. Definitely has some interesting benefits...and is worth investigating. Now I understand my daughter's fascination with Poptropica. (P11)*

This finding is in line with the results by De Freitas highlighting the pedagogical benefits of game-based learning over more traditional approaches [46].

Some participants reported that the game had a positive effect on their learning. They noted that the game was a memorable experience, it stimulated their senses and emotions and it enhanced their learning. Several also noted that they were motivated to experiment with these characteristics.

> *Great environments, I returned to explore them after the class. (P3)*
>
> *Getting around with a disfigured body was a scary yet memorable experience. (P8)*
>
> *I liked the game a lot especially the Trojan horse. The ticking bomb made me a little anxious. The game definitely helped my learning and connected with the lecture. (P10)*

This result is also in line with the results by Jarmon et al. They showed that engagement and learning improved thanks to the pedagogical use of Second Life [49].

6 CONCLUSIONS AND RECOMMENDATIONS

Regarding the paper's research question, one can say that this study confirmed the hypothesis that mini serious games in a 3d social virtual reality environment can have a positive impact on the quality of learning in an e-learning course. One of the major concerns of educators is how to increase the quality of learning for all students. New technologies such as SVREs have attempted to offer some answers. A 3d SVRE makes the experience of interacting with a situation available to people. They can see different parts of the world, can feel to be there, and can touch items over there. This kind of learning environment is extremely close to reality by evoking a feeling of immersion. SVREs can be of great value since the physical counterpart might be too expensive, too dangerous or just unavailable. SVREs can offer a truly new way to engage people and provide them with unique experiences. The participants of this study appreciated the variety of active learning modes and acquired new skills for virtual team work. The course demonstrated that the effective use of SVREs for rich, synchronous formal and informal learning can enhance distance education.

However, the findings of this study also confirmed that the steep learning curve of new users in SVREs is an obstacle for learning. This issue needs to be addressed meticulously. On one hand, the question is about time and effort that is needed in order to achieve an appropriate technical skill level for using SVRE for increasing the quality of learning. That is, the students must be trained. On the other hand, the question is about technical fluency. From this perspective, it is disappointed that we still have not managed to overcome the technical difficulties. These put unnecessary obstacles while trying to improve learning by using the tools and environments as well as running smoothly the course. Moreover, the continuous facing of technical challenges can be a very frustrating experience particularly for non-technically oriented persons. This negative experience can evoke emotions and feelings such as anger, anxiety, boredom, hopelessness and even shame, which can decrease learning and performance and reduce interest and increase task irrelevant thinking. However, the same negative emotions and feeling can improve for example persistency, which is a valuable feature for learning, if one chooses to carry on regardless difficulties.

The findings of this study showed that participants considered playful experiences in SVREs beneficial for their learning. There has been an increasing trend to personalise the learning process by using new technology. Particularly designed learning games or serious games are thought to assist people's learning process and achieve their current learning needs. Playful games can produce enjoyment and fun which can have positive influence for learning. Nevertheless, by overemphasising the fun part of learning might lead to the development of an attitude that learning must always be fun and enjoyable, and if learning does not feel like it, then a person might think that he/she is not learning.

The findings of this study showed that participants valued learning activities which were based on social interaction and active participation. Games have the potential to exert a powerful influence upon players' social development which can have a positive impact on the quality of learning. By embedding social content within the games, such as caring of something or of someone, through characters, plots and themes, players can experience decision making with the real consequences. By presenting a system of rules and act on it, such as facing an ethical dilemma, can have a positive influence upon players' social development and social learning. In addition, by discussion and debating about the game and its content online and offline can have a positive impact on developing players' argumentation, elaboration and reasoning.

Games can be useful for preparing students for the "real world" of work. SVREs enable educators to create interactive exhibits and 3D content in order to illustrate and visualise, for example real

Cybersecurity practices. Learning by doing, learning with others and learning through problem finding as well as resolving can be considered as benefits of games.

Educational context can be considered relatively traditional as a nature. That is, every new educational idea must be very convincing in order to become as a norm. This is for very good reason since education is not a random activity. The use of SVREs and games are still relatively uncommon ways of improving the quality of learning. Many worries might exist such as how to align SVREs and games to the existing curriculum or course, what if students use the limited time not for learning from the game but spend the time learning the game itself, and how expensive, time consuming and labour intensive it is for designing, developing and testing games for educational purposes. One appropriate way to start can be by using mini serious learning games for educational purposes i.e. in SVREs. They can be developed relatively quickly and cost-effectively.

7 LIMITATIONS AND DIRECTIONS FOR FUTURE STUDY

The main limitations of this study can be considered to be i) the research design. This study used a cross-sectional design but by using longitudinal study design could have revealed different results for example how impact on mini serious learning games for improving the quality of learning might change over time. ii) The data was collected by using a questionnaire and semi-structured interviews, but by using different data collection methods such as unstructured interview or narrative diary, writing the results might have been different. iii) The data was collected from university level students which were novices concerning with 3D SVREs. Data from experts on SVREs, or data from different education levels such as primary education might have produced different results. iv) The data was collected from a formal learning context, but informal learning context might have brought different results. v) The data was collected from Western culture, but for example Eastern culture might give different results. vi) The data sample was relatively small. By collecting larger data and from many different mini serious games the results might be different.

For researchers who are interested in studying SVREs and use of mini serious games we would like to recommend focus on the relationship between learning and emotions. Also it would be worth investigating if students would be motivated and interested in becoming co-creators of games and co-designers of the courses' content and activities. This could be a revolutionary step toward participants' empowerment. In addition, further studies could reveal similarities and differences among participants in other disciplines, from various cultures and geographical locations. That is, what kind of attitudes different disciplines, cultures and countries hold concerning the use of mini serious learning games in SVREs for learning.

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VI

THE PATRAS BLENDED STRATEGY MODEL FOR DEEP AND MEANINGFUL LEARNING IN QUALITY LIFE LONG DISTANCE EDUCATION

by

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The Patras Blended Strategy Model for Deep and Meaningful Learning in Quality Life-Long Distance Education

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Abstract: Life-long learning is currently being embraced as a central process that could disrupt traditional educational paths. Apparently, the (ideal) type of learning often promoted is deep and meaningful learning, though it is not always required to be so. Deep learning goes beyond superficial knowledge assimilation of unlinked facts; it aims at developing deep disciplinary understanding, transformative knowledge, personal meaning, emotional intelligence, critical thinking, creativity and metacognitive skills. Meaningful learning occurs when learning is active, constructive, intentional, authentic, and cooperative. Technology enhanced teaching and learning methods should prove their potential to transform life-long learning provision and facilitate the achievement of deep and meaningful learning. In the context of distance education in life-long learning, one important challenge is the design of versatile quality assurance strategies for e-training. Based on the experiences in distance lifelong learning programmes in the University of Patras' Educational Center for Life-Long Learning (KEDIVIM) the authors present how the principles and attributes of deep and meaningful learning can be combined with project management in practice and be incorporated in an e-Learning quality strategy. We present i) the methods used to assess the quality of the e-Learning programmes, ii) key findings of the evaluation process and iii) first research evaluation results on the quality of learning. This research study on learning process quality was conducted by using an online questionnaire, which aimed at estimating the level of participants' satisfaction while using interactive learning methods such as collaborative learning. Some results of the evaluation indicate that the e-Learning quality strategy led to e-Learning programmes that used active learning methods to achieve high learners' satisfaction towards deep and meaningful learning.

Keywords: e-Learning, distance education, technology enhanced learning, life-long learning, deep and meaningful learning

1. Introduction

Lifelong learning is often embraced as a central transformative function that could disrupt the traditional and formal educational path of most professions. Learning is not just a prerequisite for employment; it is gradually becoming the actual core of work. This rather uncontrolled process is expected to affect 30-50% of today's jobs that could possibly be automated over the next 10 to 20 years (Peters, 2017). It seems that curricula in schools, colleges and universities and the way education itself is organized might need to adapt in order to enable young people and adults to acquire some skills and key competencies and update them throughout their life. In this contextual framework, the nature of learning that people are experiencing in various forms of education is of prime importance. In many instances of their lives people have been exposed to information-transfer teaching and studying methods and activities that lead to rote, surface learning in form of memorization and raw assimilation of unlinked facts or procedures. In the era of the fourth industrial revolution a different kind of learning is encouraged to ensure employment (Gleason, 2018). Many new types of learning predominantly claim to consider a deeper disciplinary understanding combined with the essence of our humanity, our emotional intelligence, critical thinking, and creativity. This kind of learning is called deep and meaningful learning.

2. The Distinctness of Deep and Meaningful Learning

Deep and meaningful learning is the unification of two concepts and respective theories, deep learning and meaningful learning. The two concepts can be combined due to correspondences in their construction (Hay, 2007), as explained next.

Deep learning is the result of a deep approach to studying. This approach is characterized by the inherent interest in and active engagement with a discipline in a quest to grasp the underpinning principles and

Reference this paper: Mystakidis, S., Berki, E., and Valtanen, J., 2019. The Patras Blended Strategy Model for Deep and Meaningful Learning in Quality Life-Long Distance Education. *The Electronic Journal of e-Learning,* 17(2), pp. 66-78, available online at www.ejel.org

associate it with previous knowledge. It encompasses the achievement of transformational knowledge, meaning and metacognitive skills (Marton and Säljö, 1976). Deep learning is positioned in the opposite spectrum of surface learning (or surface processing) as a quantitative increase of knowledge without reflection (Marton and Säljö, 1997).

Meaningful learning occurs when learning is active, constructive, intentional, authentic, and cooperative or relational (Jonassen, 2003). Meaningful learning builds on the interconnected attributes of teaching, studying and learning (Ausubel, 1961). Meaningful learning is associated with learning approaches such as discovery and problem solving resulting in the ability to identify the underlying structure and connect existing with new concepts (Howland, Jonassen and Marra, 2012). Short explanations for each feature follow:

- Active: Learning is an active mental process. This dimension signals the active participation of learners by interacting with content and the learning environment, and engaging with a subject matter so as to make a personal cognitive contribution.
- Constructive: Learners are expected to construct continuously their own meaning by interpreting and reflecting on observed phenomena and the results of their actions.
- Intentional: Learners are encouraged to exhibit individual ownership, agency, be self-directed, set goals consciously and commit emotionally.
- Authentic: Meaningful learning requires tasks linked to an authentic experience or simulated, realistic context so that they become personally significant and transferable.
- Cooperative/relational: Human learning is also a social process involving learners and teachers. Group collaboration and peer conversation occurs naturally in knowledge building communities. Also, the engaged, passionate teachers contribute significantly to the emotional involvement of learners (Howland, Jonassen and Marra, 2012).

3. Deep and Meaningful Learning in Distance Education – Two Daunting Challenges

Achieving deep and meaningful learning is a challenge in all modes of instruction -classroom-based, distance or blended- considering that the key stakeholder of the learning process is each learner with his/her unique features, characteristics, mental and emotional capacities. Thus, deep and meaningful learning requires considerable care, preparation, attention, mastery and effort. Deep learning is an even more daunting challenge in distance education. Distance education features predominantly flexible self-directed study in asynchronous mode. Even when learning combines synchronous teacher-lead or peer collaboration activities, learner isolation is an inherently inhibiting factor (Tyler-Smith, 2006). Researchers suggest using active and challenging learning activities, collaborative problem-solving tasks and emotional empowerment to promote deep learning in distance education (Hacker and Niederhauser, 2000).

Studies in the context of distance education and e-Learning connect deep learning with active learning, peer communication and collaboration (Morin, Thomas and Raafat, 2012) as well as high levels of teaching and social presence (Bangert, 2008). Meaningful learning in distance education is based on quality versus quantity of meaningful online interactions of learners with content, instructors and peers (Yoon, 2003). Meaningful interactions enable learners to enter the zone of proximal development (Jonassen et al., 1995; Lambropoulos et al., 2012). These interactions should be designed around authentic open-ended online activities that require complex knowledge construction tasks and provide opportunities for collaboration and reflection (Garrison and Cleveland-Innes, 2005; Woo and Reeves, 2007).

One often neglected factor in e-Learning is learners' emotions and motivation. Emotions are an inherent element of learning. Knowledge is associated with emotions and feelings. Feelings and emotional states evoked by internal or external factors can either facilitate or inhibit learning. Humans can have multiple goals and motives of different nature, extrinsic or intrinsic (Covington and Müeller, 2001). Learners with extrinsic goals engage learning for external incentives such as passing an exam or material rewards. Extrinsic motivation is associated with surface learning, anxiety and high drop-out rates (Rothes, Lemos and Gonçalves, 2017).

Learners with autonomous, intrinsic motives and goals are driven by the practice of learning itself. Intrinsic motivation is associated with deep learning, high performance and learning resilience (Zainuddin, 2018).

Thus, ignoring the importance of intrinsic motivation in distance education has resulted in high drop-out and attrition rates (Tyler-Smith, 2006). Education practitioners do not always know or are able to motivate, engage

learners and integrate meaningful social activities (Mimirinis and Bhattacharya, 2007). This effect has been observed in a magnified scale in the Massive Open Online Courses (MOOCs) movement, where global participation in MOOCs rose to thousands and even hundreds of thousands but completion rates typically fluctuate around or below 10% (Jordan, 2015).

4. Distance Education and Life-Long Learning – A Convenient Combination

The adoption of technology enhanced learning has often been designated as a critical success factor for education. European Union's Digital Agenda strategy encouraged the mainstreaming of e-Learning for all subjects in all levels of education in the national policies of all member states (European Commission, 2010; Hernández-Ros, 2012). Additionally, the EU's Digital Education Action Plan prioritizes the digital transformation of teaching and learning (European Commision, 2018). The ongoing development of new technologies and their applications influenced job market changes and trends and pinpointed the need for continuous professional development and update of skills and competencies. The latter is especially evidenced in the field of vocational education and training (European Commission, 2016a), where there has been created an emerging, dynamic field for distance Life-Long Learning (LLL). According to a recent study, distance education sector is rapidly growing and was recently estimated to represent the approximately 30% of the total education provision in Europe (Schneller and Holmberg, 2014). The European Centre for the Development of Vocational Training in its key policy priority "quality of VET delivery" also associates quality of learning directly with Technology-Enhanced Learning (CEDEFOP, 2016). In this context, LLL has been emphasized as a key policy objective in the Education & Training 2020 strategic framework (European Commission, 2016b).

Traditional and emerging training providers have utilized distance education in order to offer life-long educational services to audiences far wider than those approached through traditional classroom-based method. Furthermore, online learning is considered as a critical component for their future long-term strategies by 70,8% US universities (OLC, 2014). This process could open vast opportunities for the re-creation of flexible, agile and customizable educational programmes in a cost-effective way.

Training providers face the multi-faceted challenge to transition into a new and often unknown operation mode considering all aspects that influence learning quality, such as: i) proper application of administrative procedures, ii) effective instructional and learning design, iii) sound use of media and materials, iv) the appropriate choice and utilization of technological applications and platforms, v) the certification of knowledge and skills, vi) the smart talent recruitment and onboarding, as well as vii) the optimal human resources management.

Several higher and adult education institutions with aligning strategic approaches and experience have undertaken the task to bridge education with LLL, continuous professional development, corporate training and vocational education and training by applying distance and blended learning methods. Next there is a presentation of the case study of the Educational Center for Life-Long Learning (KEDIVIM) in the University of Patras, Western Greece along with its initiatives for LLL programmes and strategies. This paper is a development of research presented in the Proceedings of the European Conference on e-Learning (Mystakidis et al., 2018a).

5. Case study: The University of Patras distance life-long learning strategy

The University of Patras has a long track record in the adoption of innovative action in education and learning, partly due to its strong technological component but also because of the progressive educational culture it embraces. In 1995 the University of Patras founded its own Centre for Vocational Education and Training (KEK). KEK notably operated in fields of excellence where the institute's personnel had demonstrated rich experience, national and international presence through scientific knowledge, research and professional expertise. The Centre implemented subsidized, national and European programmes, as well as self-financed actions along with open and free training courses. Following a new national higher education legislation, in 2018, KEK was transformed into the Educational Center for Life-Long Learning (KEDIVIM). Since 2014 KEK/KEDIVIM deployed the University of Patras' strategy project for Distance Life-Long Learning through the development of e-Learning courses and programmes. Three pillars have been selected as strategy foundations: Quality; Deep and Meaningful Learning; and Innovation.

Quality is a rather 'elusive' concept with multiple dimensions and varying definitions depending on time, geographical location and contextual factors such as economy, policy and culture (Harvey, 2009). While there is no single, unanimous definition of quality, in the context of this paper the authors adopt the definition of quality as the degree to which a sum of endogenous characteristics satisfies a set of requirements (International Organization for Standardization, 2015) and is broadly accepted by (most of) the quality stakeholders (Berki, Georgiadou and Holcombe, 2004). In education, specifically, quality is associated with effectiveness, efficiency, equality, relativity and sustainability (Barrett et al., 2006) and the way these influence learners, instructors and other stakeholders.

Deep and Meaningful Learning encompasses the metacognitive level achievement of transformational knowledge, meaning and transferable skills (Marton and Säljö, 1976). It is directly linked to manifold thinking which is a balanced combination of caring, creative, critical and reflective thinking skills (Valtanen et al., 2008).

Innovation (in the form of creativity and critical thinking) is a dynamic priority for constant (both gradual and disruptive) change signals in distance education. Along with reflective and caring thinking that could point to the identification, experimentation, evaluation and adoption of novel methods, environments and tools for learning, quality improvement and facilitation of deep and meaningful learning can be realised in the quest for personalized lifelong learning.

According to various research studies' findings and reviews, distance education when designed, planned and implemented with an appropriate blend of pedagogical approaches, methods and technological means is equally effective and in some specific cases more effective than classroom-based instruction (Means et al., 2010; Siemens, Gasevic and Dawson, 2015).

For the achievement of the aforementioned three pillars, the University of Patras' e-Learning courses have been delivered using the blended learning model. Thus, the courses combine two or more of the following modes of learning: i) classroom instruction, ii) asynchronous e-Learning (flexible self- and group study, production of individual and team assignments and projects), iii) synchronous e-Learning (live meeting(s) with instructors and co-participants in a virtual environment); iv) social eLearning (informal, emergent learning).

More details are provided in e.g. Valtanen et al., 2013; Mystakidis, Berki and Valtanen, 2017; Mystakidis and Berki, 2018.

5.1 The University of Patras model - A blended strategy for quality distance education

Reviewing quality assurance approaches and strategies in education, one can identify approaches that focus on different aspects of quality. Some strategies focus on the system's internal structure considering internal stakeholders such as learners and instructors and examine whether specific measurements are consistently met. Other approaches assess the effect(s) of the system in question towards exterior recipients (e.g. customers, external stakeholders) and their satisfaction. Finally, alternative strategies correlate quality with the achievement or specific threshold or standards of excellence (Van Damme, 2000).

In the University of Patras' KEDIVIM along with its strategic focus on excellence, quality is not seen as a static object. It is perceived as a live, vibrant process that is first and foremost evaluated through the eye of the beholder (learner). For the purposes of quality assurance in educational or/and administrative processes we take into account the inputs, the outputs as well as the involved actors' feedback. Especially in the e-Learning courses, quality assurance guidelines and policies are shaped, informed and updated by international schemes, models, quality labels, and good field practices. Also the LLL courses operational life-cycle has been organized according to the elaborated Project Management methodology proposed by the Project Management Institute – PMI (Project Management Institute, 2008; Schwalbe, 2015).

International e-Learning Quality initiatives such as ECBCheck, EFQUEL, E-xcellence and Epprobate offer the opportunity to the e-Learning providers to assess internally or audit externally all aspects of e-Learning courses' provision and courseware (Vlachopoulos, 2016) such as a) Information about and organization of the programme, b) target audience orientation, c) course design and methodology, d) learners' motivation, e) collaborative learning, f) assignments & learning progress, g) assessment & tests, h) quality of content, i) media design, j) technology, k) evaluation & review.

The University of Patras' KEDIVIM blended strategy for quality e-Learning programmes is realized through the fostering of a mixed culture of quality attributes, self-evaluation and innovation components in the following ways: i) Active commitment to quality and excellence empowerment on and for all levels (executive/top, managerial/middle, operational/low), processes and personnel; ii) the establishment of flexible/agile frameworks with clear procedures for all the life-cycle stages of the programmes; iii) resolution to seek and willingness to accept feedback for improvement from various internal and external actors/stakeholders; iv) identification and dissemination of good practices, internally and externally.

More specifically, the University of Patras' blended quality LLL programmes model inspired by Morrison, Ross and Kemp (2006) includes the following processes in five stages:

- Stage I – Analysis, Initiation & Preparation: Interested university faculty members or course leaders receive templates and guidelines to prepare the application of new LLL programmes in collaboration with KEDIVIM's personnel. Each submitted application is examined and approved by KEDIVIM's Council. One essential evaluation criterion is the programme's sustainability and correspondence to existing or anticipated learning or certification needs. Also, apart from subject-matter expertise and experience, an essential course leader selection criterion is experience in distance education and certification in professional e-Learning.
- Stage II – Design & Development: In this phase, course leaders or instructors without experience in professional e-Learning are expected to prepare themselves by experiencing and participating in an e-Learning trainers' crash-course. One outcome of the course is the elaborated design of their new LLL programme. In this process, one quality measure is safeguarding the selection, formulation and commitment to adequate and achievable learning outcomes with an effective mix of learning activities, usually in various, blended modes to achieve deep and meaningful learning. Simultaneously starts the flexible development of the learning environment, activities and materials for the new study programme. This can be produced usually by the members of the course teaching team with the guidance of KEDIVIM's professional staff or by external collaborators.
- Stage III – Marketing & Implementation: KEDIVIM prepares relative communication material and, upon completion of Stage II, starts the marketing campaign of the new e-Learning program using a variety of media so as to reach the identified target audience. Here we highlight special considerations for sensitive population groups.
  After the minimum number of participants is reached, starts the realisation of each course's iteration. Pilot iterations of courses are early encouraged. Special attention is given to the detailed preparation of all registered course participants to ensure smooth participation without any technological or emotional barriers.
- Stage IV – Evaluation: Internal or/and external assessors evaluate the programs in a formative and summative way, based on the Context, Input, Process, Product (CIPP) model (Stufflebeam, Madaus and Kellaghan, 2006). Course leaders and KEDIVIM's management receive the formative and summative evaluation results to improve aspects of current and subsequent course iterations.

5.2 Principles for Deep and Meaningful Distance Life-Long Learning

The strategic focus on quality, deep and meaningful learning and innovation formed important aspects of the stages of the model, as described above. More in depth information is provided next.

1. Analysis, Initiation & Preparation: Instructors, tutors and trainers in the University of Patras' e-Learning courses are expected to exhibit advanced techno-pedagogical competences in distance teaching and learning according to the TPACK model (Koehler and Mishra, 2009). They are expected to identify the learners' needs and involve them in the curriculum focus of each course instance (Brinthaupt and Fisher, 2011). One basic goal is to combine elements and active learning techniques from three generations in distance education (Anderson and Dron, 2011) to contribute to the formation of a virtual community of inquiry and practice (Wenger, 1998). Course leaders and instructors have the choices to (a) participate in an experiential 8-week crash-course on e-Learning course design, development and teaching (Figure 1), (b) prepare learning activities, lesson plans and lead synchronous meetings with the direct collaborative involvement and presence of a coach, and (c) young trainers can seek support and informal guidance to improve learning from mentors, more experienced practitioners.
2. e-Learning Design & Development: The five prescriptive characteristics of meaningful learning (active, constructive, intentional, authentic, and cooperative) were the overarching guidelines in Stage II –

Course Design & Development. More specific, instructors are encouraged to incorporate these principles in the instructional design of new proposed distance life-long learning programs. First, the achievement of learning outcomes is structured around related *active* learning activities. Passive learning and the delivery of knowledge in its final form are discouraged. Active learning activities model and enhance skills and behaviors that participants are expected to practice and transfer to their workplace. Another conscious effort is to incorporate spaced skills repetition so as to improve retention (Loftus, 1985). These activities should have an open dimension that allows the free, conversational interpretation of the studied discipline and the subsequent *construction* of meaningful artifacts or products that represent learners personally. The activities can be individual or *collaborative*. Collaboration and facilitated communication among peers are instrumental processes for the emergence and formation of a community of inquiry (Rourke and Kanuka, 2009). Moreover, effective e-Learning design for deep and meaningful learning should contain the element of choice. Learners should have some degree of freedom to choose *intentionally* a learning strategy combining different activities that reflect their personal interests and goals. Finally, a conscious effort is to enable *authentic*, realistic contexts in which these activities take place through techniques such as simulations and case studies.

3. Marketing & Implementation: Each e-Learning programme has a preliminary period for the participants' onboarding process. During this period we take all the necessary steps to help learners' confidence and fluency with all learning tools, platforms and methods; first, they receive detailed instructions in text and video; second they are invited prior to the start of the program to attend to at least two test online meetings, where they have the opportunity to use all the available tools and prepare for all upcoming activities. In case of technical problems in that stage or during the course, they can contact technical support personnel via email, voice over IP systems or telephone.
   During each LLL course iteration trainers are encouraged to consider the *emotional* aspect of deep learning by increasing participants' *motivation* in ways that reflect their personality and teaching style, especially in their written and oral communication.
4. Evaluation: An integral part of the quality assurance process is the systematic inquiry of the effectiveness of the course, the evaluation of distance LLL courses (Rossi, Lipsey and Freeman, 2004). For the evaluation we used the general quality indicators categories proposed by the European Union, that are: *relevance, synergy, compatibility, effectiveness, efficiency, sustainability, impact, flexibility* (European Commission, 1999). According to the CIPP model, we evaluate three axes, the supportive framework of the course (infrastructure, content, support, coordination), trainers (teaching performance), and course implementation (learning methods, results). The evaluation takes place during and after the end of courses. The principles of deep and meaningful learning are revisited after evaluation data are available to steer a program's upgrade. At the end of each course's iteration a final course report is produced that captures all essential information and evaluation findings. The report contains lessons learned during this course as described in the Closing process group in PMI's project management methodology (Project Management Institute, 2008). These lessons are entered as separate tagged entities in KEDIVIM's digital collaborative knowledge base, accessible to all personnel.

6. Evaluation and Assessment Procedure: Research Questions and Methodology

In order to assess the performance of the measurements towards excellence in KEDIVIM's e-Learning course design and delivery, we conducted a mixed research study. The study aimed at answering the following research question:
How were the participants' perceptions and experiences in the University of Patras Distance LLL programmes while using a blended quality strategy for teaching and learning?

The research was conducted in two stages. At the first stage, we combined data from the formative and summative evaluation of the University of Patras' LLL courses that KEDIVIM delivered from November 2016 to December 2018. Data collection instruments for each course's evaluation were: (i) anonymous online questionnaires that participants completed voluntarily; the formative in the middle of the course, and the summative after its implementation, (ii) structured and semi-structured observations for virtual, synchronous and face-to-face meetings. The formative and summative evaluation questionnaires consisted of closed and open-type questions, 82 and 41 items in total, respectively. They featured 39 and 27 quality indicators respectively (66 in total) on all aspects of the course's design and delivery. The quality indicators were formulated either as an overall course component (e.g. assignment feedback) or as an individual trait (e.g.

motivation provided by a specific trainer) to be rated in a scale from 1 to 5 (none, low, moderate, very good, excellent). The formative questionnaire included also a section on participants' demographic data. The data was analyzed both quantitatively and qualitatively. Closed questions were analyzed statistically while open-ended questions were further processed utilizing content analysis' techniques (Cohen, Manion and Morrison, 2007).

We collected and combined data from 20 evaluated trainers' training courses in the field of Educational Sciences with 372 total participants by 16 training personnel members in various roles and with distinct or shared responsibilities. Seven of them had no previous experience as trainers in distance education. Each course featured at least 4 trainers and had a duration of 8 to 16 weeks. All courses were delivered using blended learning and had overall a completion rate of 85.48%. In particular, we analyzed 202 responses from the formative and 176 responses from the summative assessment questionnaire, respectively. The majority of the participants in this study were female (70%). As far as age is concerned, the two main categories were 25-34 years (54%) and 35-44 (25%). Concerning their level of education, almost all held a higher education degree (97%) while 38% had an additional postgraduate degree. The participants had various backgrounds, the strongest representation being Humanities (22%), Economy & Management (21%) and Natural Sciences (16%).

The majority are at the beginning of their professional life, with zero (13%) or less than ten years of professional experience (54%). In this context, 66% currently work while 34% are unemployed, seeking to enter the job market. Their main motivation is the improvement of their place in the job market (starting a job, CV improvement, extra income, promotion). The full profile of the course participants are presented in Figure 1.

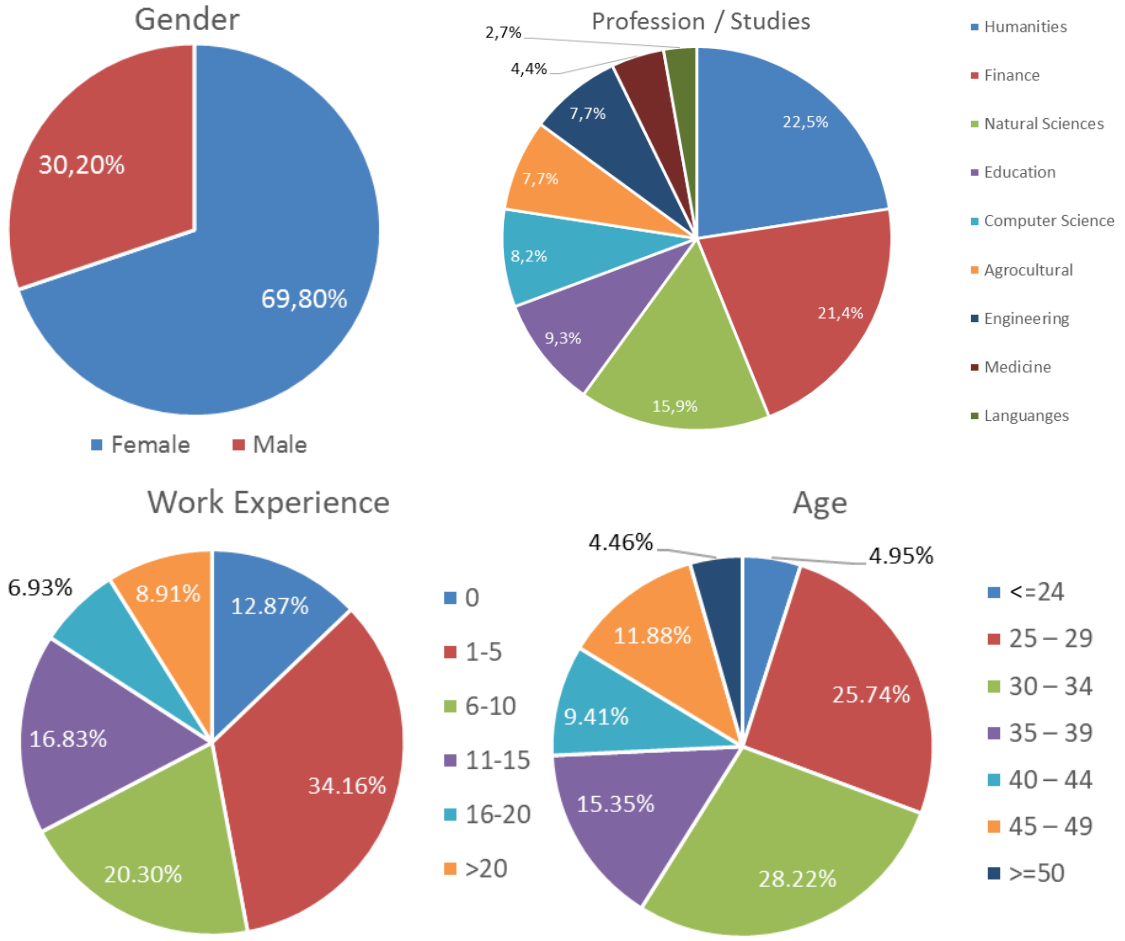

Figure 1: Profile of participants in University of Patras KEDIVIM LLL courses

At the second stage, in collaboration with Hellenic Open University, we participated in an ongoing study on e-Learning courses' participants' views on peer communication and collaborative learning for learning quality (Batsila, 2018). The study postulates that peer communication among learners and active learning methods such as social, collaborative learning are factors that can have a positive effect of the quality of distance LLL programmes (Ossiannilsson et al., 2015). The study used an anonymous online questionnaire consisting of three sections; (a) demographics, (b) general views on communication and collaborative learning, (c) inhibiting factors for collaborative learning. It had a total of 36 closed type questions using mainly a five-point Likert scale on the degree of agreement. The study took place between January and April 2018. KEDIVIM's participants from the above past courses were invited by email to participate in the survey in April 2018, i.e. 4 to 12 months after the end of the courses. 66 out of KEDIVIM's 318 contacted participants completed anonymously and voluntarily the online questionnaire. The survey received 157 responses in total. Early data analysis led to relevant findings supplementing the first stage. All questionnaires and responses in both phases were written in Greek language. The translation into English was carried out by one of the authors.

7. Research Evaluation Outcomes

7.1 Formative and summative evaluation results

7.1.1 Statistical analysis

Key findings on participants' satisfaction on quality from the evaluation process were the following:

1. All 20 LLL courses met the overall participants' expectations (cumulative Mean=4.39; SD=.753). Also when participants were invited to rate their overall learning experience in a scale from 0 to 10, their responses were quite positive (cumulative Mean=8.6; SD=1.339).
2. 34 of 35 quality indicators concerning overall aspects of the course (Table 1) received very favourable ratings with average ratings ranging from 4.25 to 4.66. Aspects with the highest satisfaction rates were live meetings, technical support, content, assignment usefulness, organization.

Table 1: Main quality indicators concerning the overall aspects of all courses

Quality indicators	Mean	St. Dev.
KEDIVIM's Organization	4.42	.648
Course Structure	4.30	.734
Learning Material	4.46	.681
Synchronous Learning	4.47	.683
Asynchronous Learning	4.32	.763
Assignments Usefulness	4.48	.631
Assignments Feedback	4.30	.882
Technical Support	4.47	.752
Administrative Support	4.45	.724

The overall quality indicator that received the lowest rating was Time Allocation (Mean=3.69; SD=.941). The qualitative analysis of open questions revealed details in depth.

All 31 individual indicators concerning the trainers' performance (Table 2) revealed very high quality with means ranging from 4.48 to 4.91.

Table 2: Main quality indicators on individual aspects of teaching performance in all courses

Quality indicators	Mean	St. Dev.
Synchronous Learning Trainer (SLT) Knowledge	4.83	.400
SLT Active Teaching	4.79	.504
SLT Trust	4.78	.522
SLT Motivation	4.68	.597
Asynchronous Learning Trainer (ASLT) Knowledge	4.66	.592
ASLT Active Teaching	4.56	.700
ASLT Trust	4.54	.691
ASLT Motivation	4.50	.720

Observing the progress of quantitative results across time, we recorded a steady gradual improvement of metrics especially in trainers' performance indicators and the corresponding overall course quality indicators. In their first efforts with distance education, some trainers without prior experience, faced some difficulties, especially in the synchronous mode. This was evident also in the qualitative data. These trainers weren't always successful in their early efforts to establish a collaborative culture of active learning. Another difficulty

they faced was an inability to manage effectively the limited time of synchronous meetings; sometimes it was hard to achieve a proper balance between meaningful open discussion among participants and off-topic wanderings. In the asynchronous mode, sometimes new e-trainers weren't punctual or effective in their feedback of assignments or at answering participants' questions. After appropriate timely feedback, guidance and mentoring, they were able to improve their practice or focus on their core strengths. As a result, critical comments on individual trainers decreased significantly and performance results of individual newcomer e-trainers improved in each subsequent course they joined.

7.1.2 Qualitative analysis

Analyzing the responses to the open-ended items in the questionnaires, participants expressed their satisfaction for their learning progress and achievements as it was recorded in the ratings. Participants with experiences from similar courses praised the superiority of the KEDIVIM's courses both orally to the trainers and in their written comments. Opinions are unfolded below:

> *"The course in general offered me a plethora of new knowledge and helped me acquire new competences that I can apply in my professional activity, with some practice. The work done during meetings with trainers and through studying the educational material and completing learning assignments was very well organized and effective".*

> *"I have no improvement suggestion. The program was very good and in comparison to courses from other universities e.g. (name), University of Patras' program is far superior in all aspects and especially in regards to microteaching".*

The biggest challenge that was reported by some participants in certain programmes was the lack of time to participate in various aspects such as attendance to all synchronous meetings, study of the theoretical material and completion of mandatory assignments, in alignment with the survey finding (iii). Thus, they suggested longer course durations. This was an anticipated issue in LLL of adults who work and have additional roles and obligations. As this issue was detected early, we countered it with increased flexibility and personalization in course deadlines as well as positive reinforcement in the communication.

> *"The program should last longer with more frequent distance meetings of shorter duration so as have more time to study the educational material."*

> *"The time allocation should be better. Time spans among virtual meetings and assignment deadlines could be longer so as to allow for better study of all units".*

In certain programs some participants reported that the most troublesome element they encountered was the extensive content that made its study too demanding.

> *"I thought the volume of information was like a torrent, something that could be attributed to the fact that I have basic computer skills".*

> *"As the course is aimed at adults with various roles and obligations, I believe the material is over compressed so as to be absorbed".*

This is an indication of cognitive overload that inhibits deep and meaningful learning. In literature it is confirmed that when learners are overwhelmed, they tend to resort to surface approaches to complete the course in sketchy manner (Entwistle, Peterson and Elizabeth, 2000). Thus, course leaders received the recommendation to reduce educational material or workload.

Another finding was the total absence of technical problems mentioning and frustrations, a frequent phenomenon in e-Learning courses. This is consistent with the very high satisfaction rate with the technical support (AV=4.47; SD=.752). This fact exposes the successful selection of suitable technological platforms, their smooth operation and, apparently, the effectiveness of the participants' preparation process.

7.2 Quality evaluation findings - Learning process and outcomes

The early analysis of the provisional data suggested that the delivery of the University of Patras' e-Learning programmes used successfully peer and active learning methods to achieve high learning quality, learner satisfaction, confidence and optimism. First, despite the considerable long period since course completion and the rudimentary communication effort, the response rate (20.75%) reached levels significantly higher than the empirically reported averages in distance education programmes participants' surveys in Greece, which are

around 5% (Batsila, 2018). This could be interpreted as an indicator of appreciation and trust; they did not just complete a course and ran away. This observation is consistent with responses to question item 40 of the summative questionnaire; 78% would be interested in participating in future e-Learning courses provided by the University of Patras.

Moreover, 83.3% of KEDIVIM's respondents in the study confirmed that the communication among the participants was encouraged and facilitated. Further, 66.7% reported that collaborative learning took place during their course. In contrast, only 55% and 41.7% respondents from other Greek institutes and training providers reported the existence of peer communication and collaborative learning respectively.

This experience led to another interesting finding in parts B and C of the survey. The University of Patras courses' participants responded significantly *higher* (stronger degree of agreement) to all six "positive", "optimistic" statements in part B on the value, feasibility and importance of the aforementioned two factors for the quality of learning. Reversely, in part C, they responded consistently *lower* (weaker degree of agreement) to 21 out of 24 "negative" statements about problems and troublesome conditions that can hinder collaborative learning.

8. Concluding Remarks, Implications for Practice, Limitations and Future Research

A pilot evaluation study like the one presented herein revealed findings that contradict existing results from similar distance and LLL courses evaluation and unfolded rather surprising aspects of the learners' satisfaction.

Evaluation and data analysis from completed e-Learning courses revealed in accordance to preliminary results (Mystakidis et al., 2018) that the University of Patras' blended quality strategy had an overall positive effect.

All aspects of learning quality regarding design, development, content, personnel, media, platforms, organization, implementation and communication were confirmed. Teachers in both synchronous and asynchronous settings performed at a very high level considering the respective environments' affordances.

The participants expressed their high satisfaction in KEDIVIM's distance lifelong learning programmes that met their expectations.

The findings from this research study on learning quality support the claim that the perceived quality in the eyes of University of Patras' distance LLL program participants was high, possibly higher than experienced in other HE settings. This could also be attributed to the successful use of peer and active learning methods, and general commitment to other essential elements striving for realising deep and meaningful learning. The courses' participants (and survey's respondents) also appeared to be more confident and optimistic both by recognizing factors for learning quality improvement (learning process improvement, in particular) and not being discouraged by potential obstacles in peer collaboration. In summary, the issue of time management provided feedback for improvement while the live meetings, technical support (e.g. choice of suitable learning platforms) content assignment usefulness, overall organisation and trainers' performance make the Patras blended model outperform other models.

The provision of life-long learning and continuous education services is of growing importance for the information society and knowledge-based economy. Training providers need to find effective ways to meaningfully integrate technologies that enhance quality of education while at the same time guarantee the educators' commitment that can lead to deep and durable learning. The latter can be achieved by actively encouraging the emergence of a learner-centric involvement and pedagogic culture that aligns the assessment of learning through its outcomes in a more natural and pragmatic manner with 'liquid' curricula (Steils et al., 2015). For example, technology enhanced natural assessment methods focus on students' competences to synthesize knowledge and apply skills in contextual, realistic, simulated settings. This can be achieved by engaging learners in authentic experiences. This strategic priority needs to be nurtured and underpinned by a sustainable quality learning model. We argue that trainers should be at the heart of this model and be empowered to be the main motivating drivers of change towards digital transformation and innovation.

The empirical evidence of the current study should further be enriched in order to achieve a more compact and coherent Patras model. Undoubtedly, more survey results are needed from a representative number of

courses with different duration and from all disciplines. In so doing the validation of the sustainability of the Patras model quality strategy could be objectified. Concerning the study's research design, one could point to the suitability of other research instruments such as focus groups or unstructured interviews which, in turn, could reveal different data and information; possibly also among participants from different ethnicity and culture. The authors also consider extending the current study in the direction of assessing the impact of the current, blended quality strategy on teaching effectiveness (by measuring learning outcomes), learning quality (by measuring learners experiences) and participants' overall satisfaction in the University of Patras distance LLL programmes. Additionally, the authors intend to measure the advancement of deep and meaningful learning in the course's and broader social context. In these contexts, the plan is to continue experimenting with e-Learning platforms, tools, applications, environments, techniques and methodologies that could provide the ground to found and realise learners' experiences for deep and meaningful learning.

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VII

DEEP AND MEANINGFUL E-LEARNING WITH SOCIAL VIRTUAL REALITY ENVIRONMENTS IN HIGHER EDUCATION: A SYSTEMATIC REVIEW

by

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VIII

ENTER THE SERIOUS E-SCAPE ROOM: A COST-EFFECTIVE SERIOUS GAME MODEL FOR DEEP AND MEANINGFUL E-LEARNING

by

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Enter the Serious E-scape Room: A Cost-Effective Serious Game Model for Deep and Meaningful E-learning

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***Abstract*— Escape rooms are a phenomenon that has taken the world by storm in the last decade. Simultaneously Virtual Reality is a promising technology for innovation in education, training and e-learning. Combining these two concepts, this paper outlines a new model for designing serious games in virtual reality environments for high quality, deep and meaningful learning, the Serious E-scape Room. It describes the theoretical grounding, general guidelines and principles of the model. It also presents the case study "Room of Keys", a serious virtual escape room for biology concepts. To test the assumptions of the model, researchers conducted a mixed research study with 148 students in a US high school. Pre-post test results recorded a 13.8% performance increase and high overall satisfaction. The game has been received enthusiastically by students, it increased their motivation and helped them build a deeper understanding of the learned concepts.**

Keywords—escape room, virtual reality, serious games, deep and meaningful learning, biology

I. INTRODUCTION

Virtual reality (VR) is a technological field with origins in analog, mechanical systems such as the Sensorama [1]. VR re-emerged in recent years offering psychological and sensory immersion [2] through digital, computer-generated virtual environments. Desktop VR environments have been utilized effectively for a long time in education [3]. Educators have been able to design and develop innovative, immersive resources, environments, experiences, such as simulations and games for teaching and learning [4]. VR experiences are currently being used mainly for entertainment but also for educational purposes [5]. As new VR software platforms and hardware such as head-mounted displays and peripherals emerge in quick pace, it is essential to provide affordable tools and paradigms for educators to adopt VR and use it effectively for high quality, deep and meaningful learning experiences.

In this paper, we present a new model for designing mini serious games in VR environments, virtual escape rooms. We present the design and development of the awarding-winning educational serious escape room "The room of keys", for learning biology concepts. We also provide preliminary evaluation results from first user experiences breaking out of the virtual escape room.

II. BACKGROUND

A. Deep and Meaningful E-learning

Deep learning is the result of a deep approach to learning. This approach is characterized by an intrinsic interest in the subject matter and a drive to understand the underpinning principles behind studied phenomena and processes [6]. Deep learning thus is durable and interconnected with existing knowledge.

Meaningful learning occurs when learning is active, constructive, intentional, authentic, and cooperative [7]. More specific, meaningful learning experiences include tasks linked with *authentic*, realistic context so that new competences can be transferred and applied in real settings. In these experiences, learners participate *actively* to make a personal cognitive contribution by interacting with content materials and learning environments. Their actions should be *intentional*, self-directed towards their own individual goals and serve the *construction* of personal interpretation and meaning through reflection on new knowledge and observed phenomena. This sustained critical discourse takes place in a knowledge community with *collaborative* tasks that involve both teachers and co-learners [8].

These two concepts have correspondences in their structure and thus have been unified in the term deep and meaningful learning [9]. The achievement of deep and meaningful learning is challenging in e-learning where learning quality and drop-out rates are constant concerns [10]. Addressing e-learning participants' emotions and intrinsic motivation improves deep learning and performance [11].

B. Escape rooms in Education

Appropriately designed gameful and playful motivation enhancement methods such as gamification and serious games can empower learners to develop and adopt autonomous, intrinsic goals, increase their engagement and facilitate deep and meaningful e-learning [12], [13]. Serious games are experiences that offer a set of meaningful choices with a primary educational purpose [14].

Escape rooms are a new type of leisure spatial activity originating from Japan that are spreading rapidly world-wide in the last decade [15]. Escape rooms are defined as live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order

to accomplish a specific goal (usually escaping from the room) in a limited time [16]. Currently there are estimations of 10,000 operating escape rooms globally [17]. Escape rooms are usually themed and sometimes driven by a narrative where players engage in role play. Popular themes are modern era, historic, horror, fantasy, science, future (sci-fi), military [18]. Escape rooms have been used successfully for educational purposes in higher education [19], [20].

III. The Serious E-scape Room Model

The concept of breakout rooms can be transferred also in virtual, computer-generated environments. Leisure virtual and augmented reality escape rooms produced in physical locations are an emerging trend in the escape room industry [21]. From a technical point of view, virtual escape rooms are a good fit in the current generation of VR platforms and mostly tethered peripherals, as they require limited physical space and movement. Interactions in VR escape rooms should be designed carefully to avoid technical pitfalls and gain the trust of players [22].

Virtual reality is the ultimate empathy machine for education, as it allows users to immerse themselves into transformative experiences of the self [23]. The potential of VR for simulated procedural training is established [24] and will grow proportionally with the fidelity of peripherals such as gloves that monitor accurately finger movement. However, educational solutions from both categories require special technical skills, are complex and costly to develop. There is a need to democratize immersive education and make VR learning apps an attainable aim for all educators.

Educational virtual escape rooms as a special genre of serious games seeking to balance entertainment with education, fun with learning. Educational virtual escape rooms have been developed successfully to address psychological phobias [25] and team-building in corporate groups [26]. Combining organically content within a narrative, a story, rearranges learning into an appealing experience that facilitates agency and mastery [27].

The proposed model of Serious E-scape Room unites virtual escape rooms with deep and meaningful learning theories. Serious E-scape Rooms are educational game-based and problem-solving experiences in virtual online environments with a special focus on deep and meaningful learning. Serious e-scape rooms provide learners with challenging activities and puzzles they can undertake autonomously from a distance in an authentic context, narrative or theme [28]. Participants are invited to act, explore, identify, think, experiment, solve problems, communicate, discuss, coordinate, distribute roles, collaborate and reflect, so as to build mental connections between new and existing knowledge. Additionally, these experiences when designed effectively can attract the attention, and create a pleasurable atmosphere that excite and enables intrinsic motivation. Hence, serious e-scape rooms can address the cognitive, emotional and social domains of learning in a cost-effective manner. Therefore serious e-scape rooms are theoretically well-positioned to offer enjoyable, deep and meaningful e-learning experiences for various playing styles and learning preferences [29]. In the next sections we present our effort to apply the model and test the validity of the above theoretical assumptions.

IV. Case Study: The Room of Keys

The serious e-scape room "Room of Keys: A lesson on enzymes" (see Fig. 1) was built as a proof of concept to examine if a game-like VR experience can affect students' learning approach, motivation and performance.

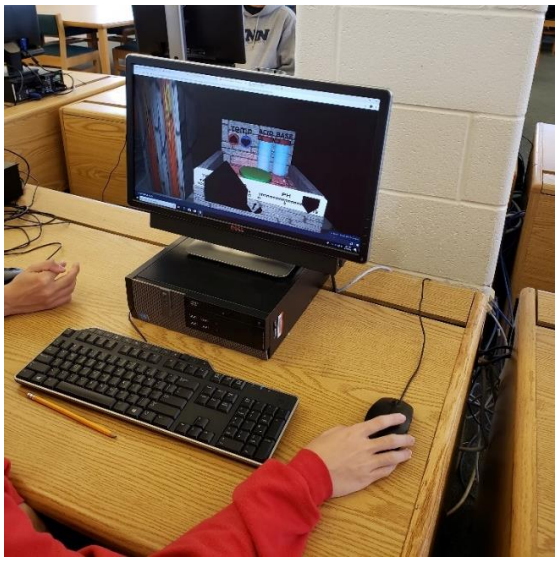

Fig. 1. A student playing the "Room of Keys" serious e-scape room at a desktop computer in the library

A. Pedagogical Design

The material covers the biology curriculum standard Bio.4.1.3 as defined by the North Carolina Department of Public Instruction [30]: "Develop a cause and effect model for specificity of enzymes - the folding produces a 3-D shape that is linked to the protein function, enzymes are proteins that speed up chemical reactions (catalysts) by lowering the activation energy, are re-usable and specific, and are affected by such factors as pH and temperature."

This topic appeared especially fitting since enzymes operate as "keys" in chemical reactions and thus constitute a perfect metaphor in a breakout activity. The Room of Keys challenges users to be observant and unlock information about enzymes, then use that information to solve puzzles and challenges on the way to escaping the virtual room.

B. Game Design

The game is broken up into an introductory/tutorial phase, an expositional experience, which conveys the necessary content, and finally a set of puzzles or challenges that can be solved through the application of the knowledge from the previous phase. The information necessary to solve the latter puzzles, which is presented during the expositional phase, stays under display for the entire experience. This allows the player to go back and review as necessary to solve the puzzles. To allow flexibility in exploration, we chose not to introduce a time limit in which the activity must completed.

The introductory phase is composed of a series of panels that form a pseudo-room around the user when he/she begins the game. The panels instruct the user in how to look around and interact with objects and the environment, how to move around the space and the general goals of the game.

The next, expositional phase is composed of a set of five flying keys, each labeled with an icon. After a brief mini-game that involves knocking down and collecting the keys, the user

can then unlock panels of information relevant to enzymes. The information is presented both visually and through audio to cover different learner types (see Fig. 2).

There are icons that correspond to each of the five "chunks" or sections of information that the material is broken up into. The activities are marked with the icons that correspond to the information necessary to solve it. This is to make it easier for the player to find the necessary clues in the information to solve the puzzles in the next levels.

After all five panels are revealed, the first puzzle unfolds. To complete the level, as is the case with all puzzles, the user must apply the information from the expositional phase. In this first challenge, the user must use both the knowledge that enzymes are a protein, from the general enzyme information panel, and that proteins are identified using Biuret solution, from the Indicators panel. This reveals two new keys, one of which opens the way to the next level.

The activities that follow continue to challenge the user to apply the information in realistic, simulated contexts. For example, in the denature activity the user is presented with a warped shape representing an enzyme, which is contained in a large vat that has controls for temperature and pH. In the denature panel the user is informed of how enzymes only retain their shape under normal temperature and pH conditions. Otherwise, they lose their normal shape and become denatured, and therefore cannot work since they no longer fit in their substrate. The user can alter the temperature and pH in the vat using buttons and levers, which in turn changes the shape of the enzyme. Once both of those variables reach the optimal conditions, the user is given feedback that they were successful, and the enzyme appears in the user's HUD. This enzyme in turn can then be used on the next level challenge, which simulates a synthesis reaction. The enzyme the user just picked up is placed in a translucent placeholder that matches that shape and begins a chain reaction where steps meld together to form a staircase that allows the user to reach the key to the next activity. This process further models enzymatic activity by showing how the enzyme initiates and takes part of the reaction, but that it is not consumed in the process.

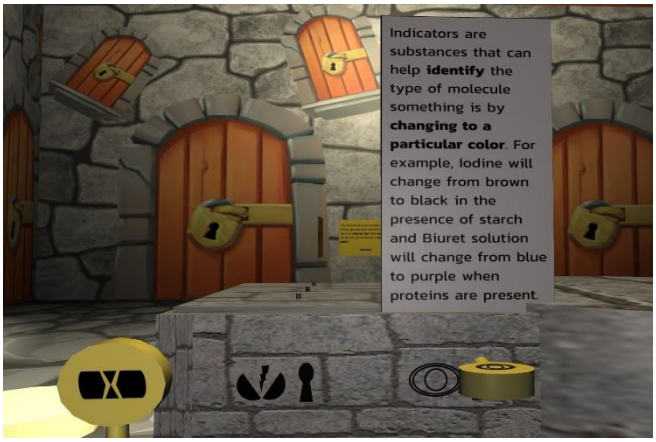

Fig. 2. The expositional phase of the gaming experience

Puzzles in each subsequent level increase in complexity and difficulty. These simulated activities challenge learners to reflect on the content and solve the puzzles, as well as exemplify and model key concepts of the content being used and thus develop deep understanding of the concepts and construct higher order thinking skills [31]. The game was developed in collaboration with a local librarian, Natalie Strange, who was experienced in constructing physical escape rooms, as well as Jessica Tidmore, a local Biology teacher. The game was deployed at the library using their desktop computers and Ms. Tidmore's current Biology class students.

C. Development

"Room of Keys" was developed in the Amazon Sumerian platform. This platform was chosen for its affordability, ease of access and low learning curve. The platform is appropriate for educators without a programming background for developing device-agnostic and mobile-device friendly applications and experiences. It is also capable of developing VR and AR experiences.

The platform, and any experiences built in Sumerian, are cloud based. There are no purchase fee or downloads required to work in it, or to play the application. There is also a minimal cost model based on the number of users that play the experience. To distribute a build, one simply shares the URL after publishing it. Anyone with that link can then access it from any browser.

V. Evaluation Process

To evaluate the model, we conducted a mixed exploratory pilot study combining quantitative and qualitative methods [32]. This approach was preferred in our effort to explore in depth and build consensus of the intervention's effect. Our data collection methods were pre- and post-test questionnaires that tested the deep understanding of the learned content and oral feedback from students. We hypothesized that (1) there would be a significant knowledge increase in test performance and (2) students would enjoy the experience and increase their motivation.

A. Procedure

148 students at Northwest Guilford High School in North Carolina, USA played the beta version of the "Room of Keys". The students were given a pre- and post-test at the same day, immediately before and after playing the game. Most of the participating students were between 14 and 16 years of age, while there was an almost equal representation between males and females with 71 male, 72 female, and 5 students choosing not to identify a gender. Students played the game on desktop PCs at the school library between January and February 2019.

B. Instruments

The pre-test contained four demographics questions and eight closed, multiple-choice items regarding the game content and outcomes. The post-test was comprised of the same eight assessment questions and seven evaluation items on user experience and perceptions; six closed and an open question item. The closed evaluation questions used a five-point Likert scale where students expressed their degree of agreement or disagreement with the particular statement. Both tests were eponymous. The tests were created and administered electronically using Google Apps for Education.

The eight closed, multi-choice assessment questions in both pre- and post-tests were the following:

1) Which characteristic is MOST LIKELY true for enzymes in the human body?

2) Why is the "lock and key" analogy often used to describe enzyme function?

3) Humans can use starch as an energy source, but are unable to use cellulose for energy. Which of the following BEST explains the difference in how these molecules are processed in the body?

4) To which class of organic compounds do enzymes belong?

5) Many people are lactose intolerant and cannot digest dairy products. What enzyme are their bodies MOST LIKELY lacking?

6) Sucrase, an enzyme, is added to a solution containing water and sucrose. Which variable would change?

7) How does an enzyme speed up chemical reactions?

*8) *How is the role of enzymes in biochemical activity BEST explained?*

VI. Results

148 students completed the pre-test and 143 of those students completed the post-test, with 5 students failing to do the post-test after completing the activity. The average activity completion time was 15 minutes. 90.2% of the students reported that they had been already taught the game's content, enzymes, during their Biology class. Total possible points on the evaluation was 7 points, one point being awarded for each correct answer. The last question (8) was excluded from the data analysis because its formulation didn't have one, definitive correct answer.

A. Student performance

Student performance between pre- and post-test improved by 13.8% as was evidenced by the distribution of students scoring higher on the examination. The pre- and post-test results are illustrated in Fig. 3 and 4. There was an increase for all but one of the questions, which saw a decrease and would bear closer examination. Two questions were answered correctly significantly more with a 20% or greater increase in incidence of correct answers. Student's performance in each assessment item is depicted in Table 1 and Fig. 5. This finding is consisted with students' subjective sentiment that played the game increased their understanding and performance (see Table 2).

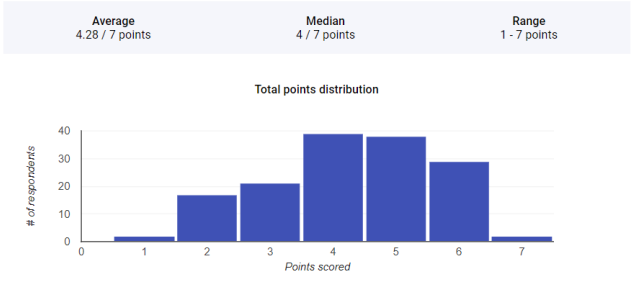

Fig. 3 Pre-test Score Distribution

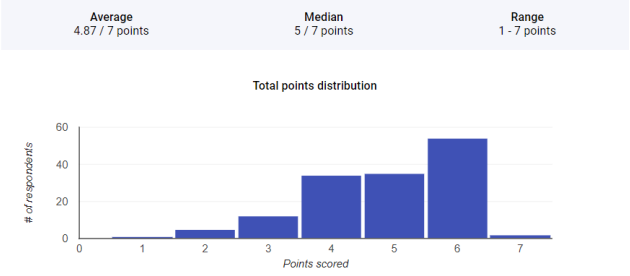

Fig. 4 Post test score distribution

B. User Experience and Satisfaction

The results of the user experience evaluation results are summarized in Table 2. The subsequent feedback revealed that students generally enjoyed the game and playing increased their knowledge and motivation albeit facing some technical challenges. Some of the specific written and oral comments of learners on the game were the following:

"I thought it was fun to play"

"I have no thoughts or suggestions about the game. It was well put together and enjoyable. I only got confused once, but after I understood what I was trying to do, I was able to complete the task! :)"

"When's the 3rd one coming out!?!?!?!?!?!?!?!?!?!?!?"

"This should be played during/before the students learn about enzymes, not months later. It is somewhat okay to use a review tool."

"Make it longer and harder."

"It was simple and had good notes with it. It is also easy learning."

In the post-test section on experience evaluation, learners were also asked the following questions; "Do you feel like this game could be used in a classroom to help teach students about enzymes?" and "Do you feel like this game could be used in a classroom to help reinforce students understanding about enzymes?" to which students answered yes 85% and 88% of the time, correspondingly.

Another finding of the evaluation was the need to improve the game instructions and more specifically player movement. Several students expected to be able to move in the virtual environment using the keyboard's arrow keys. Instead they had to click on specific spots on the ground to move around. This decision was made to accommodate full compatibility with players wearing VR headsets. As a result, students faced initially technical difficulties navigating the environment and playing the game. Another factor that could have lead to this phenomenon in this pilot study was the absence of teachers or other personnel to answer student questions or address technical problems. Here are some indicative comments:

"Although the game is supposed to be fun it is difficult to figure out the mechanics, but once you figure them out the game is pretty easy. Just maybe explain that the game is a point-and-click game."

"You need to have a teacher in the room that can explain if students need help."

"I was confused about how to move until i realized it was the dots on the ground."

We responded to the feedback by providing printed instructions in a hand-out and by adding instructional panels with elaborated game instructions in the virtual environments that players see at the very start of the game.

Overall, students enjoyed the game, developed a deeper understanding the concepts, and increased their interest in biology as demonstrated by their comments and performance increases as well as observations by Mrs. Strange and Ms. Tidmore, included below:

"The virtual environment was key in allowing students to experiment with enzymes and pH factors in ways that are

difficult in a standard high school lab. The program encourages students to think beyond rote learning and move into application through experimentation." – Natalie Strange, Librarian

"The kids really enjoyed being in the computer lab and working on the escape room. They do struggle with puzzles because they don't know how to be critical thinkers, so I really enjoyed this experience in helping the students realize that puzzles can be fun and educational." – Jessica Tidmore, Biology teacher

Results overall confirmed both hypotheses.

TABLE I. PERCENTAGE OF CORRECT PRE- AND POST-TESTS ANSWERS

Question	Pre-Test	Post-Test	Change
1	52.03%	72.03%	20.00%
2	78.38%	87.41%	9.03%
3	72.97%	76.92%	3.95%
4	73.65%	80.42%	6.77%
5	95.27%	96.50%	1.23%
6	10.14%	6.29%	-3.84%
7	45.27%	67.13%	21.86%

Fig. 5 Summary of incidence of correct answers in the pre- and post-tests

TABLE II. GAME EVALUATION

Question	Average	St. Dev.
How did you like the Room of Keys?	3.59	1.17
Do you feel like this game helped you learn about enzymes?	3.15	1.19
Was the game easy to understand?	3.03	1.32
Do you feel that you answered more questions correctly after playing the game?	3.55	1.02
Do you feel like this game could be used in a classroom to help teach students about enzymes?	85.3% (Yes)	
Do you feel like this game could be used in a classroom to help reinforce students understanding about enzymes?	88.1% (Yes)	

VII. CONCLUSION AND FUTURE RESEARCH

In this paper we present a new and cost-effective model for designing serious games in virtual reality environments for deep and meaningful learning, a virtual escape room. We provide the general guidelines and principles for the design and development of such experiences. We present also the process and the positive results of the application of the proposed model to the "Room of Keys" virtual escape room. Playing the game improved significantly high school students' understanding, despite the fact that the topic was taught and supposedly already known to them. The pilot study revealed important findings that will guide the improvement of the user interface and experience. The proposed Serious E-scape room model can be beneficial both for educators and VR developers. Educators can use creatively the established, popular yet fully customizable template of escape rooms to develop virtual immersive experiences that engage learners. Similarly, VR developers can partner with subject-matter experts and deliver robust, compelling and scalable serious games that demonstrate the immersive affordances of VR platforms for education.

In the future, we intend to improve the game based on user feedback and conduct experiments to study the learning quality and effectiveness of the experience also in adult audiences such as higher education students. Also, we want to further develop the model to assist practitioners from all fields to design and develop smart VR learning experiences that share their passion and create excitement that leads to durable, deep and meaningful learning.

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