Creative Thinking Experimentations for Entrepreneurship with A Disruptive, Personalised and Mobile Game-based Learning Ecosystem

Lameras, P. , Tsiatsos, T. , Petridis, P. , Tolis, D. , Liarokapis, F. , Anastasiadou, D. , Protopsaltis, A. , Hendrix, M. and Arnab, S.

Creative Thinking Experimentations for Entrepreneurship with A Disruptive, Personalised and Mobile Game-based Learning Ecosystem

Petros Lameras[1], Thrasyvoulos Tsiatsos[2], Panagiotis Petridis[3], Dimitris Tolis[4], Fotis Liarokapis[5], Despina Anastasiadou[6], Aristidis Protopsaltis[7], Maurice Hendrix[1], Sylvester Arnab[1]

[1]Coventry University
Coventry, UK
Plameras@cad.coventry.ac.uk

[2]Aristotle University of Thessaloniki, Thssaloniki GR

[3]Aston University
Birmingham, UK

[4]Grant Thornton
Nicosia, CY

[5]Masaryk University
Brno, CZ

[6]Innovation Academy
Thessaloniki, GR

[7]Friedrich-Alexander-Universität
Erlangen-Nuremberg, DE

Abstract— Based on an unprecedented need of stimulating creative capacities towards entrepreneurship to university students and young researchers, this paper introduces and analyses a smart learning ecosystem for encouraging teaching and learning on creative thinking as a distinct feature to be taught and learnt in universities. The paper introduces a mashed-up authoring architecture for designing lesson-plans and games with visual learning mechanics for creativity learning. The design process is facilitated by creativity pathways discerned across components. Participatory learning, networking and capacity building is a key aspect of the architecture, extending the learning experience and context from the classroom to outdoor (co-authoring of creative pathways by students, teachers and real-world entrepreneurs) and personal spaces. We anticipate that the smart learning ecosystem will be empirically evaluated and validated in future iterations for exploring the benefits of using games for enhancing creative mindsets, unlocking the imagination that lies within, practiced and transferred to multiple academic tribes and territories.

Keywords: Creativity; disruptive mobile games; creative mindsets, entrepreneurship; higher education; problem-based learning.

I. INTRODUCTION

The European higher education landscape is undergoing significant change as a result of technology-driven innovations. Europe's "New Modes of Learning and Teaching in Higher Education" report [1] argues that "*conventional learning and teaching settings will be enhanced by the integration of new tools and pedagogies, and it will be complemented by many more online learning opportunities [...]*". This is congruent with Europe's "Opening up Education" [2] initiative for "*stimulating ways of learning and teaching through ICT and digital content*". We fully embrace this initiative by conceptualising and analysing an integrated smart learning ecosystem for encouraging student's creativity and creative thinking, as an overarching and most challenging feature to be taught and learned for stimulating entrepreneurship in higher education, using playful, mobile and data-driven interfaces. In harmony with the "Entrepreneurship in Higher Education, Especially in Non-Business Studies" report [3] evidenced that the majority of entrepreneurship courses are offered in business and economic studies, this paper aims to embed creative entrepreneurial capacities and mindsets across the academic spectrum by involving diverse academic tribes and territories, not only in Business Schools as means of building inter-disciplinary approaches, but also in engineering, computer science and arts disciplinary backgrounds.

Key to increasing the chances of students becoming more creative, developing mindsets for entrepreneurship as a skill, is to demonstrate ways to teach entrepreneurship and creative thinking grounded in everyday settings. The application of engendering creative ideas therefore will be inextricably tied to lifewide creativity to describe the application of creative ideas to the breadth of interdisciplinary ideas contexts in everyday life. This is instantiated via creative entrepreneurship pathways, representing gamified story-based tasks and challenges, to enable adaptation and response for liberating creative natures. The creative pathways are disruptive, introducing a re-imagined manifestation in the fostering of creativity in entrepreneurship education by proliferating open and participatory technologies in the context of a story with elements of visual authoring, learning analytics, gaming and physical object-creation. Students and teachers are able to ideate, create and learn playfully and guided through a process of invention virtually, physically in the classroom or during a field trip. This serves as the basis for delivering a framework that introduces an adaptive design process for re-thinking the learning and teaching of creative entrepreneurship in the classroom with the use of mobile game-based learning.

The paper embarks on by setting the context of entrepreneurship education and elaborates on the meaning of creativity and creative mindsets. Then we present the ecosystem's infrastructure and enabling technologies followed by an application scenario. The approach and methodology is then analysed complimented with future avenues for research, validation and evaluation.

II. CREATIVTY IN ENTREPRENEURSHIP EDUCATION

The "Expert group on indicators on Entrepreneurial Learning and Competence report" [4] argues that entrepreneurship education is central of any entrepreneurial ecosystem in Europe because education is key to shaping young people's mindsets, attitudes and skills. The recommendation of the European parliament and the Council on Key Competencies for Lifelong Learning [5] recognized the sense of initiative and entrepreneurship as one of eight key competencies for every European citizen, which was expected thereafter to be instilled at all stages of education and training. The Survey of Entrepreneurship in Higher Education in Europe [6] stresses the importance of agreeing on and practicing of a broad definition of entrepreneurship. *"Entrepreneurship is much more than just starting a business: it is a mindset for creativity and sustainable change."* As often happens with new ideas, entrepreneurship as a teaching and learning process met controversy and challenging arguments. As a teaching and learning subject, demanded more activity-based approaches to learning and cross-curricular teaching methods and a multidisciplinary approach. This is evident from the EU commission Communication Fostering Entrepreneurial Mindsets through Education and Learning [7] which clearly states the integration of entrepreneurship as an important part of university teaching and learning for combining entrepreneurial creative mindsets and competence with excellence for enabling students and researchers to better commercialise ideas and new technologies developed.

A. Integrated components: Game and Learning Authoring Environments

The technical state-of-the-art in serious games mirrors that of leisure games, however the technical requirements of serious games are frequently more diverse and wide ranging than their entertainment counterparts. Serious game developers frequently resort to bespoke and proprietary development due to their unique requirements, such as difficulties exist for game engine developers in accurately understanding and supporting the needs of instructional design. Although many serious games have limited visual interactivity, immersion and fidelity, there is an increasing motivation to create serious games that intend to support situative (social and peer-driven) and experiential pedagogies; partially because behaviourist approaches have been shown to be limited (e.g. people learn to play the game, not address learning requirements), whilst cognitive approaches struggle to impart deeper learning in the areas of affect and motivation. Recent work demonstrated enhanced learning when introducing game elements to a standard flight simulator.

B. Mashing up 3D virtual with real worlds

Lately, there has been an increasing interest in the educational applications of three-dimensiona (3D) multi-user virtual environments (3D MUVEs) [11]. A 3D MUVE learning environment is a simulated, three-dimensional online space where learners, represented by avatars, can interact with each other, computer generated agents, digital artifacts, and the virtual environment in real time that is similar to real-life face-to-face interactions1. 3D virtual learning environments are different from online learning environments, such as MOOCs and LMS, since they have several significantly distinctive features that can enhance the learning experience. The use of a virtual world for university courses as educational classroom has indicated that virtual worlds are engaging and stimulating spaces that give students the opportunity to meet online for a variety of class activities, both synchronous (such as lectures, discussions, labs, projects, etc.) and individual or asynchronous (games, simulations, etc.). The essence is to create a user-friendly authoring tool to facilitate the use of gaming mechanics and other widgets, in a 3D Virtual World, helping users accept more easily the technology and adopt it more quickly in favour of students and their enriched experiences.

C. Pedagogy: Problem-Based Learning

Problem-Based Learning (PBL) is an approach to learning that challenges students to learn through an active engagement in real life problems. It was first used as a pedagogical approach in the 1960's at McMaster University Medical School (Ontario, Canada), in an attempt to restructure medical school education and enable students to apply their scientific knowledge to clinical problems. Today, PBL is used extensively in elementary, secondary and tertiary education institutions worldwide, and has also been adopted in various fields of professional training, such as nursing, engineering and architecture. We integrate problem based pedagogy in the 3D virtual and serious games authoring environment, by designing various forms of feedback and assessment units, to guide the learning process and improve the learning experience and outcomes.

III. INTEGRATED ECOSYSTEM AND ENABLING TECHNOLOGIES

Based on the mechanics and dynamics of the activity-based architecture (Figure 1), the PBL pedagogical modality and the gamified creativity creation and application process, the smart learning ecosystem extends the learning experience and context from the classroom to outdoor (co-authoring of creativity for entrepreneurship modules, real-world entrepreneurs) and personal spaces (home, workplace). Figure 2 illustrates the ecosystem consisted of games authoring tools, 3D virtual worlds, 3D printing functionality, and widgets for gamification,

cognitive training, AI, AR and multisensory games and finally a learning analytics component. All components are developed semi-independently and use a common integration component to communicate. The integration component consist of a set of RESTful web services that can easily be integrated into any Internet enabled device or tool. At run-time the delivery components (3D worlds and gamification) will send data for storage via the integration services. There is a web-interface for analyzing courses and the analytics component offers access to its information for both the run-time components (3D virtual worlds, games) and the authoring tools.
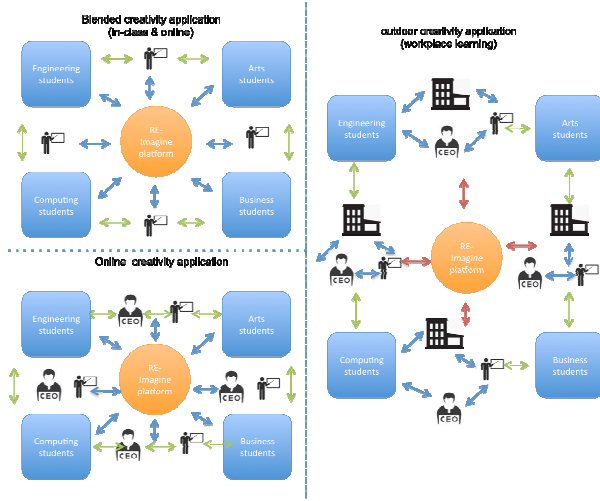

Figure 1.   Ecosystem based on context of use

The tools encompass the learning analytics, serious games, games and authoring environments and 3D printing. Spaces run through classroom and workspace learning, 3D world, collaborative environment. The processes are creativity identification, creativity pathways, collaborative pathways applications and the creativity entrepreneurship solution
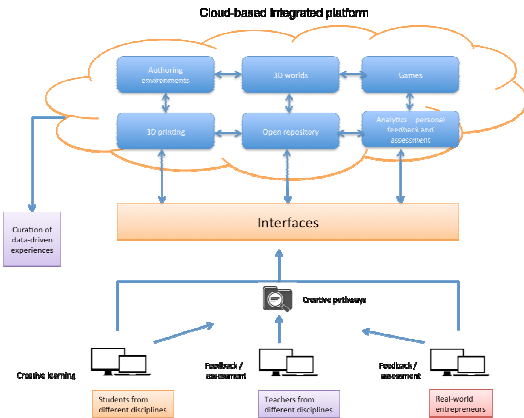

Figure 2.   Cloud-based infrastructure

The games authoring tool is based on the Generalized Intelligent Framework for Tutoring (GIFT) [8]. Figure 3 demonstrates the functional elements of the authoring tool which includes the components, modules, databases and the interfaces that support the authoring process within the authoring tool.
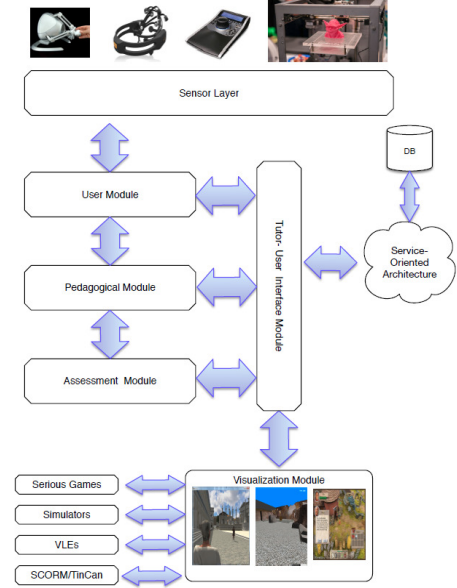

Figure 3.   Functional elements of the authoring tool

The creativity-learning platform encompasses a game-learning authoring environment for designing, implementing, sharing and re-using learning activities and games specifically focused on creativity for entrepreneurship. The innovation includes (i) an authoring environment for the creation of learning activities that can be visually sequenced, orchestrated and shared; (ii) combined with a games authoring environment with learning attributes used for designing creativity-focused games. This all-in-one authoring platform allows both the creation of learning activities and the automatic integration of games into the lesson plan. This fills a large-gap in the evidence-base that supports teachers' difficulty to amalgamate games as learning activities as part of a lesson plan.

IV.   APPLICATION SCENARIO

As an example scenario to describe the application, figure 4 illustrates a scenario the accessing, application of creativity for entrepreneurship in a computer science context. This will be built over the platform with open and re-usable content (creativity pathways with story-based gamified tasks for emotional awareness). This application uses responsive design and can therefore be accessed anywhere in any learning environment. Access interface, assessment and feedback will be personalised for learners, teachers and real-world entrepreneurs.
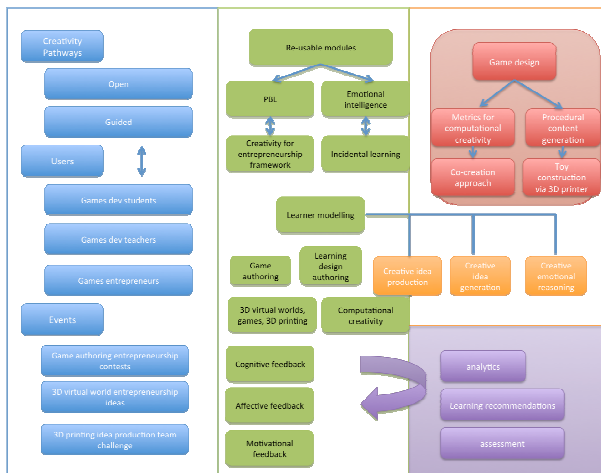
Figure 4.   Creative game development skills – application scenario architecture

Problem-based systems typically specify learning objectives and perhaps even engage learners in a problem assuming that the learner will understand the relevance and the value of the problem. Unfortunately, very often learners will not accept the goals of the instructional system, just focusing on completing the task. However such activity will not support their creative thinking and definitely will not nurture an entrepreneurship spirit. Therefore, it is very important that the goals the learners bring to the environment are consistent with the goals of the problem-based environment. To achieve that, a system or a teacher can solicit problems from the learners and use them as a stimulus for the learning activities. The system offers that opportunity to the learners, in a unique and creative environment. The system also allows learners and teachers to define a domain and then work together individually or collaboratively to set up meaningful tasks or problems in that domain. It is essential that the system challenges the learners' thinking. The system should not be telling the learner what to do or how to do it, but rather the learner should be able to draw his own conclusions using the material in the system and the tools offered by the system. Knowledge and learning are essentially the result of a negotiation and its value very often is revealed within its social context. Therefore the system will offer the ability to the learners to build their communities and also work collaboratively. These activities will allow them to test their ideas and solutions, challenge other's solutions and engage in a dynamic and creative dialogue.

The use of the game-based learning environment offers the opportunity to deliver personalized feedback to learners. For feedback to be useful, it is important that it is relevant to the individual and therefore it needs to be personalized. This personalization is often done on the basis of selected pedagogy and characteristics such as

learning styles. In the field of user modelling and adaptive hypermedia, pre-determined personalized versions of courses have been developed for a number of years now and recently this has been integrated into the authoring process of Serious Games with the integration of Experience Engine and Serious Games Authoring tools.

The analytics component is built around a series of web services. These web services use the RESTful standard. The RESTful standard allows developers of the other components to simply make requests to the RESTful end points (web addresses) and will directly get a result in either the standard XML or JSON format, depending on their preference. The web services are hosted on a modern commercial grade webserver and connect to a database server for data storage and retrieval.

V.   DEVELOPMENT FRAMEWORK AND PROCESSES

The overall scientific and technical approach taken, based on [9], [10], corresponds with a rapid, concept design methodology as applied to a public / private partnership (PPP) context where research and product development expertise is combined into one seamless process to boost creative thinking and creativity for entrepreneurship. This methodology will bring together learning management system development SME's along with key university and business research leaders, in the field of entrepreneurship, creativity and cognitive training games, 3D collaborative virtual environments and games and learning authoring environments, mashed up with learning analytics and cloud-based infrastructure, in a cohesive integrated way.
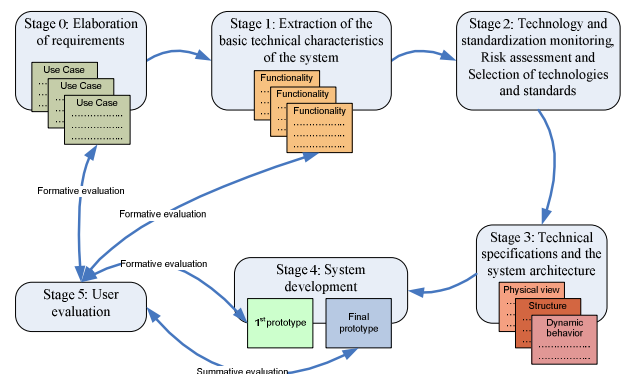

Figure 5.   Development framework

Stage 0: Elaboration of Requirements consisted of the target group identification and mapping, analysis of creativity skills and meta-analysis of pedagogical and cognitive theories. **Stage 1** involves primary effort to extract some of the most basic technical characteristics of the system, based on the inputs and requirements main goal of this stage is to describe the system interface and system functionality. **Stage 2** is an extended monitoring

of the technologies, platforms and/or standards available in each research field and from these explored there is a selection of the ones that met some basic criteria. An intermediate step concerns the risk assessment for each technologies, platforms and/or standards. **Stage 3** is to define the technological basis for the system, as well as to identify the relevant tools and protocols to be implemented. **Stage 3 also** describes the system architecture in the form of functional blocks and their interrelations, including a description of hardware and software requirements on the server. **Stage 4** involves the system development and system's functionality. **Stage 5** is the user evaluation as means to discover potential problems in advance as well as to contribute to our understanding of the application of new technologies for creative work in learning and teaching.

VI. CONCLUSIONS

The paper presented an interpretation of an integrated cloud-based game-based mobile learning environment for improving creative skills and establishing creative mindsets for entrepreneurship education. Smart widget interfaces including games with deep learning features and multi-sensory technology are considered for giving a sense of presence and immersion complimenting a 3D virtual world. To add a sense of craftsmanship students will be able to print their virtual objects (buildings, characters, cars, scientific objects etc.) realised in the virtual world through an integrated 3D modelling application.

The integrated platform supports technical and human participatory processes that enable students, teachers and experts to network through different modalities: (a). The design of creative pathways (open and guided) are tailored in line with the technology to be used will be participatory in nature and will allow students together (co-creativity) to develop learning activities for entrepreneurship taking different roles, establishing teams and network with resources and experts (teachers, entrepreneurs) for jointly sequencing of learning topics and tackle challenges of learning design and games development combining expertise, building a critical mass and constructing learning through experience building.

The underlying assumption of this conceptual architecture is the strengthening of the social context in which informal creativity learning will take place: (a) within a group, and (b) facilitated by real-world entrepreneurs. This personal context may be influenced by (a) motivation and expectations and (b) choice and control. Future research activity involves testing the perceived learning advancements that the platform envisages to address such as: (1) creativity and creative mindsets development, personalised learning / recommendations, learning through games creation and 3D worlds as well as helping teachers to design creativity

lesson plans using visual authoring environments and their impact on teaching and learning creativity.

VII. REFERENCES

[1] European Commission: 'Entrepreneurship in higher education, especially within non-business studies', Available at: http://ec.europa.eu/enterprise/policies/sme/files/support_measures/training_education/entr_highed_en.pdf [Last accessed 8 September 2015], 2008

[2] European Commission: 'Openning Up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources', Available at: http://bit.ly/1K4tRL7 [Last accessed 8 September 2015], 2014

[3] European Commission 'Entrepreneurship in higher education, especially within non-business studies', Available at: http://ec.europa.eu/enterprise/policies/sme/files/support_measures/training_education/entr_highed_en.pdf [Last accessed 8 September 2015], 2008

[4] Chatzichristou, E.: 'Expert Group on Indicators on Entrepreneurial Learning and Competence' Available at: http://ec.europa.eu/education/library/reports/2014/entrepreneurial-expert-report_en.pdf [Last accessed 8 September 2015], 2014

[5] European Commission 'Rethinking Education:Investing in skills for better socio-economic outcomes ', Availabe at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0669:FIN:EN:PDF [Last accessed 8 September 2015], 2012

[6] ECON: 'Survey of Entrepreneurship in Higher Education in Europe', Available at: http://ec.europa.eu/enterprise/policies/sme/files/support_measures/training_education/highedsurvey_en.pdf [Last accessed 8 September 2015] 2008

[7] Weinberger, C.: 'Commissions Communication: Fostering entrepreneurial mindsets through education and learning', Availabe at: http://ec.europa.eu/enterprise/policies/sme/files/support_measures/training_education/oslo/plen_th_b_00_weinberger_en.pdf [last accessed 8 September 2015], 2014.

[8] Sottilare, R.A., Brawner, K.W., Goldberg, B.S., Holden, H.K.: 'The Generalized Intelligent Framework for Tutoring (GIFT)', 2013

[9] Dillenbourg, P.: 'Virtual Learning Environments. Workshop on Virtual Learning Environments', in Editor (Ed.)^(Eds.): 'Book Virtual Learning Environments. Workshop on Virtual Learning Environments' (2000, edn.), pp.

[10] Burbules, N.: 'Rethinking The Virtual, The International Handbook Of Virtual Learning Environments', 2006, pp. 37-58[11] Qian, Yufeng, "3D Multi-User Virtual Environments in Science Education: Potential and Challenges." STEM Education: Concepts, Methodologies, Tools, and Applications. IGI Global, 2015. 841-863. Web. 1 Sep. 2015. doi:10.4018/978-1-4666-7363-2.ch045