



## Serious games and the development of an entrepreneurial mindset in higher education engineering students <sup>☆</sup>



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### ABSTRACT

The paper discusses adoption of Serious Games (SGs) for supporting development of an entrepreneurial mindset in university students of technical and scientific universities. The paper relies on the authors experience in the eSG project, which aims at introducing students, mainly through practice, to basic concepts of entrepreneurship and company management. In the framework of the project, courses have been designed and carried out in three different countries: Italy, Spain and the Netherlands.

The paper discusses the main requirements for the courses and presents a table template, based on state of the art models for entrepreneurship education, that we have used for the scouting of the most suited SGs and defining the most appropriate mix for their use in the courses, keeping into account targeted competences and skills, usability and pedagogical effectiveness.

Using the template, the paper draws a comprehensive overview of relevant SGs available on the market and identifies, through an expert analysis, key benefits and issues concerning their adoption in teaching entrepreneurship for the target students. Finally, the paper critically analyzes the state of the art, indicating directions for future research that should lead to development of more effective SGs for entrepreneurship education.

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### 1. Introduction

Entrepreneurship is a personal skill and motivation which draws a person to engage his abilities and efforts in the creation of new products and services. Entrepreneurship has a clear social potential, because it stimulates the entrepreneur to consider needs and requirements from potential customers, and because running a business requires setting up and managing a team of people and creating workplaces. For these reasons, entrepreneurship is considered as a key factor for contemporary societies.

However, entrepreneurial education is still relatively immature and rarely adequately addressed at strategic level by universities or national policies. This is true in particular in the technical universities, which is critical, considering the innovation potential coming from the technological studies and researches. The issue involves both contents and teaching methodologies and tools, since problem-solving and decision making are important for the

development of entrepreneurial attributes of students in scientific and technical fields [1].

This paper relies on the idea that Serious Games (SGs) may be considered powerful tools to sustain entrepreneurship education and discusses key issues underpinning their adoption. As a matter of fact, educational SGs combine instruction and gameplay [2–4], by challenging and involving players in motivating learning contexts. From a methodological perspective, SGs can foster learning since they offer the students a genuine “situated” learning experience [5] and can concretely support the “learning by doing” approach. According to the Dale’s cone of experience, students can only remember 10% of what they read, but almost 90%, if they engage in the job, even if a simulation [6].

Exploring the experts’ opinions on the opportunities and limitations of SGs for learning, De Grove and colleagues [7] stress that SGs should be considered “de facto effective learning environments because games challenge and support players to approach, explore and overcome problems”. As matter of fact, SGs challenge players by trying out their capacity to set different alternatives and experience the relevant consequences. SGs also provide immediate

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feedback, which is efficient for procedural learning and assessment [8]. Furthermore, they lend themselves to collaborative and social use [9] and can be used as a lifelong learning tool, without time/space barriers [10]. SGs can show the concrete relevance and application of topics and skills that may be difficult to explain in words, which is particularly important for sustaining the development of an entrepreneurial mindset as well as of other soft skills.

These considerations, together with the recognition of the social relevance of entrepreneurship, led the University of Genoa, the Institute of Educational Technology of Italian National Research Council (CNR-ITD), the Technical University of Delft and the ESADE business school of Barcelona to join their forces in the eSG project (stimulating entrepreneurship through Serious Games). In a previous conference paper, [11], we presented the methodology we developed for collecting requirements and designing the courses. The current paper proposes a streamlined synthesis of that work and focuses on how we used the developed conceptual tools for analyzing serious games for entrepreneurship. This allowed us to draw a comprehensive overview of relevant SGs available on the market and to identify, through an expert analysis, key benefits and issues concerning their adoption in teaching entrepreneurship, particularly for university students in scientific and technological fields. Finally, the paper critically analyzes the state of the art, indicating directions for future research that should lead to development of more effective SGs for entrepreneurship education.

## 2. Background: using serious games for business and entrepreneurship

Ref. [12] reports that, in the US, in 1994, over 200 business games were being used by nearly 9,000 teachers at over 1,700 colleges offering business programmes. The current state of the art [13] shows an increasing use of such tools in US Universities and the progressive adoption of cutting edge technologies (e.g. virtual reality, artificial intelligence). The European situation is less investigated and appears more fragmented, although interesting initiatives are to be considered (e.g., the project carried out at Exeter [14], those carried out at ESADE and INSEAD, and the interesting experiment carried out in [15]).

Ref. [16] reports his experience at the US Department of Defense, where 3 different Components-Off-The-Shelf (COTS) management simulation videogames were added to 3 courses. The study stresses that “Students in classes using the game scored significantly higher means than classes that did not”. Ref. [17] states that user performance in simulations is largely the result of players’ skills rather than luck; that learning through “trial-and-error” led to better simulation performance; and that skills employed in simulation are not the same as those being assessed in conventional academic evaluation. Ref. [18] describes a project about evaluation of business simulation software for mechanical engineering students, analyzing various open source and COTS tools.

There is a certain number of high-level business games and simulations that are being used with different features and targets, in business schools, also in Europe (e.g., [18–22]). And here is the list of main games that we have considered in our analysis (described in Section 5): Marketplace Venture Strategy, SimVenture, GoVenture Small Business, Virtual Trader, Intopia, Beer Game, Zapitalism, Virtual U, Industry Giant II, Virtual U, Innov8, EagleRacing, The Enterprise Game, The Finance Game, MetaVals.

Ref. [18] presents an interesting study to identify a business simulation appropriate for MEng Engineering students. The selection was based on factors such as: exploring methods for evaluating potential software and enhancing the learner experience. After the initial scoping study, they spotted two products, namely Marketplace – Venture Strategy and SimVenture, and reported that

“Marketplace proved to be the most suitable in terms of the pedagogic and technical requirements”. Also our paper discusses selection of suited business simulations. But it describes a wider number of games, that we evaluated according to an ad-hoc defined methodology.

Effectiveness of business games is questioned by [23], that stresses the current unavailability of specific evaluation tools and methods, due to the high variability (dimension, content, structure...) of the educational actions. The lack of a common framework for describing/classifying the educational interventions in a SG is a limitation that is being addressed by the state of the art research on SGs and is one of the research questions that the eSG project is investigating in the specific field of entrepreneurship education.

## 3. Designing the short course for stimulating entrepreneurship through SGs

### 3.1. Target students profiles and expected benefits

The first phase of eSG concerned the identification of the user requirements for a SG-based entrepreneurship-oriented higher education course, considering three main stakeholder categories: students, teachers and entrepreneurs. The results of this analysis are reported in [11]. eSG involved students of different countries (Italy, Spain and Netherlands), with a different background (ICT in Genoa, Business in Esade Barcelona, Engineering in Delft) and at different levels (Bachelor, Master and PhD in Genoa, Bachelor and Master in Delft and post-graduate/professionals in Esade), these differences set different targets and contents in the different courses. Attendance, in all the three courses, was left as voluntary, as it was expected that the appeal of the games and the importance of entrepreneurship would attract students.

Table 1 lists the expected benefits for the different target courses. In particular, it reports a summary of the requirements coming from the various stakeholders, considering the differences (in terms of course type, student level, local enterprises, etc.) in the eSG’s three pilot sites. Students stressed in particular the need for deepening company management competences also in an entrepreneurial perspective (creation of own business), for understanding important social realities, that may help them enter the world of work in a more aware way, and for better understanding their potential to become entrepreneurs. The interviewed entrepreneurs highlighted the importance of the entrepreneurial values and gifts (e.g., risk and innovation aptitude, rapid decision taking, long-sight, ability to understand the others, to read the reality’s factors, to deal with complexity, to compete), that cannot be generated from scratch but can be developed and, anyway, should be known by students.

### 3.2. Educational goals

In order to assess validity of the new entrepreneurship courses, we set goals in terms of acquisition of awareness, knowledge and skills. Based on the European Standards and Guidelines for Quality Assurance in the European Higher Education Area<sup>1</sup>, which establishes the present foundation for web-based learning provisions and regulations, we defined a set of high-level evaluation criteria/targets aimed at monitoring the progress and development of students during the course in entrepreneurship using SGs.

Targets include:

- Awareness of and motivation for entrepreneurship.

<sup>1</sup> <http://www.enqa.eu>

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