UNIVERSIDAD DE GRANADA

Facultad de Ciencias Económicas y Empresariales
Departamento de Organización de Empresas
Programa Oficial de Doctorado en Ciencias Económicas y Empresariales

TESIS DOCTORAL

TITULO:

ASSESSING THE EFFECT OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) IN EDUCATION: THE ROLE OF GAMIFICATION AND SIMULATIONS AS ENABLERS OF ENTREPRENEURIAL ATTITUDE IN BUSINESS SETTINGS

Tesis doctoral presentada por:
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Dirigida por:
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General Introduction

1.1. Introduction to the Research Topic

1.1.1. Introduction

The XXI century of human development is characterized by a strong influence of computer technologies. Nowadays it has affected almost all areas of human activities, ensuring the dissemination of information flows in society, forming a global information space. The emergence of these conditions entailed many educational institutions across all over the world to adopt Information and Communication Technology (Van der Wende and Beerkens, 1999). According to Hawkridge (1990) from educational rationale, Information and Communication Technology (ICT) has possibility to improve teaching and learning; from social side, ICT gives possibility for all users to receive real time information; from catalytic rationale, ICT is expected to advance in educational innovations and from economic perspective, future workplace requires ICT skills. In case of a proper implementation into education system, ICT has potential to expand the access to education, effective improvement of educational quality, enhance the relevance of education to progressively digital establishment and to make teaching and learning process more engaging. (Tinio, 2003).

According to Blurton (1999), ICT can be defined as a set of technologies with tools and resources used to process, store and disseminate information, and to communicate, create and manage information. These technologies can be considered as important enablers of organizational competencies in educational performance, both formal and non-formal especially to formerly underserved constituencies. One of the determining aspect of ICT-enabled education is the capacity to transcend time and space, the other one excludes dependence on reliance solely on printed books and other materials in physical form (Tinio, 2003).

Several authors affirm that ICT equate with improvements at preschool education by inducement creativity and play, their cognitive development and social interaction of learners (Dockett et al., 1999; Downes et al., 2001; Bolstad, 2004; Hatzigianni and Margetts, 2012). According to OECD school case studies, the implementation of ICT is a constant process of educational

change, where the teacher plays significant role in ICT adoption and its further practicing (Venezky and Mulkeen, 2002), moreover ICT can be a powerful lever for achieving planned innovations in education (Venezky and Davis, 2002).

Undoubtedly, nowadays computer technology has already become pervasive in educational institutions of developed countries and is being implemented progressively in universities and schools of developing countries. Through the years, ICT have been offering a wide range of diverse technological learning tools, as telephony, radio and TV broadcasting for distance learning, computers and the Internet for E-learning (Tinio, 2003) and relatively new technological learning tool, so-called gamification that aims to motivate and engage to study process via software applications and different platforms (Aranda et al., 2016). Computer simulations as a tool of ICT-enabled education are becoming extended resources in universities, colleges and secondary schools, due to their constant acceptance and embracement by society in growing evolution and technological development. A large number of studies have been conducted related to the learning effects of simulations on students' performance at university and college level (McEnery and Blanchard, 1999; Wolfe and Luethge, 2003; Tao et al., 2012). Recently, some studies are drawing attention towards the extent to which computer simulations encourage entrepreneurship for graduate and undergraduate students (Arias-Aranda, 2007; Huebscher and Lendner, 2010; Haase and Lautenschläger, 2011). According to Feldman (1995), computer-based simulations are able to create an environment in which students feel themselves as in the realities of the business world, without being involved in all the difficulties inherent for managers of the operating environment of everyday routine. In this way, students are encouraged to become practitioners rather than just learning about practice.

Furthermore, gamification as an innovative ICT-enabled education tool is gaining its popularity in academia (Huotari and Hamari 2012). This relatively new concept has already been implemented in business, education, training, health and wellness (Ramaswamy, 2008; Berns et al, 2012; Kapp, 2012; Werbach and Hunter, 2012; Duggan and Shoup, 2013). On this, Huang

et al. (2013) claim that a great achievement of a proper implementation of gamification can transform a mundane task into engaging learning process, in other words applying successful gamification techniques can positively effect on students behavior. In this line, Lee and Hammer (2011) assume that gamification has all the premises in motivation of learners to classroom engagement and encourage them to bring their strength into the learning aspiration. While, at the same time it can provide teachers with better reward system and tools to guide, in order to demonstrate to students that education can be a joyful and fruitful experience (Werbach and Hunter, 2012).

In light of the aforementioned, this PhD thesis focuses on the role played by ICT-enabled education within the two interrelated concepts: Simulations and Gamification, as learning tools for enhancing entrepreneurial attitude of high school students. These concepts are analysed on the basis of the EAO (Entrepreneurship Attitude Orientation) scale though the participation of students in a gamified business simulation; considering the necessary requirements that play a key role for such purposes. To that aim, the current research provides a vast and detailed theoretical review, which introduces the main concepts of the study: ICT-enabled education, Simulations, Gamification and Entrepreneurship Attitude Orientation with a wide and complete literature review on these concepts. Further, it provides well-defined research methodology to clarify the role of effects of gamified business simulations on entrepreneurial attitude at high school level.

1.1.2. Importance of the Research Topic

Recognizing the great potential of ICT for improving the quality of education, General Conference of UNESCO in 1997 establishes the Institute for Information Technologies in Education (IITE) (Unesco, 1998). The proclaimed strategies referred to strengthening the capacity of UNESCO Member States in the field of ICT in education, rely upon the evidence-based policies and teacher advanced training, and promoting education using ICT tools. Today IITE participates in the development and implementation of

UNESCO's programs related to the use of ICT at various levels of education and in its various sectors (Kinelev et al., 2004; Rajashekar et al., 2008).

The Europe 2020 strategy admits that it is required the fundamental transformation of education and training to address the new skills and competences (Brecko et al., 2014). According to European Commission (2010) one of the key priorities for the flagships as *Agenda for New Skills and Jobs, Youth on the Move, the Digital Agenda and the Innovation Agenda* is innovating in education. Various national policies for ICT in education around the Europe are focused to facilitate the promotion of implementing technology in education. Recently, European Commission (2013) presented a communication on "*Opening up education*" aimed at facilitating high quality of learning and teaching, with innovative approaches through new technologies and digital content. The idea is to help learning environments including teachers and students to gain ICT skills, to interconnect classrooms with digital devices and to unite all stakeholders of learning institutions to embrace the role of digital education in learning environments.

According to Friedman (2005), future employee must be disposed in changing workplaces and careers more frequently, to be versatile and flexible in acquisition of the skills at workplace, and to consolidate a changing combination of job and education knowledge on business processes and problems. One of the inherent skills of future worker is the ability to use Information and Communication Technologies (Baker et al., 2005). For instance, today, graduated students have a certain amount of knowledge to work at business companies which now swiftly becoming antiquated (Business Roundtable, 2005). In this line, Dede (2007) assumes that near future holds the tendency of own business and students will prefer to work for themselves, that requires fast adoption in learning new skills and continuous improvement in ICT to be effective entrepreneurs.

Consequently, the importance of this PhD thesis comes from the fact that it focuses on highly relevant issues for learning environments. Particularly, the role of ICT in educational settings have acquired a remarkable importance in the last years, covering strategically aspects of the education sector. Thereby, we attempt to contribute to the improvement and

development of education environments by introducing two concepts of ICT-enabled education: simulations and gamification, in case of properly applied, the learning process may become more dynamic, cognitive, and ludic and engaging (Aranda et al., 2016). In this way, it can stimulate the acquisition of new skills in entrepreneurship that can foster creation of new startups by future entrepreneurs in the context of growing uncertainty of the 21st century. Thus, this research provides innovative and relevant insights for educational organizations aspiring in effectively engaging information technologies to the learning process.

1.1.3. Scope of the Research

The present PhD thesis examines the role of ICT in educational environments. To this aim, we explore ICT-enabled education capabilities considered persuasive for integration and dissemination of simulations and gamification across the learning environments. Moreover, we synthesize the relevance of computer simulations and gamification in business education for high school students, which have not yet oriented in their professional career. However, there is a dearth of research focused on computer simulations and gamification in high school curricula, especially considering their influence on attitude of the students towards entrepreneurship.

This PhD thesis is oriented towards the combination of ICT-enabled education concepts: simulations and gamification to analyse how entrepreneurship orientation attitude is affected, when high school students participate in a gamified business simulation. This thesis attempts to be a nascent contribution to a new educational paradigm, where the role of ICT become preponderant.

Once delimited the scope of the study, we reveal the questions that we attempt to clarify through it.

1. What is the role of ICT-enabled education in learning environment? Why simulations and gamification are important aspects for education system?

2. Does participation in a complete gamified business simulation cycle influences the entrepreneurship attitude of high school students?
3. Are there significant differences in the influence of participating in a gamified business simulation in the different dimensions of the entrepreneurship attitude?

1.1.4. Objectives of the Research

The overall and main objective of this PhD thesis is to examine the impact of ICT-enabled education in learning environments, exploring gamified business simulations potential in entrepreneurship orientation attitude and resulting benefits for education system particularly teaching staff and students in utilizing innovative ICT-enabled education strategies. In particular, this thesis based on a research study, which presents an investigation performed at 28 public high schools in Spain with the participation of around 1000 students from ages 16-18.

For such aim, chapter two introduces a detailed and vast literature review on:

(a) Information and Communication Technology (ICT), distinguishing its role in learning environment.

(b) Gamification, introducing the concept, describing characteristics and features from education perspectives.

(c) Simulations, providing insights definitions and/or explanations of key processes and highlighting the implementation importance for learning purposes.

(d) Innovative learning strategy, enabled by the capacity of ICT in complementing traditional education system oriented on entrepreneurship.

In the third chapter, the objective is to present the methodology and the results of the research study that have been obtained through a specific experience of blending two concepts of ICT-enabled education for high school students in Spain. This study is denominated "*Effects of gamified*

business simulations on entrepreneurial attitude at high school level", and focuses on the role of ICT-enabled education at entrepreneurship level of high school students with basic knowledge of business and economics subjects.

The objective of fourth and fifth chapters is to analyse the conclusions and implications attained from the results of the research study described in chapter three. Limitations and future research lines are presented in this chapter, as well.

1.1.5. Outline Structure of the Research

Apart from the current introductory chapter, the PhD thesis includes three more chapters, in which we develop the main idea of this study more specifically to finally, summarize the conclusions in the last chapter.

Chapter two aims at ensuring a comprehensive and vast literature review on the main topics of this thesis. Firstly, the chapter introduces the concept of ICT-enabled education and describes its potential for innovative approaches in learning environments. Furthermore, it describes the features and characteristics of ICT-enabled education based on a relevant and significant European Commission Survey.

Secondly, chapter two conceptualizes the role of two concepts represented as tools of ICT-enabled education: Gamification and Computer-based simulations in learning environments. Principally, it introduces the concept of gamification by providing insights definitions, as well as explains the core principles, highlighting the importance of gamification for learning and motivational purposes.

Further, it describes the features and functions of Computer-based simulations as a tool for enabling efficient development of learning process to increase students' interest.

Thirdly, it introduces an entrepreneurship attitude orientation considering it as a crucial topic in business and economic research; intending to extend the knowledge frontier of business simulations in conjunction with gamification as entrepreneurship drivers/enablers. This chapter also

describes specific strategic orientation, which still officially has not been accepted in traditional education system, but with enormous potential to contribute to the modern education system in near future by introducing information and communication technology to foster entrepreneurial orientation of students.

Chapter three aims to provide the research methodology and the findings obtained from the study performed, which is presented in this PhD Thesis. For such purposes, this chapter presents the methodological approach and the results emerged from the research study *"Effects of gamified business simulations on entrepreneurial attitude at high school level"*. Particularly, which by following an empirical analysis examines the entrepreneurial attitude of high school students on the basis of the Entrepreneurship Attitude Orientation (EAO) scale through the participation of students in a gamified business simulation.

Finally, chapter four and five, aims to analyse the major conclusions as well as the implications emerged from the study presented in chapter three of the thesis. To conclude, this chapter presents limitations of the study and future research directions.

Chapter 2

Theoretical Framework and Review of the Literature

2.1. ICT-enabled education: Features and Characteristics

2.1.1. Introduction

Describing the impact on high and middle-level management, Leavitt and Whisler (1958) for the first time introduce the concept *information technologies*, which is composed of several related parts. The first relates to techniques for expeditious manner on the processing of information in a large amount resulted from the use of computers. The second part is based on implementing statistical and mathematical methods concerning the decision-making issues by using mathematical programming and operational research methodologies, and last part consists of the simulation of high-level analyses through computer programs. The evolution of communication medium is leading to the extension of the concept of Information and Communication Technologies (ICT).

As a result, Information and Communication Technology is commonly relates to all digital devices in terms of capacities to acquire, store, process and transmit information (Edward Steinmueller, 2000). In this line, UNESCO represents ICT as *"…the tools and the processes to access, retrieve, store, organize, manipulate, produce, present and exchange information by electronic and other automated means. These include hardware, software and telecommunications in the forms of personal computers, scanners, digital cameras, phones, faxes, modems, CD and DVD players and recorders, digitized video, radio and TV programs, database programs and multimedia programs"* (Anderson, 2005). However, since Information and Communication Technology is constantly being improved, different assets are slowly disappearing and/or being taken over by more effective and modernized devices (Ion, 2012).

During the last twenty years the parallel and rapid development of both globalization and technological processes have led to the formation of new global economy in which information, technology and knowledge play a critical role. New global economy, in turn, has significant impact on the multicultural societies (Carnoy, 1993). Contribution to the development of information technology sustain the advancement of all sectors of activity: education, industry, health, defense, production etc. (Leidner and Jarvenpaa,

1995; Devaraj and Kohli, 2000; Melville et al, 2004; Rivard et al, 2006; Basaez et al, 2014; Basaez et al, 2017).

Therefore, the key issues for the countries in order to be prepared for the new global economy are focused on improvement of education systems and raising of education levels. (OECD, 1999; OECD, 2002; World Bank, 2002; OECD, 2003; World Bank, 2003; OECD, 2004; OECD, 2005). From an educational perspective, Information and Communication Technology is regarded as a possibility to contribute to educational change, improve the learning process and prepare learners for new global economy. (Haddad and Draxler, 2002; UNESCO, 2002; McNamera, 2003; Wagner and Kozma, 2005).

Today, Information and Communication Technology (ICT) is becoming an inherent part in learning environments, due to constantly increasing integration processes, penetrating into different spheres of education. On this, national policies on ICT have achieved a determined position in both developed and developing countries (Shanmugaratnam, 2002; Baradei and Baradei, 2004; Paige et al, 2004; Sahlberg, 2007). According to Kearns and Grant (2002), the majority of national ICT policies are focused on the educational sphere by following and achieving its objectives drawing on the prevailing rationales in curriculum development. In this way, Commission of the European Communities (2000) established the objectives, which are called for literacy in ICT for all graduates due to formed challenges of new global economy. Subsequently, School Education Action plan for the Information Economy (EdNA School Advisory Group) and the National Educational Technology Plan (US Department of Education) followed the same idea (Tondeur et al., 2007). The study of Condie and Munro (2007) revealed the positive impact of integration of ICT on the learning and teaching experiences in primaries and secondary schools.

2.1.2. ICT-enabled education in pre-school environments

The process of improving the entire education system, which has been going on for many years, demands the highest standards on the organization of pre-school education and intensifying the search for new, more effective approaches to this process. Innovative processes at the current stage in the development of society, primarily affect the system of pre-school education, as the initial stage of revealing the potential abilities of the child (Shade and Watson, 1990; Schofield, 1995; Wood, 2001; Ko, 2002). The transition to a new qualitative level of pre-school education can be achieved with the implementation of Information and Commutation Technology (Morgan, 2010; Nikolopoulou and Gialamas, 2015).

Some authors argue that ICT in pre-school education provides children with a number of features, functions, and benefits (Passey et al., 2004; Hatzigianni and Margetts 2012). However some of them claim that ICT is able to foster poor concentration of the child, solitariness, impaired linguistic development, etc. (Cordes and Miller 2000; Healy 2003).

According to Plowman and Stephen (2005, 2006) the advantage of preschool learning process is that curriculum can be less prescriptive and it has possibility to use different approaches in study process; learning through play can be more effective rather than formal teaching. In this context, implementation of ICT into pre-school curriculum cannot be similar to primary or secondary education (Campbell and Scotellaro, 2009). Plowman and Stephen (2005) claim that child-centeredness in education process explains the interaction between the learner and ICT in a sense of different activities in free play, with the ability of choice, when and how long to play. However, Terreni (2010) argues that there are no guarantees of child's development or engagement during free play, it is still important the participation of mentors in informing and guiding children.

Wood et al. (2008) define the issues of the integration of ICT in early childhood education that satisfy main constraints of a child-centered approach.

Children related issue based on the educators' opinion.

- First, it is related to children's access and their experience in ICT use, especially at home. It is perceived that nowadays ICT has become a common part of most children's lives. Therefore, those families who have digital devices at home, let their children feel more comfortable with the technology and ability to use ICT (Zevenbergen and Logan, 2008). However, children with the access to ICT only in educational centers are eager to use digital devices. Lee and Houston (1986) affirm that young children are fearlessness and highly motivated in using ICT.

- Second, is related to the skills of children. Specifically, the speed of children in learning and their lack of concern in experimental practices to use ICT. Overall, skills obtained from learning how to use ICT in early childhood, perceived as initial knowledge base for further schooling.

- Third, is related to the desire of children to use ICT. Some educators face the challenge in persuading some children to make other activities instead of cognition of ICT.

Parental related issues.

- In terms of education, the majority of parents acknowledge the usefulness of ICT for their children. (National School Boards Association, 2000; Sutherland et al., 2000)

Issues related to early childhood education educators.

- ICT as learning tools are something unique for children in terms of immediate feedback and the attractiveness of visual and sound features in counterpart to traditional education tools.

- Continuous professional development and more opportunities to practice are necessary for educators in order to feel more comfortable with ICT.

- Location of the equipment in early childhood learning environments should be placed in such way to create "home" atmosphere. Kalas (2010)

suggests that it is easier to integrate ICT into different activities of the curriculum once it is installed directly in the classroom.

- As ICT is constantly developing, the financial resources are the critical priorities.

- ICT serves more as free play for children, rather than as instructional tool. ICT as learning tool is considered when working independently or with peers. Also inclusion ICT in the curricula a certain amount of time.

Figure 2.1. Provide an overview of relevant issues towards the adoption of ICT-enabled education in preschool environment.

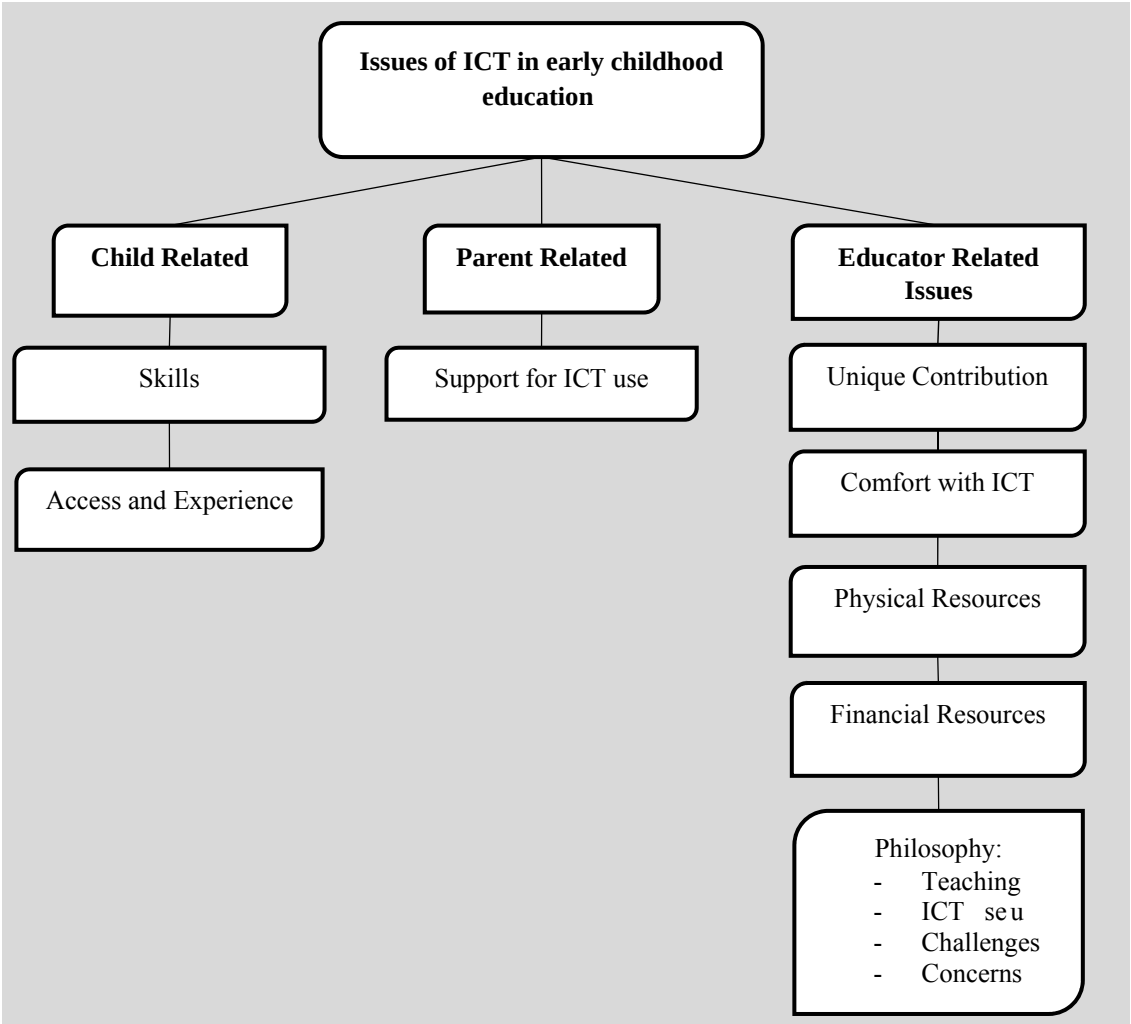

Figure 2.1. Key issues for ICT integration into pre-school education

According to Bolstad (2004) ICT has potential value in terms of children' playing activities via realistic and imaginative socio-dramatic role-play by studying vocabulary and simultaneously learning how to use different forms of ICT. Further, ICT in preschool has possibilities to contribute to problem solving activities as mathematical thinking by processes and manipulation of visual and sound forms, given by screen objects and micro worlds (Kalas, 2010). As well, Clements and Sarama (2003) state that ICT can be a catalyst for social interaction, integrated in informal learning in a form of play in the classroom.

The delicate process of ICT implementation to pre-school environments requires clear understanding of factors that exert influence on it. One of the important factors is the ability and degree of educators' competence in using ICT. (Compeau et al, 1999; Sang et al, 2010). The other factor is the age of pre-school children (Hermans et al. 2008); hence, the grade affects the ability of children to perceive ICT integration into early childhood education. According to Mertala (2016) the age of a preschooler is based on basic knowledge of using digital media devices at home. In this line, some authors affirm the importance of developmental appropriateness concept, which provides the idea of ICT appropriateness, due to scope of pre-school children' development (Siraj-Blatchford and Siraj-Blatchford, 2000; Bolstad, 2004; Kalas, 2010). That implies continuous integration of ICT to the study process, but it should be achievable for learners of a certain age (Kerckaert et al, 2015).

2.1.3. The potential of ICT-enabled education in primary schools

There is no doubt of momentous technological breakthroughs over the last three decades that foster a set of broader social changes, resulting in representation of generation Z (ICT-influenced generation) in primary and secondary education environments for whom, the exciting digital technology as smart phones, the Internet, social networking services, tablets, 3D reality etc. has become routine affaires (Schroer, 2008). Consequently, some educators recognize the need of deep reshape and reconsider the system of

education and its goals (Kalaš et al., 2012). Therefore, the governments of the European countries proclaimed objectives in raising ICT literacy of learners and schoolteachers towards the Digital Agenda for Europe and EU2020 goals (EC-European Commission, 2013; Brecko et al., 2014; Union, 2014).

The variety of international studies on learning environments resulted in common recognition of the realms for which, benchmarks for achieving, use and impact of ICT in schools are necessary, as well as ICT policy initiatives in learning environments (Balanskat et al., 2006; Hunt et al., 2006; Condie and Munro, 2007; Fredriksson et al., 2008). ICT may facilitate the use of educational tools and resources, which in turn have enormous potential of transformation and enhancement in classroom learning, in cases where schools adhere to policies on ICT integration in teaching and learning processes (Tondeur et al., 2008; Majumdar, 2015). According to National Council for Curriculum and Assessment (2007), ICT can be applied to primary education as a complementary approach, where significant proportion of teachers and children can be involved in learning *about* ICT. Becoming aware of ICT may foster successfully use of productivity tools to enhance new ways of teaching and learning *through* ICT, that supports general aim of ICT use in the primary school curriculum, and foster variety approaches and methodologies in teaching (Smeets, 2005).

In primary schools, children commonly use visual-spatial skills (Bull et al., 2008); therefore, one of the crucial aspects is to construct the education through the use of as much as possible illustrative materials, involving children to the process of perception of new information not only by eyesight, but also with audio effects, emotions and imagination (Mayer and Moreno, 2002). ICT-enabled education makes it possible to move from an explanatory-illustrated way of learning to action-related activity, whereby learner becomes an active subject of educational process (Dede, 2008).

Figure 2.2. Adapted from Gannon (2015). Provide a holistic picture of how ICT can be used in teaching and learning process in primary education.

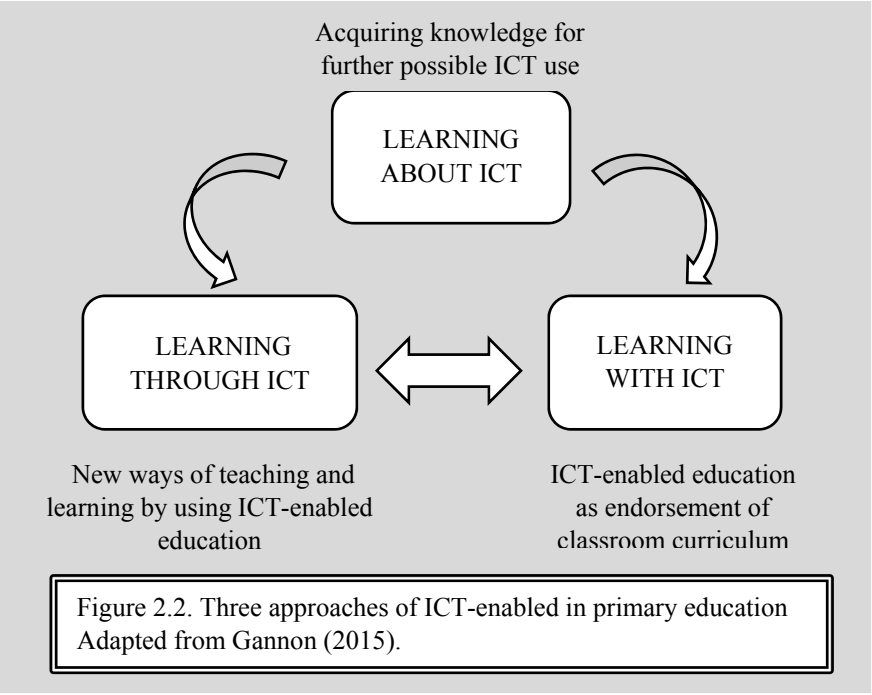

Figure 2.2. Three approaches of ICT-enabled in primary education Adapted from Gannon (2015).

In this line, Pegrum et al., (2013) state that in primary education is observing a constant developing of ICT by introduction of mobile handheld devices as digital media players, smartphones, personal digital assistants and tablet computers by which educators and learners are finding new ways of using them to realize a wide range of learning goals. Moreover, ICT has great potential in parents' involvement to educational process by informing them with the achievements of their children and simplifying communication among parents, teachers and children (Graham-Clay, 2005; Razak et al., 2016).

ClassDojo or *Classcraft* are some of the innovations that foster developing ICT in education (Bicen and Kocakoyun, 2017). These are gamified applications for managing primary and secondary classrooms, covering over thirty five million users targeting to transform the education by digitalization of study process to encourage a positive behavior of learners, providing immediate feedback and facilitating permanent communication between educators, children and parents (Bolick and Bartels, 2014; Da Rocha Seixas et al., 2016). According to Jayaprakash and Chandar (2015), these innovative

approaches of teaching can foster development of children's persistence, curiosity and collaboration in their learning. Besides those schools that combine ICT policies in teaching and learning processes, a competent teacher in technologies is the one who can realize innovative ideas to engage students in the classrooms. (Zhao at al., 2002; Chen et al., 2009).

Figure 2.3. (Adapted from Zhao at al., 2002). Depict an overview of conditions for classroom technology innovations.

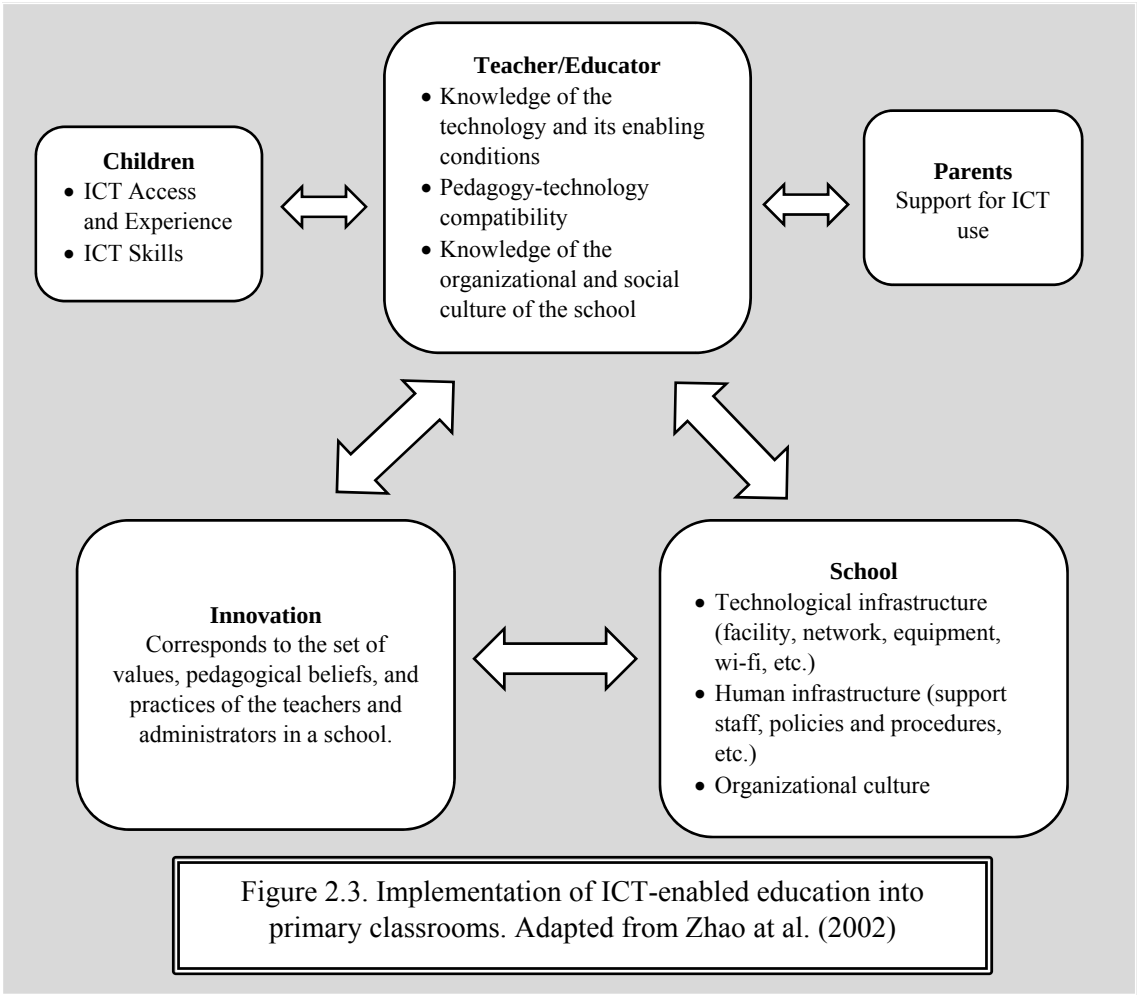

Figure 2.3. Implementation of ICT-enabled education into primary classrooms. Adapted from Zhao at al. (2002)

2.1.4. The potential of ICT-enabled education in secondary and high schools

According to Pelgrum (2001), secondary/high schools are equipped with more quantity of computers in comparison with primary schools, although the latter tends to possess the higher percentage of multimedia computers.

For secondary education system, ICT is not only a vital means that provide learning process, but ability to create new opportunities to enable the acquisitions of independent and cognitive activity of the student (Montrieux et al., 2014). In this regard, the role of the teacher is changing as well, the tutor becomes an agent of change in study process. One of the main functions of the teacher aims to support and develop the ability of students in decision-making, understand the essence of investigated phenomena and ability to reason. In this sense, ICT is emerging as a catalyst, which helps motivate students to encourage aspiration for new knowledge.

Regarding the digital competence of teachers and students and overall utilization of ICT in education, European Commission Directorate General Communications Networks, Content and Technology authorized a Survey of Schools: ICT in Education (EC Survey) to provide a vast analysis of students' and teachers' access, use, competence and attitudes to ICT, together with the impact of ICT school infrastructure on students. (Schoolnet, 2013).

Figure 2.4. Taken from Schoolnet (2013). Provide key elements and features of ICT-enabled education.

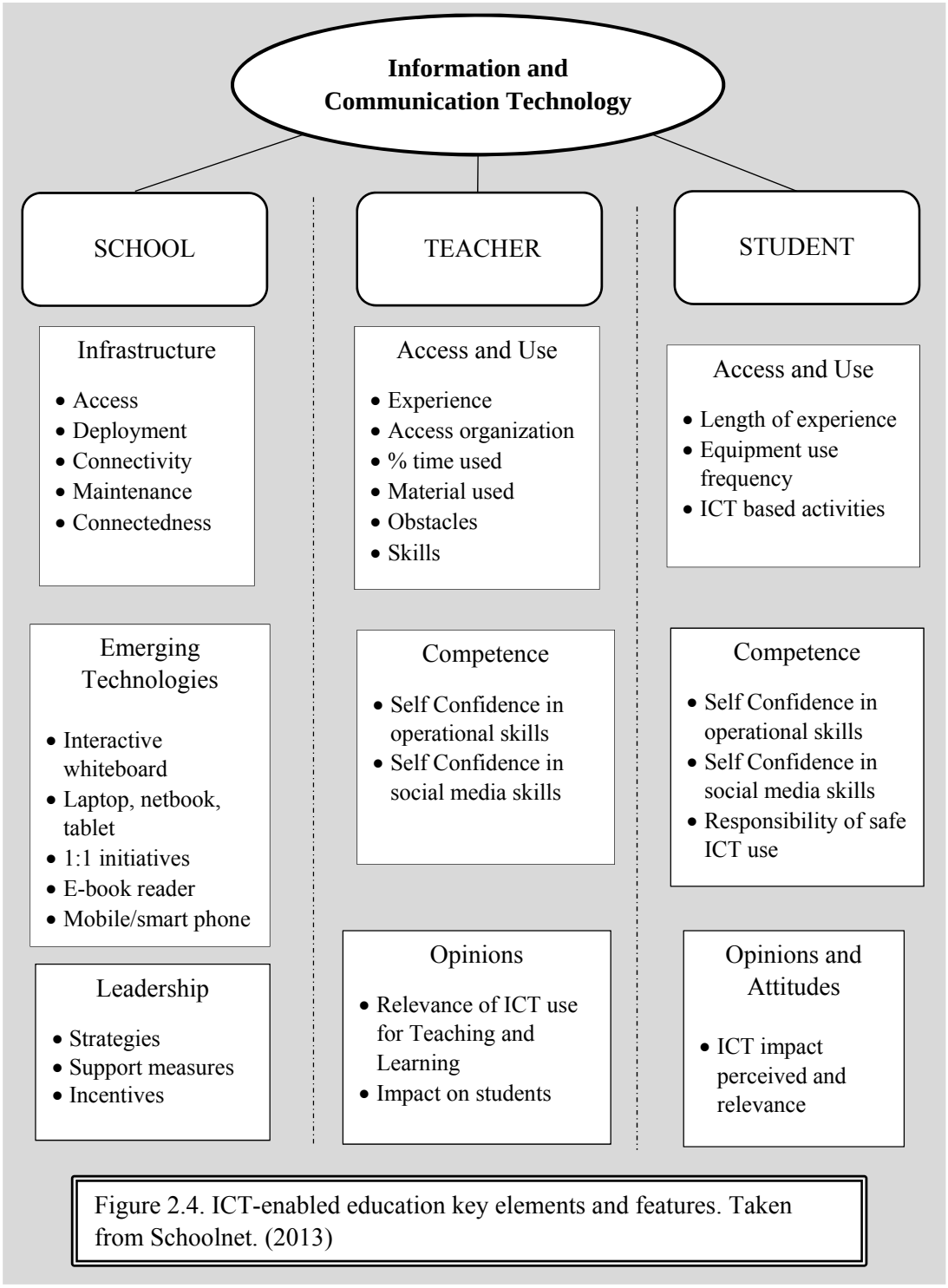

Figure 2.4. ICT-enabled education key elements and features. Taken from Schoolnet. (2013)

ICT School infrastructure and Emerging Technologies research areas determine that the use of laptops, interactive whiteboards and tablet computers are constantly growing in educational process. Moreover,

concerning connectivity, a tablet is considered more convenient in using along with wireless network and wireless data projector, since all students can easily exploit the device during the class (Haßler et al., 2016). Furthermore, there is an emerging body of research shows that implementation of interactive whiteboards into primary and secondary education affects teaching and learning process (Glover et al., 2005; Higgins et al., 2007). The results of EC Survey (Schoolnet, 2013) shows that the average use of interactive whiteboards in European schools is over hundred students per item. However, Greiffenhagen (2004) states that even it has been claimed that interactive whiteboards have potential to transform educational infrastructure, it would be possible only when this technological device would form a part in the regular classroom daily life.

Nowadays, students and teachers have tremendous access to computers in secondary schools, in comparison with the last decade, today schools comprise twice as many computers per hundred students (Schoolnet, 2013). Some classrooms are equipped with iPads (Reid and Ostashewski, 2011) and laptops (Inan and Lowther, 2010), not to mention the fact that almost every school is equipped with the broadband (Belo et al., 2013; Turner-Cmuchal and Aitken, 2016). Generally, computers are still located in labs, but there is a tendency of direct positioning of laptops, notebooks and computes in classroom (Weaver and Nilson, 2005; Passey et al., 2016). The use of tablets becomes pervasive in primary and secondary education, which may positively affect on student behavior (Clark and Luckin, 2013).

Nevertheless, school executives and teachers consider one of the main obstacles to use ICT, consist in lack of equipment, especially laptops and interactive whiteboards in primary and secondary classrooms (Schoolnet, 2013). In addition, no relationship has been found in the EC Survey between high levels of provided ICT infrastructure and student and teacher use and confidence in ICT, and their attitudes toward ICT as defined in Figure 2.4.

Teachers' access to ICT, the use and confidence in ICT research areas show that the majority of teachers are aware of ICT approach in teaching and learning process. However, most of them are using ICT as a tool for preparing the classes and administrative issues; only limited number of

teachers implement ICT in the classrooms, and even fewer use ICT to keep parents informed of their children's learning progress. According to Enochsson and Rizza (2009), newly minted teachers, who usually know how to use electronic devices in their social life, have all necessary prerequisites to teach children through ICT, nevertheless, most of them adhere to traditional way of teaching. In this line, Redecker et al. (2009) state that social media may contribute to high-tech, methodological and organisational innovations in education process to meet new challenges of twenty first century. However, according to the EC Survey (Schoolnet, 2013) educators have more confidence in operational skills and less in social media.

Figure 2.5. (Adapted from Wastiau et al., 2013). Provide an overview of the confidence of teachers in ICT use.

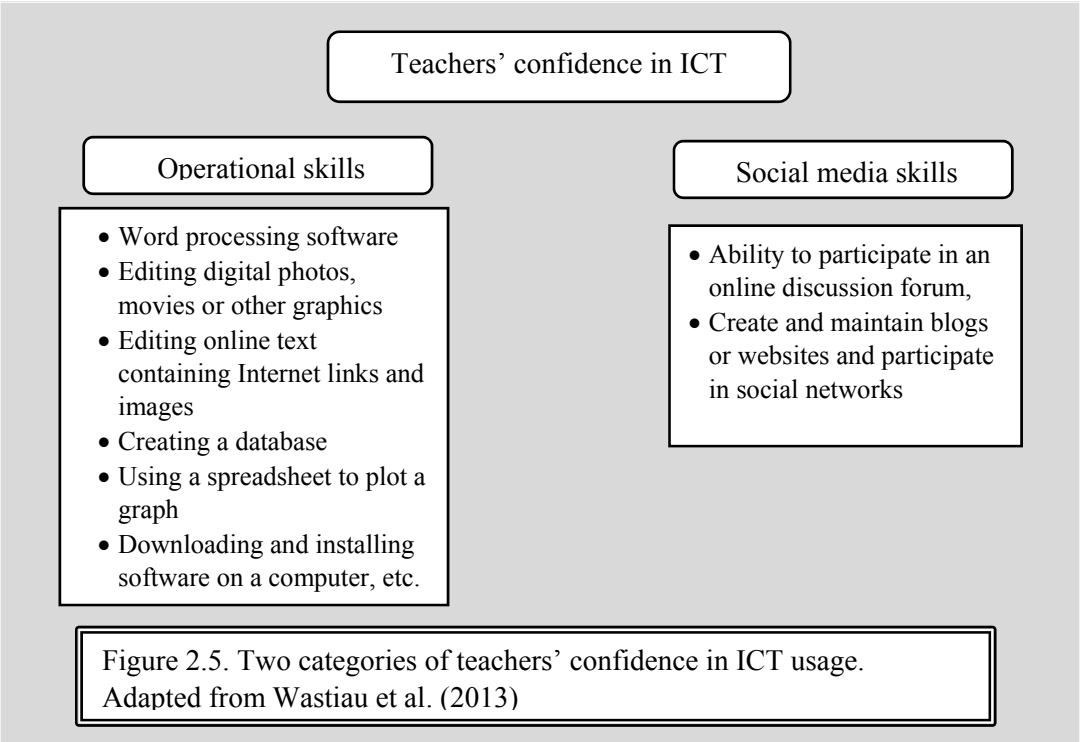

Figure 2.5. Two categories of teachers' confidence in ICT usage. Adapted from Wastiau et al. (2013)

For the moment, a small percentage of the students are taught by teachers, who have compulsory ICT trainings, however the majority of students from primary and secondary schools are involved in learning through ICT with whose teachers who learned about ICT during their spare time (Schoolnet, 2013). Despite the existence of open and accessible online

resources in Europe, only a small portion of such opportunities adopted by schools.

According to Prestridge (2012), there is a relationship between digital pedagogical practice of teachers and ICT use in primary and secondary education. Thereby Valiente (2010) stated that implications of teachers' participation in their ICT development can have significant impact on using them in the classroom. EC survey (Schoolnet, 2013) found that teachers are in favour of informal approaches of trainings, blended learning methods or training that relates to real classroom settings, and cooperation among them is an efficient way for professional development in ICT use. So far, the more confident teachers are in their operational use of ICT and their use of social media, the more they inclined to implement different ICT activities to the classroom (Risinger, 2006).

Following the research study of OECD (2010), there is an express correlation between students' technology use experience and their digital skills and confidence in using ICT.

In the research areas of *Students' access to ICT, the use and confidence in ICT,* the factor analysis has identified four scales, including operational skills, social media skills, ability to use the Internet safely and responsibly.

Figure 2.6. (Adapted from Wastiau et al., 2013). Provide an overview of the student confidence in ICT use.

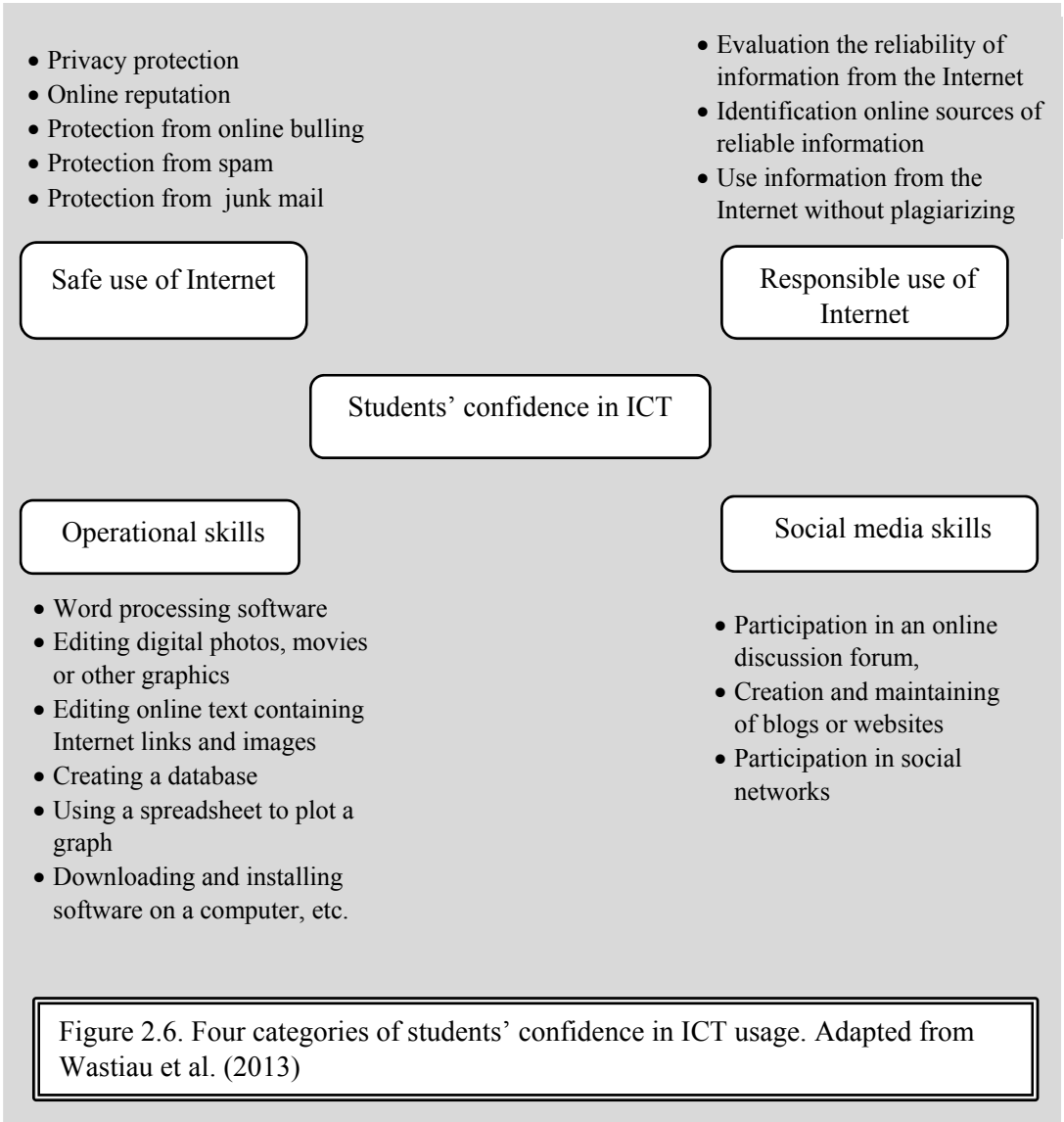

Figure 2.6. Four categories of students' confidence in ICT usage. Adapted from Wastiau et al. (2013)

Participated students in the European Commission Survey (Schoolnet, 2013) considered themselves as very confident in using Internet safely, confident in responsible use of Internet, less confident in operational skills and even less so in social media skills. Students do not so often use computer simulations, online tests or different software exercises, as they would like. Using ICT as learning tools is more frequent at home rather than at school. This finding underlines, that schools have possibility to enhance ICT confidence to students, whilst home provide opportunities to absorb new knowledge using that technology (Pullen, 2015). Therefore, f*lipped classroom*

can positively effect on teaching and learning processes (Tucker, 2012). Bishop and Verleger (2013) define the flipped classroom as *"an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom"*.

According to EC Survey, teachers assert that the average use of ICT based activities in classroom is several times a month, while students' view on ICT based activities differ from several times a month and never or almost never. The reasoning behind that would be the lack of equipment available to every student of the class and teacher-centered prevailing approach, which is still widespread in many educational environments. Across the European countries, the highest rate of digitally confident students is observed in high schools, especially if they have high access to ICT both at school and at home (Schoolnet, 2013).

However, the vast majority of teachers from both primary and secondary education expressed a favourable opinion about appropriateness and crucial impact of ICT to support student cooperation, autonomous work, practicing and other learning processes (Smeets, 2005), as well as the objectives - higher order thinking skills, ability to learn and initiative-taking, entrepreneurial skills, etc. Due to this opinion, it is necessary not to miss the opportunity to provide teachers with every accessible professional development that may foster efficient practice in the classroom at every level of educational process.

2.2. Gamification as potential tool for ICT-enabled education

2.2.1. Introduction

During recent years, there has been considerable market penetration of both, mass consumer software, oriented towards an average user, as turnkey solutions for integrating into corporate systems, which open boundaries between games and other systems and services. This context refers to a phenomenon known as gamification - a trending topic that has already raised significant interest in industry (Kim, 2009; Xu, 2011), as well as, in academia (Stenros and Sotamaa, 2009; Huotari and Hamari, 2012; Werbach

and Hunter, 2012; Hamari et al., 2014). This trend seeks to combine significant amount of existing concepts with the human-computer interaction field of research and game studies (Deterding et al., 2011a). It can be seen as a new paradigm for enhancing innovation with the aim to increase engagement and motivation (Fitz-Walter et al., 2012), and change behaviors and attitude (Jipa and Marin, 2014).

Gamification already has been applied in social networking (De-Marcos et al., 2014), business (Kappen et al., 2013), education (Miller, 2013; Arnold, 2014), learning (Tu et al., 2015), health and wellness (Ramaswamy, 2008). For instance, different companies via social networking services have created the variety of gamified applications to increase program participation of their products by building up communities of social networking service members (Hamari and Koivisto, 2013). In addition, various business companies based on information technology, such as Microsoft and SAP have implemented gamification in order to improve users' experiences by motivating them in monotonous work (Schacht and Schacht, 2012). Nike in cooperation with Apple provided a gamified service to motivate people to run (Ramaswamy, 2008).

2.2.2. Gamification

Deterding et al. (2011b) advocate that the first introduction of a new phenomenon "Gamification" was in digital media industry and its officially documented use dates back to 2008, however it did not gain popularity until several industry players and relevant conferences started the promotion of its widespread adoption. As the interest in the topic has increased over time, different authors propose alternative definitions of gamification. According to Perryer (2012), *"Gamification refers to the application of characteristics from computer games into nongaming contexts"*. Huotari and Hamari (2012) define gamification from service marketing perspective as *"… a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation"*. According to Domínguez et al. (2013) *"…incorporating game elements into a non-gaming software application to increase user experience and*

engagement". However, the most common definition of the term is *"…the use of game design elements in non-game context"* (Deterding et al., 2011b).

Although gamification is a relatively new concept, its origins go back to the distant past. Nelson (2012) argues that the idea of gamification was already being used by Soviet Union in the early to mid-twentieth century, by motivating the working class, while at the same time avoiding capitalist-style monetary incentives. Workers and factories were able to compete with each other as at individual, as well as at collective levels in order to increase production (Kusluch, 2012) using points and other game-like elements. For instance, symbolic-motivation approach was adopted from the army, the most productive workers or production plants could be rewarded with a medal of the Order of the Red Banner of Labor (Nelson, 2012).

Deterding et al. (2011b) suggest not to define the boundaries for gamification in certain use to avoid the same confusion as with *"Serious games"*, when some authors initially linked the term with only learning purpose, whilst today according to Sawyer's taxonomy, serious games are used in different areas (Sawyer and Smith, 2008). Therefore, non-game context can be anything other than games, for instance education, business, health or social sphere, etc.

Gamification is not intended to design full games; a good design utilizes only those elements of the game, which are perceived useful in the selected context (Deterding et al., 2011b). Whereas serious games are full-fledged and designed for non-entertainment purpose (Susi et al, 2007) with the main task of solving problem by learning and training such as flight simulators or business simulation, etc.

Figure 2.7. Taken from Deterding et al. (2011). Illustrate the differences between Gamification and Serious Games.

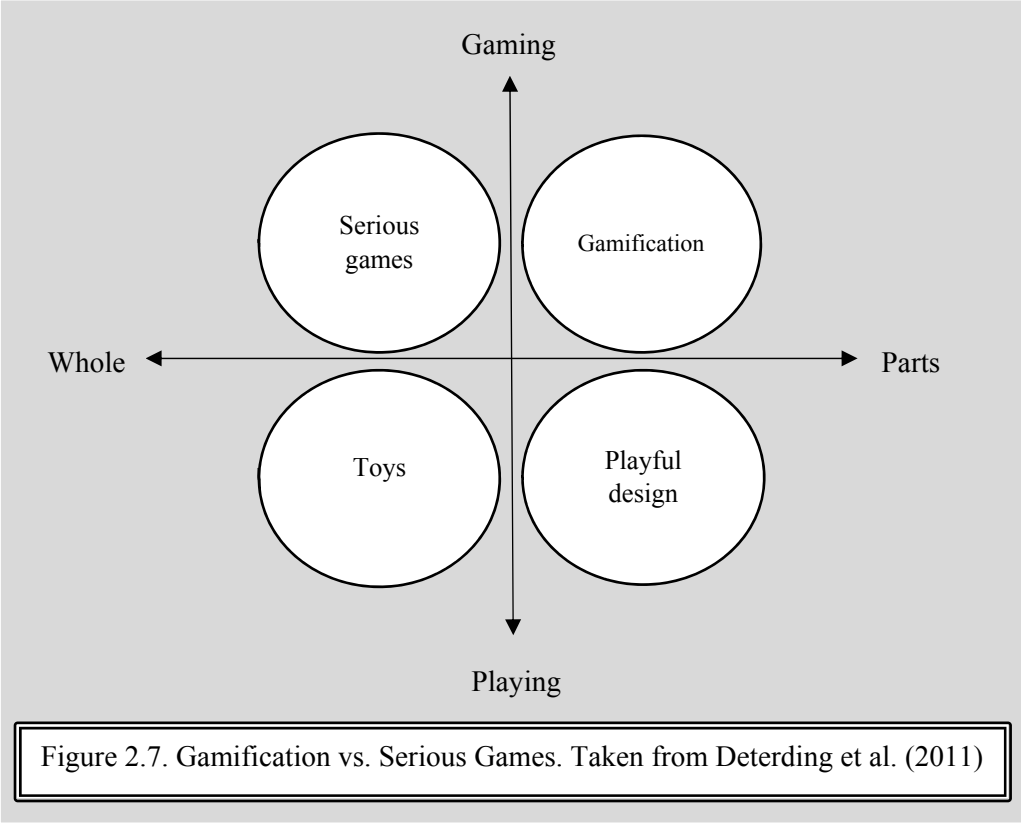

Figure 2.7. Gamification vs. Serious Games. Taken from Deterding et al. (2011)

2.2.3. Games

According to Salen and Zimmerman (2004), as a word "play"relates both for games and for toys, therefore, it is necessary to define the difference between game and play. Caillois (1961) provides a concept that describes *paidia* and *ludus* as two different activities of "play". Paidia (playing) implies more improvisation and free form of behaviors, while ludus (gaming) is characterized by rules and goals (Deterding et al., 2011b).

Suits (2014) identifies three concepts in any game:

- Pre-lusory goal (ludus - gaming), which characterise the existence of an objective of the game;
- Constitutive rules – the limitation that turns activity into a game;
- Lusory attitude – player follows the rules of the game voluntarily.

Summarizing, the term *game* is an activity where participant voluntarily overcoming unnecessary obstacles (Suits, 2014). Juul (2010) defines a game as: *"… a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable".*

McGonigal (2011) combined diverse definitions of games into one and offered four traits that game includes:

- The goal is the specific outcome of the players that has to be achieved by following rules (limitations of goal achieving process), which reveal inspiration of creativity of the participant and encourage strategic thinking.
- The feedback system may occur in a form of points, levels, a score, or a progress bar, and apprise participant in real time how far the achieving goal is.
- Voluntary participation is due to the fact that the participant consciously accepts all above-mentioned traits: the goal, the rules, and the feedback.

Hence, *gaming and games* as distinguished from *playing and toys* are determined by rule systems and the contest of participants towards outcomes. (Deterding et al., 2011b)

Nowadays, the role of video games is not limited only to entertainment, but it also can be rather instructive and informative with ability to motivate users and foster their constant interest (Garris et al., 2002). In this line, Deterding et al. (2011a) argue that implicating game elements into services and non-game products can make them entertaining and engaging.

2.2.4. Game design elements

Deterding et al. (2011b) state that *"serious game"* is characterized as a full-fledged games for the use in non-entertainment environment, whilst *"gamified"* applications exclusively consolidate elements of games; however

the limit between *"game"* and *"artifact with game elements"* can be really diluted. Werbach and Hunter (2012) state that the majority of social online games and non-game services are using the same elements in their systems. According to Zichermann and Linder (2013), the most demanded are points, badges, leaderboards, which serve to satisfy the needs of the users and motivate them in order to obtain subsequent outcomes. Game design elements considered as key factors that significantly contribute to the development of gamification scenarios (Werbach and Hunter, 2012).

Figure 2.8. Provide the key factors in a form of pyramid as enablers for development of gamification scenarios.

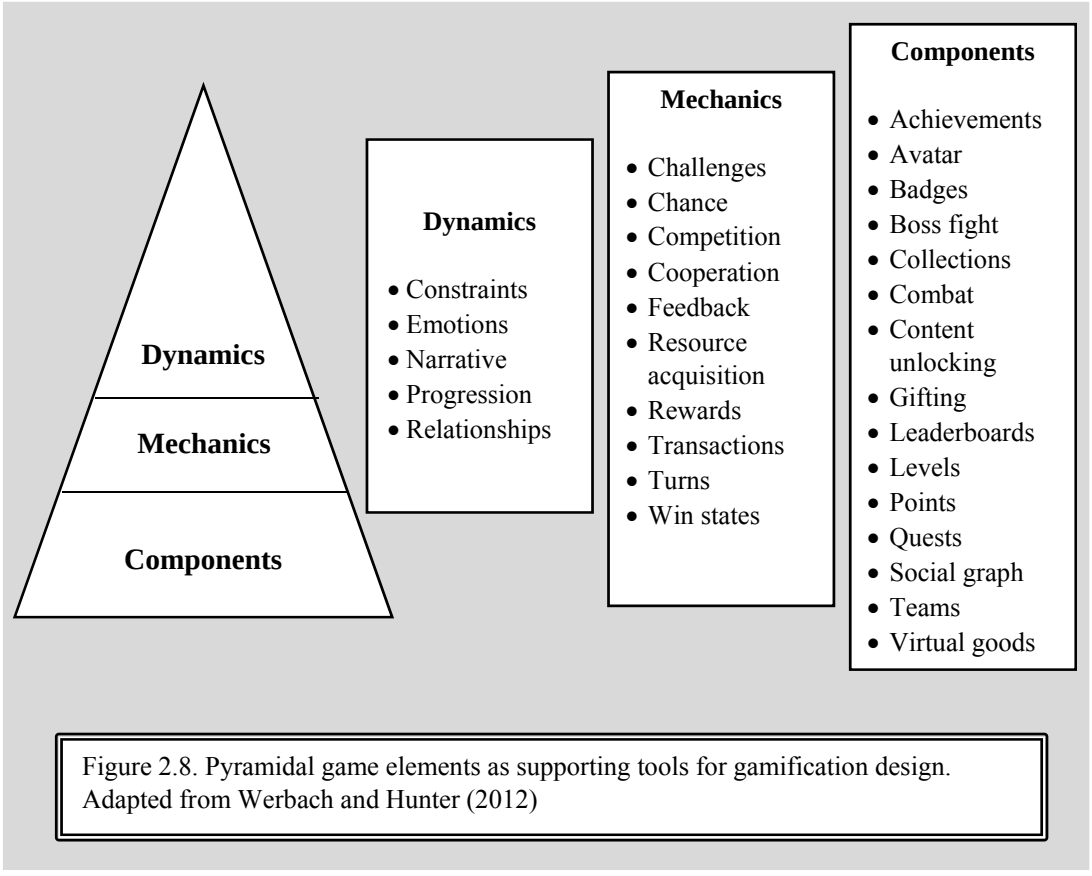

Figure 2.8. Pyramidal game elements as supporting tools for gamification design. Adapted from Werbach and Hunter (2012)

These key factors can be divided into three categories in a form of pyramid: dynamics, mechanics and components that connected with each other in decreasing order, where each mechanic ties up with one or several dynamics and each component links with one or several mechanics or dynamics (Werbach and Hunter, 2012). The most meaningful component of gamification with the highest level of abstraction is *dynamics*. *Mechanics*

remain the basic level of the gamification process and *components* represent specific forms of elements, which emerge from the mechanics or dynamics (Werbach and Hunter 2012). For instance, achievements (components) provide the player with the rewards (mechanics) that, in turn create a sense of progression (dynamics).

However, gamification is not only about game elements. A good game design involves thinking about problems in a certain way (Werbach and Hunter, 2012). For example, the international design firm and innovation consultancy IDEO in collaboration with Ford's internal team presented the *"SmartGauge"* project for Ford's hybrid cars. It is a car dashboard, where a digital plant depicts the fuel efficiency corresponding to the driving behavior. The design provides a visual reward by showing an image of growing leaves of a plant when driving efficiently (Young and Birrell, 2012). This bonus feature influences the behavior of drivers by making them drive more efficiently affecting in both in an environmental and a material way.

2.2.5. Players

It is fair to say that today's modern society is not only rich by the variety of cultures, but it is also diverse with different generations. However, according to Reeves and Oh (2008) there is noticeable difference among various authors regarding what period should cover any single generation:

The Baby Boomers (1943 –1965) approximately

Generation X or Gen – Xers (1960 – 1977) approximately

Generation Y or Digital Generation (1976 – 2000) approximately

Generation Z or ICT-influenced generation (1995 – 2012) approximately

Prensky (2001) claims that, those who were born after 1974 went through transition from analog to digital technology and are able to think faster and comprise multitask due to playing computer games and using ICT. As far as ICT-influenced generation was born in higher levels of technology, playing video games, using mobile handheld devices and internet have already

become essential part of modern life. In this context, Zicherman and Linder (2010) state that, for this generation, it is not simply a matter of staying active online, or to be connected to social network services or using ICT in general, moreover, they are engaged to all of these activities via digital games. Video games cover all demographic ages, starting from young children and teenagers (Dahl et al., 2009; Radoff. 2011), continuing with average player of thirty-seven years old (Ferrara, 2012) and concluding with the players of fifty years and older (McGonigal, 2011).

To comprehend what motivates individuals to play games, Bartle (1996) offers a model of different types of players based on Multi User Dungeon game and categorize players by four aspects, which in turn compared with the four symbols of traditional game pack of cards:

- Achievers (Diamonds) – within the game concept players set in-game goals for themselves and do everything possible to achieve them.
- Explorers (Spades) – players try to learn as much as possible about the game and landscape.
- Socializers (Hearts) – players use communication tools for role-play games through communication with other players.
- Killers (Clubs) - Imposition upon others, players use the features of the game in order to cause distress.

Notwithstanding the fact that individuals often shifting from one to another aspect in accordance with their mood or style of a game at a certain period of time, the majority abide by one dominant style (Bartle, 1996).

Figure 2.9. Identifying four types of players in games from the perspective of Focus and Game activities.

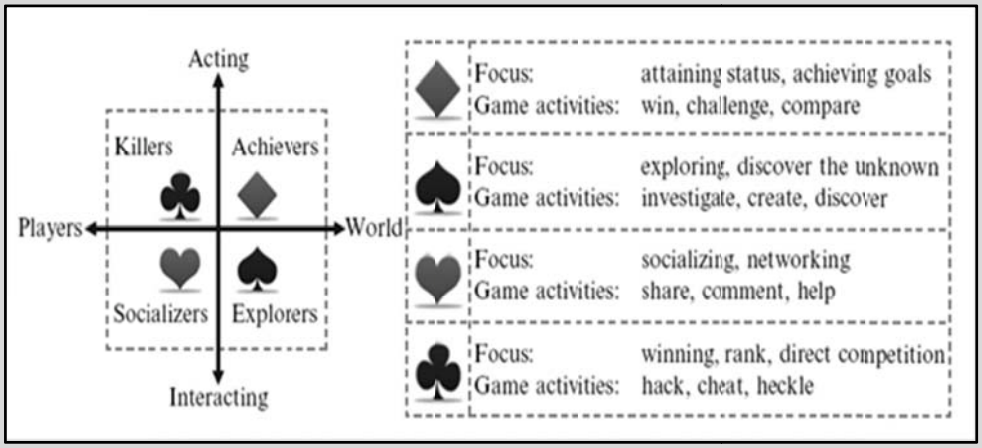

Figure 2.9. Bartle's model categorizing four types of players.
Taken from Schacht and Schacht (2012)

Furthermore, Kim (2011) took Bartle's model as a starting point to understand players' motivation by overlaying social actions from the process of playing games and provided a model of Social Actions, which can be useful for designing gamification.

Figure 2.10. Illustrates how social actions can overlaying on four type of players

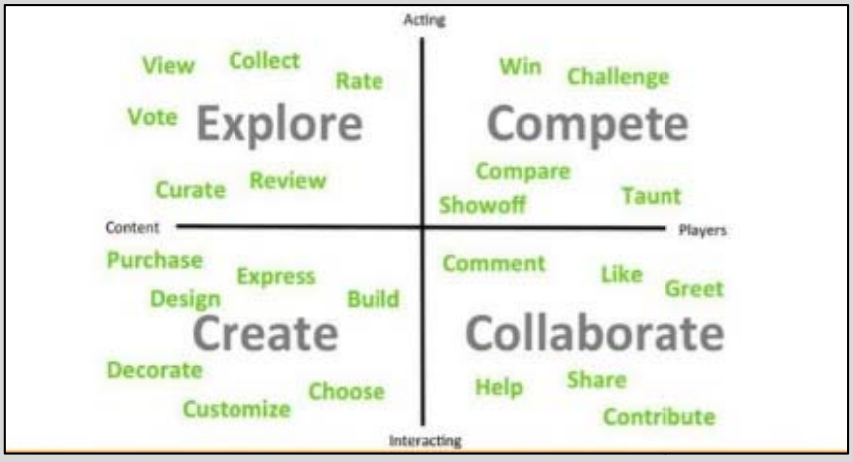

Figure 2.10. Kim's model of Social Actions towards Gamification
Taken from Kim (2011)

2.2.6. Gamification enhancing motivation

There are many theories about motivation; one of them is a well-known Abraham Maslow's (1943) hierarchy of needs with meta-motivators on the top. For better performance and personal satisfaction three elements of meta-motivators have been adopted by Pink (2011): autonomy - willingness to be self-directed; mastery - willingness to improve our skills at what we are interesting already; and purpose - willingness to do things in service of something larger than ourselves.

Figure 2.11. Taken from Ryan and Deci (2000). Taxonomy of human motivation.

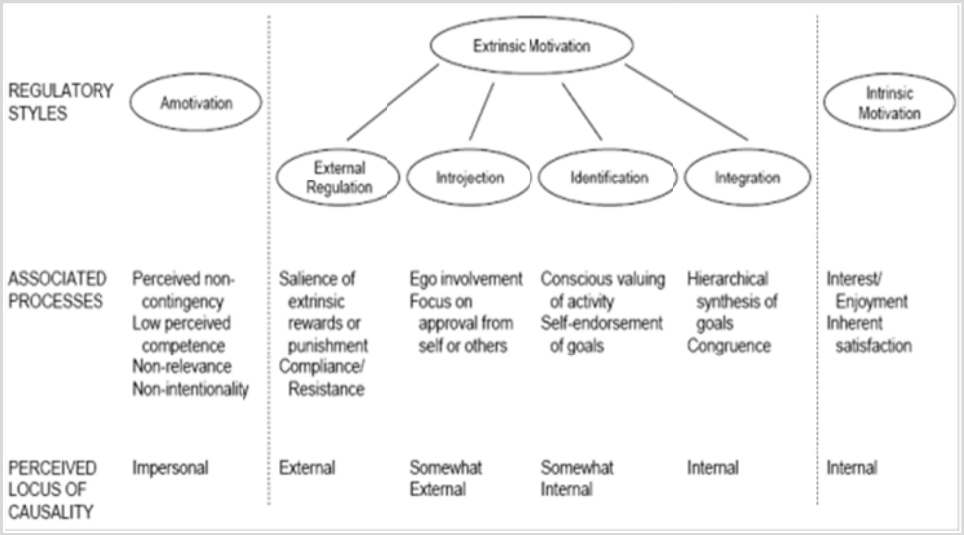

Figure 2.11. Taxonomy of Human Motivation. Taken from Ryan and Deci (2000).

Those who are energized and feel active until the end can be characterized as motivated while those who are out of inspiration are considered as unmotivated (Ryan and Deci, 2000); it varies in how much motivation there is (level) and in the type of motivation (orientation). There are two types of motivation distinguished in Self-determination theory developed by psychologists Ryan and Deci (2000): extrinsic and intrinsic. Intrinsic motivation does not associate with external circumstances, but only with the actual content of the activities. Extrinsic motivation is not related to the content of a particular activity, but to external circumstances with respect

to the subject (Ryan and Deci, 2000). For instance, according to Deci et al. (2001), student can be highly motivated in reading due to enjoying the process (intrinsic motivation) or the student possibly interested only in a physical reward such as pizza party for reading a book (extrinsic motivation).

Intrinsic motivation drives a positive effect on personal performance as long as appears extrinsic reward that reduces the value of activity and offends social meaning. In this context, Snyder et al. (2010) state, while performing any activity, in particular, when one is devotedly complying with the activity for intrinsic purposes occur a state of *flow*. In other words, almost everyone experienced losing track of time while doing something, for instance playing video games, working, talking on the phone etc. Csikszentmihalyi (1991) claimed that *flow* is a state of mental condition in which a person is fully integrated into the process. To achieve the state *flow* a person should be intrinsically motivated (Csikszentmihalyi, 1975). Therefore, intrinsic motivation is expressed in experiential state, which occurs when a person uses own skills and abilities on conditions that clear goals, immediate feedback, and perceived fit of skills and challenges are provided (Keller and Bless, 2008).

Table 2.1. Adapted from Xu (2011). Illustrate Csikszentmihalyi's Flow Conditions and Characteristics.

Conditions of Flow	***Description***
Clear tasks	Individual is aware of the mission to complete
Feedback	Individual is provided with clear and immediate feedback showing what succeeds and what fails
Concentration/focus	Individual is not distracted and can fully follow the task
An attainable, balanced goal	Goal is challenging and within their abilities to complete
Characteristics of Flow	***Description***
Control	Actions of individual have direct impact on tasks. Ability to control the outcome.
Sense of serenity	Complete focus on the task leaves little room for feeling self-conscious or doubt. Often described as becoming a part of the activity.
Timelessness	Perception of time is distorted. Seconds can feel like minutes, minutes like hours. Yet, time also passes by quickly, unnoticed.

Table 2.1 Conditions and Characteristics of Flow. Adapted from Xu (2011).

According to Csikszentmihalyi (1991), without attained conditions it is almost impossible reach the flow; characteristics in turn, appear while a person experience the flow, even if individual is not aware of it. This process is distinguished by activity concentration, full involvement and focus on success during the activity (Xu, 2011).

Another important condition of flow is an equable and achievable goal for individuals' ability. If the task is very easy without any challenge, or it takes too much time to be accomplished, or it is too hard to be solved an individual becomes bored and quickly loses interest. At the same time eventually the better skills individual acquires the more complicated challenge should be.

Figure 2.12. Taken from Keller and Bless (2008). Illustrate the optimal condition of flow between Anxiety and Boredom.

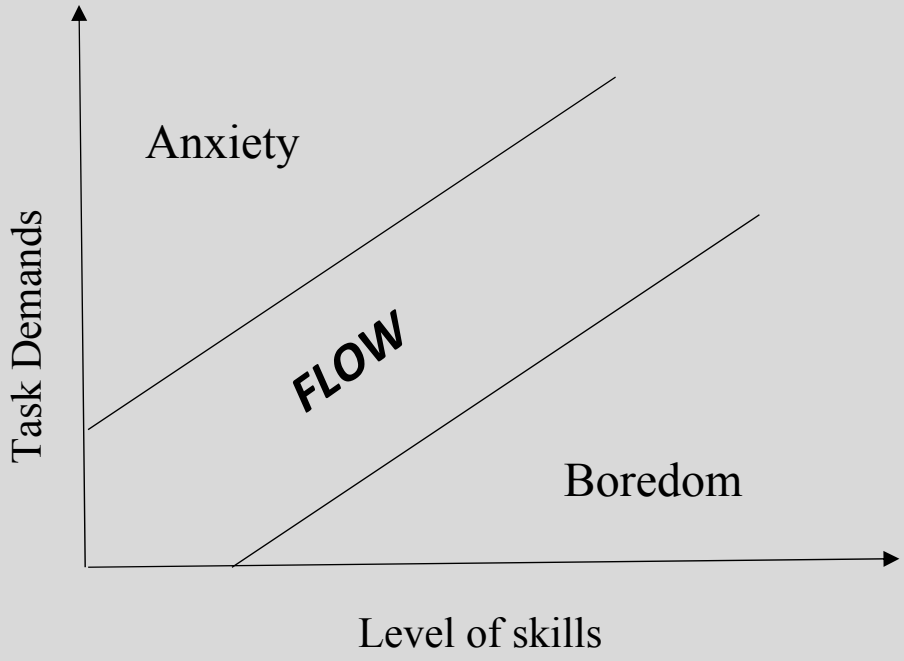

Figure 2.12. Optimal condition to obtain a state of flow. Taken from Keller and Bless (2008).

Successful implementation of Gamification provides and creates experiences involving a sense of flow; initial target is motivation that aims to foster behavior change (Hamari and Koivisto, 2013). Several companies of

gamification designing proclaimed that values as motivation, participation, engagement, fun, and customer behavior can facilitate improved productivity and customer retention (Llagostera, 2012). For instance, Siemens Shared Service Center in India provided a "Formula 1" gamified system for their employees to increase productivity and customer satisfaction. The idea of gamification was to engage employees to work in teams with provided daily competition. Results showed great team spirit of highly motivated participants plus quality and productivity of the company was immediately increased (Sommerer, 2013).

2.2.7. Gamification as a determinant for Behavior change

To find out what affects people on changing their behavior, Fogg (2009) proposed Behavior Model (FBM), drawing upon three fundamental factors that should occur at the same moment of time to effect on behavior change: motivation, ability, and a trigger. Every dimension of FBM model has its subcomponent. Motivation has three core motivators: pleasure/pain, hope/fear. Ability is driven by six simplicity factors: time, money, physical effort, brain cycles, social deviance and non-routing; and three behavior triggers: spark, facilitator and signal.

In addition, FBM perceives motivation and ability as trade-offs. For instance, gamified experiment en Sweden "Speed Camera Lottery", the idea was the use of speed traps to identify over speeding and within the speed limits vehicles. Those drivers who drove according to the rules became automatically participants of lottery funded by the fines. (Zichermann and Cunningham, 2011). According to FBM model the idea of the experiment was an attempt to effect on drivers' behavior – to drive slower; there was also a motivation – win lottery ticket; and the trigger was as a lottery sign on camera fixture. The experiment effected on drivers' behavior; speed was dropped by an average 20 percent.

Figure 2.13. Taken from Fogg (2009). Illustrate factors and subcomponents of Fogg's Behavior Model.

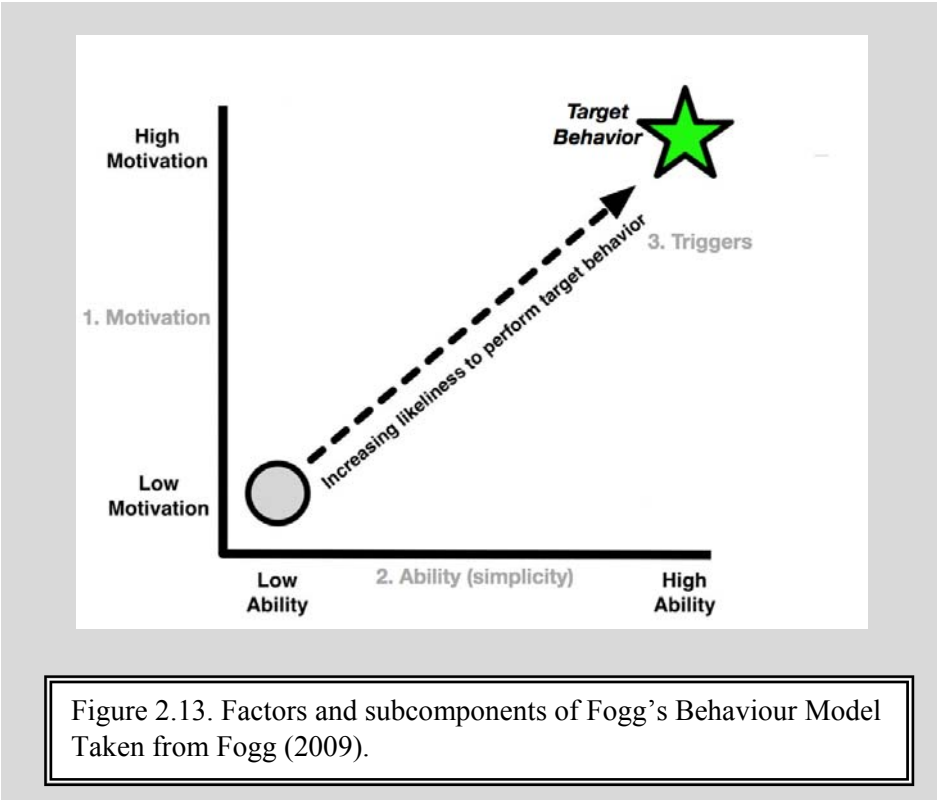

Figure 2.13. Factors and subcomponents of Fogg's Behaviour Model Taken from Fogg (2009).

The end-goal of gamification (Hamari and Koivisto 2013) in conjunction with persuasive technologies (Fogg and Eckles, 2007) is the impact of customer behavior. Persuasive technologies are defined as interactive computer technology designed to voluntary affect the attitude and/or behavior of the user, commonly via social influence (Fogg, 2002). The difference is that persuasive technologies straight affect attitude and/or behavior and gamification initially tries to affect motivation and only than behavior (Hamari and Koivisto, 2013).

2.2.8. Elucidating Non-game context: Gamification from education perspective.

It is difficult to deny that educational institutions have already use some game – like elements, for instance school marks can be equivalent to *points* or advancing from one grade to another by the end of each year is *leveling*, etc.

Yet, in practice, the latter game-like elements have no major impact as video games concerning motivation and engagement (McGonigal, 2011).

In traditional education, a student's motivation to higher academic achievements can be hampered by certain reasons, as fatigue in the classroom or lack of interest or, even being distracted by mobile handheld devices (Campbell, 2006). However, some authors admit that there is a crucial impact of ICT on students (Purcell et al., 2013; Kim et al., 2014) and suggest using it in favor for learning outcomes (Robson, 2003; Fang, 2009). In this context, Huang and Soman (2013) argue that correctly implemented gamification technique in educational environment has possibility to transform the dissemination of knowledge into engaging learning process; where data collection of students, as well as their monitoring advancement processes are automated and computer software keep detailed record of every participant in gamification (Kiryakova et al., 2014).

Some authors (Silva, 2010; Muntean, 2011; DomíNguez et al., 2013; Simões et al., 2013) state that gamification can positively effect on students' motivation and engagement in E-learning education based on ICT, by using the same approach as in video games: focusing on the goal by overcoming the obstacles and monitoring the progress, which is crucial factor for tracing every achievement.

A broad spectrum of areas in education have already attempted to implement gamification to study process, particularly in foreign languages (Flores, 2015), science (Morris et al., 2013; Rouse, 2013), medical education (Nevin et al., 2014), mathematics (González et al., 2014), computer science (Ibáñez et al., 2014), business and management (Reiners and Wood, 2014; Schacht et al., 2014), etc.

2.3. Simulations as a tool for ICT-enabled education at middle and higher education

2.3.1. Introduction

The adoption of simulations in education has brought flexible, interactive and dynamic designs across all institutions, introducing multiple features and providing new strategies for teaching and learning processes (Geban et al., 1992; Gokhale, 1996). Main benefits come from continually increasing capabilities of simulations, which provide advantages for students' learning, such as feedback, experience, ability to immerse in learning process without physically moving to a learning facility, real time access, a sense of control and ownership of exploration and discovery, etc. (Tversky et al., 2002; Podolefsky et al., 2012). From teaching and learning perspective simulations, deliver high value enabling education to improve efficiency, productivity and innovation, flexibility and collaboration to meet the new realities of employment and competitiveness in twenty first century (Harvey, 2000; Roth and Gros, 2008). As a result, adoption of simulations is turning into a major component in different fields of education (Lunce, 2004; Barry Issenberg et al., 2005; Nickerson et al., 2007; Anderson and Lawton, 2009; Rutten et al., 2012). In fact, in today's information-intensive social environment, simulations become pervasive that they are now considered an expansive learning tool that bridges all industries in a flexible manner (Scachitti, 2009).

2.3.2. Computer Simulations

In the era of information and communication technologies, dissemination of computers as research tools in such areas of education as economy, architecture, science and engineering, has fostered in the broad application of computer-based simulations as a new paradigm of scientific investigation, to complement theoretical studies and experimentation (Pawlikowski et al., 2002; Damassa and Sitko, 2010). According to Jager and Lokman (2000), computer-based simulation is one of the forms of *ICT as a medium for teaching and learning* function of the ICT use in education. Traditional classroom

environment cannot go beyond the theoretical practices; on the contrary, computer simulations enable to model a real-life or hypothetical situation on a computer, which can facilitate immediate feedback, let the learners redesign different scenarios and form their conclusions (Sutherland, 2004).

Computer simulations are becoming advanced resources in all levels of educational institutions, particularly due to their constant and growing evolution and technological development. (McEnery and Blanchard, 1999; Wolfe and Luethge, 2003; Lin and Tu, 2012; Tao et al., 2012). As additional tool computer simulations can facilitate more efficient way for students in learning different subjects, as they are provided with a variety of knowledge, and a medium where they can observe the virtual tasks and able to repeat the same tasks in case of failing (Morgil et al., 2005; D'Angelo et al., 2013). According to De Smale et al., (2015) training and modeling simulations are the most often used types of simulation in academic programs; lately, Aranda et al. (2016) combined training simulation with gamification to analyze its influence on high-school students' attitude towards entrepreneurship.

- Training simulations imitate real-life processes with implemented required conditions to improve students' performance and maximize their efficiency via a computer.

- Modeling simulations create specific environments in which digital prototypes of real model predicting its performance in the real world situations.

- Gamified simulations simulate real-world processes in conjunction with gamification, particularly with game-design elements to motivate students, improve their performance, and maximize their efficiency via a computer.

Figure 2.14. Adapted from De Smale et al. (2015). Provide overview of classification of computer simulations

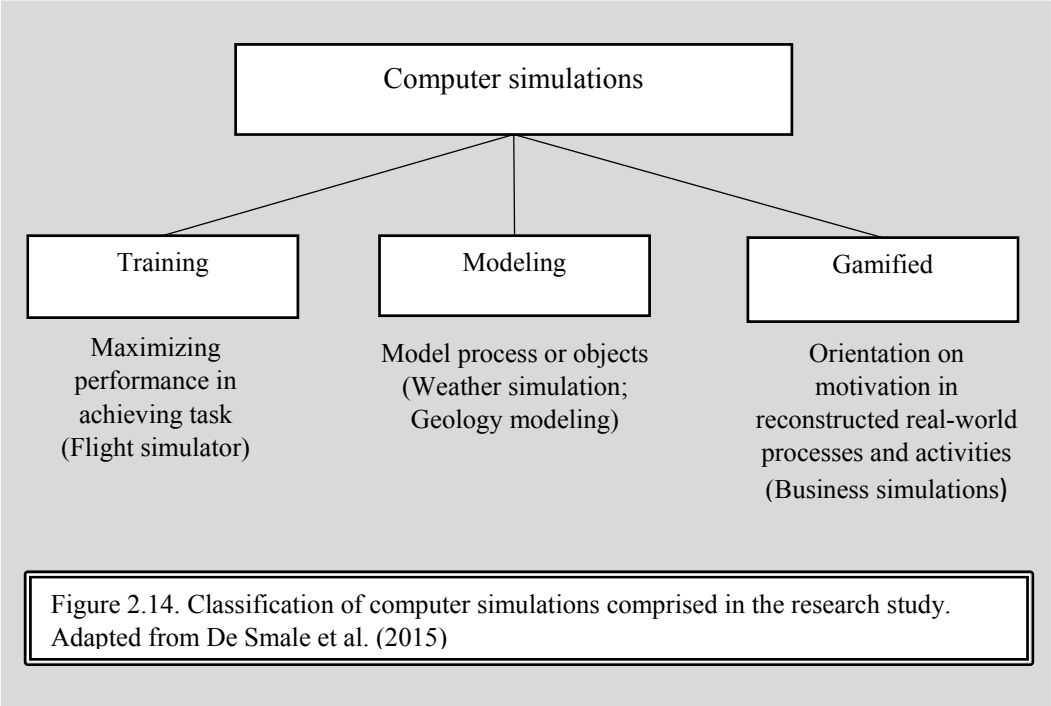

Figure 2.14. Classification of computer simulations comprised in the research study. Adapted from De Smale et al. (2015)

According to the research of Doyle and Brown (2000), the effect of computer simulations on students may transcend the learning process of the "decision and consequence" cycle in a way that enables a more thorough understanding of management. Eventually, participants are keener to undertake future projects especially in the international markets, which are usually included in modern simulation programs and applications (Segev, 1987; Heifetz and Laurie, 1997).

One could thus conclude that business simulations allow students to practice entrepreneurship, as it requires them to apply and create capabilities while acting in a proactive manner in addition to distribute virtual resources (Neck and Greene, 2011).

2.3.3. Business Simulations

Nowadays educational institutions face considerable challenges in students' motivation and engagement. Business simulations become a popular strategy in education that provides specific behaviors by increasing

motivation and engagement of learners (Landers and Callan, 2011). Business Simulations comprise computer technologies for involving students into a comprehensive experience about managing a firm. Specific environments are emulated through these technologies to facilitate the inclusion of individuals into close-to-real scenarios (Bell et al., 2008; Seaton and Boyd, 2008). Consequently, business simulations are developed to impart competences such as attitudes, concepts, rules or skills to improve participants' performance (Salas et al., 2009). They are especially helpful to fill the gap between theory and practice as well as to serve as previous stage for internships or job market.

Simulation as a learning tool improves learning mainly due to the increase of interest and motivation in contrast with theoretical classes (Pasin and Giroux, 2011). This motivation encourages students to think on the long term as the results of their own decisions depend not only on them, but also on the decisions made by the rest of the teams. In addition, simulation experiences generate a double source of learning. On one side, participants learn to anticipate the next decisions of their rivals in the competition in order to obtain a competitive advantage. On the other side, the accumulated experience of previous decisions makes later decisions to be made under a more thorough analysis and understanding of the available data, so results tend to improve as simulation advances.

Robbins (1994) investigated the learning effects of business simulations as perceived improvement of various entrepreneurial capabilities of the participants. They concluded that entrepreneurship education can really be fostered through simulation training. Other recent studies such as Klofsten (2000) points out the need to promote entrepreneurship education regardless of the major areas of study in order to foster new technology-based firms and start-ups.

The effectiveness of business simulation games on entrepreneurship training has not been deeply analyzed in literature with few empirical studies. Business simulation studies tend to focus either on the improvement of realism in simulation tools or on the adjustment and usefulness of

simulations in education and knowledge transfer (Feinstein and Cannon, 2002).

The learning effects of business simulations have been addressed in different studies proving that theoretical and conceptual knowledge is transferred and even better assimilated through the "learning-by-doing" process achieved though simulations (Wolfe and Chanin, 1993; Coffey and Anderson, 2006; Xu & Yang, 2010). In addition, the increase of motivation induced by simulation experiences has been proved in specific contexts compared to classic instructional methods (Stecher and Rosse, 2007). Huebscher and Lendner (2010) found out that simulations have a direct and positive impact not only in entrepreneurship education learning but also in fostering entrepreneurial attitude and sensitivity.

Certainly, simulations are becoming widely used in entrepreneurship education gaining complete acceptance within educators (Haase and Lautenschläger, 2011). The propensity to start a new business has been widely examined in entrepreneurship research, among others, on the basis of the theory of planned behavior (Katz, 1992; Kolvereid, 1996). In this context, perceived behavioral control involves perceived feasibility as a factor of self-efficacy. Self-efficacy has been found to be positively related to entrepreneurial propensity (Fayolle, 2005). Several studies demonstrate that simulation games are effective tools to improve management knowledge by offering additional practical details to the learning setting similar to real world, providing potential entrepreneurs with a broader insight of the entrepreneurial process (Wu and Katok, 2006; Ben-Zvi, 2010; Lin and Tu, 2012).

2.4. ICT-enabled education towards entrepreneurship.

2.4.1. Introduction

There is a shared view that education is considered as future investment for individuals (Psacharopoulos, 1994). According to Angrist and Krueger (1999) future financial success depends largely on the extent of acquisition of

education. There are numerous studies, which bond education and self-employment (Borjas, 1986; Chandler and Hanks, 1994; Holtz-Eakin et al., 2000; Arum and Müller, 2009); and fewer research studies on how the level of education can effect on entrepreneurship (Kangasharju and Pekkala, 2002; Michelacci and Schivardi; 2016). Today, entrepreneurship plays a crucial role in economy (Wennekers and Thurik, 1999), due to its significant micro- and macro-level effects (Henry et al., 2003).

Over the last two decades, there has been growing interest in the topic of entrepreneurship education that foster promotion and development of entrepreneurial orientation as one of the key policy objectives for developed countries in Europe and North America, as well as in rapidly developing countries (Mitra and Matlay, 2004; Naudé, 2010; Bourgeois, 2011). Higher levels of entrepreneurship and more effective ICT are perceived to be the important key elements of economic growth (Sternberg and Wennekers, 2005). European Commission (2012), emphasizes that the particularly attention should be focused on development of entrepreneurial skills, not only because of their possible contribution of new business ideas, but also probable influence on employability of young people as well. Moreover, European countries need to encourage entrepreneurial skills via new and creative teaching and learning approaches including primary education, focusing on secondary to higher education as a career destination (European Council, 2000; European Commission, 2012).

2.4.2. Entrepreneurship Attitude Orientation

Entrepreneurial orientation is, for potential entrepreneurs, directly related to the accomplishment of goals that emphasize aggressive innovation and involve risk (Miller, 1983). The Green paper on Entrepreneurship (EUROPE, 2003) establishes the basis to enhance a positive entrepreneurial attitude in individuals. European programs such as Erasmus for Young Entrepreneurs intend to provide aspiring entrepreneurs with skills to start and run small business in Europe (EUROPE, 2003). Hence, entrepreneurship

is considered a crucial topic in business and economic research in this century (Grant, 1998).

Entrepreneurial education has received an increased attention from literature in the recent years. Peterman and Kennedy (2003) analyse how students' perceptions of entrepreneurship can be influenced after completing a specific enterprise program focused on the attractiveness and implement ability of starting a business. Secondary schools are including contents on management and entrepreneurship in their curricula combining different activities such as student projects, experiments and simulations (Rutten et al., 2012). Luthje and Franke (2002) found that there is a stronger interest to start up high-tech growth companies after graduation among students. Some authors state that entrepreneurial education can positively effect on entrepreneurial activity (Daly, 2001) through improved required instrumental skills, cognitive ability for managing complexities related to recognition and assessment of opportunity (DeTienne and Chandler, 2004).

According to Flash Barometer research on entrepreneurship organized by European Council (2009), the main obstacles to start own businesses for European citizens are:

- Fear of bankruptcy
- Lack of available financial support
- Complexities of the administrative process
- Difficulty in obtaining information on how to start a business.

Along the same lines, Wilson (2008) asserts that individuals of European countries are less likely to take risks due to security conditions of welfare system, as well as education system, which traditionally focused on ensuring students in their future employment probability, and less oriented on entrepreneurship; however, fast development of Information and Communication Technology is changing the nature of work. It implies that education should expand the horizons to prepare students to work in a dynamic, rapidly changing entrepreneurial and global environment (European Commission, 2000).

Nowadays, rapidly changing ICT is directing companies to focus on high levels of innovation and a preparedness to fit into these developments in the shortest terms. In order to stay relevant, the education level of employers and employees should be consistent with higher levels of competency. Solomon et al. (2002) argue, *"Entrepreneurial education must include skill-building courses in negotiation, leadership, new product development, creative thinking, and exposure to technological innovation"*.

The nature of learning relations creates a significant scope, including personalisation of educational process and implementing technology applications and simulations, which has possibility to facilitate new forms and modes of learning and teaching (Glenn and D'Agostino, 2008).

Löbler and Markgraf (2005) state that entrepreneurship education can be effectively applied to constructivist-learning environment. However, there is a major gap in literature between employed and preferable teaching methods, frequently, for reason of higher value of active approaches and their inconsistency with traditional teaching systems (Samwel Mwasalwiba, 2010). It is also been acknowledged that enterprise skills cannot be assessed traditionally as for example essays or business plan submissions, and requires a transition to assessment of practical appliance of enterprise education via experiential, creative and work-based that foster a rethinking of the entrepreneurial educational programme (Penaluna and Penaluna, 2008; Quality Assurance Agency, 2012). There is a need to incorporate, knowing and doing (Datar et al., 2011) to link theory and practice via active learning, meanwhile education should be provided with the efficient application of ICT. However, Oosterbeek et al. (2010) found that there is still a way to go in developing entrepreneurial orientation after analyzing the factors that influence entrepreneurial thinking and attitudes in secondary education.

2.4.3. Dynamic learning relationships

The new era of globalisation, facilitate economic, political and cultural factors, which, in turn, put forward significant challenges for the

entrepreneurial education development (Vinig and De Kluijver, 2007). In this line, Rae (2010) implies entrepreneurial education in the capacity of dynamic learning relationships, which are active, social and connected and provide an overview of key factors that affect current entrepreneurial education, in particular:

- Outcomes and applications of learning
- Purpose of learning
- Content and process of learning
- The role of educators

Figure 2.15. Illustrate how entrepreneurial education influenced by government, environmentalism, technology and changing learners' expectations, as well as by economic and market-oriented changes.

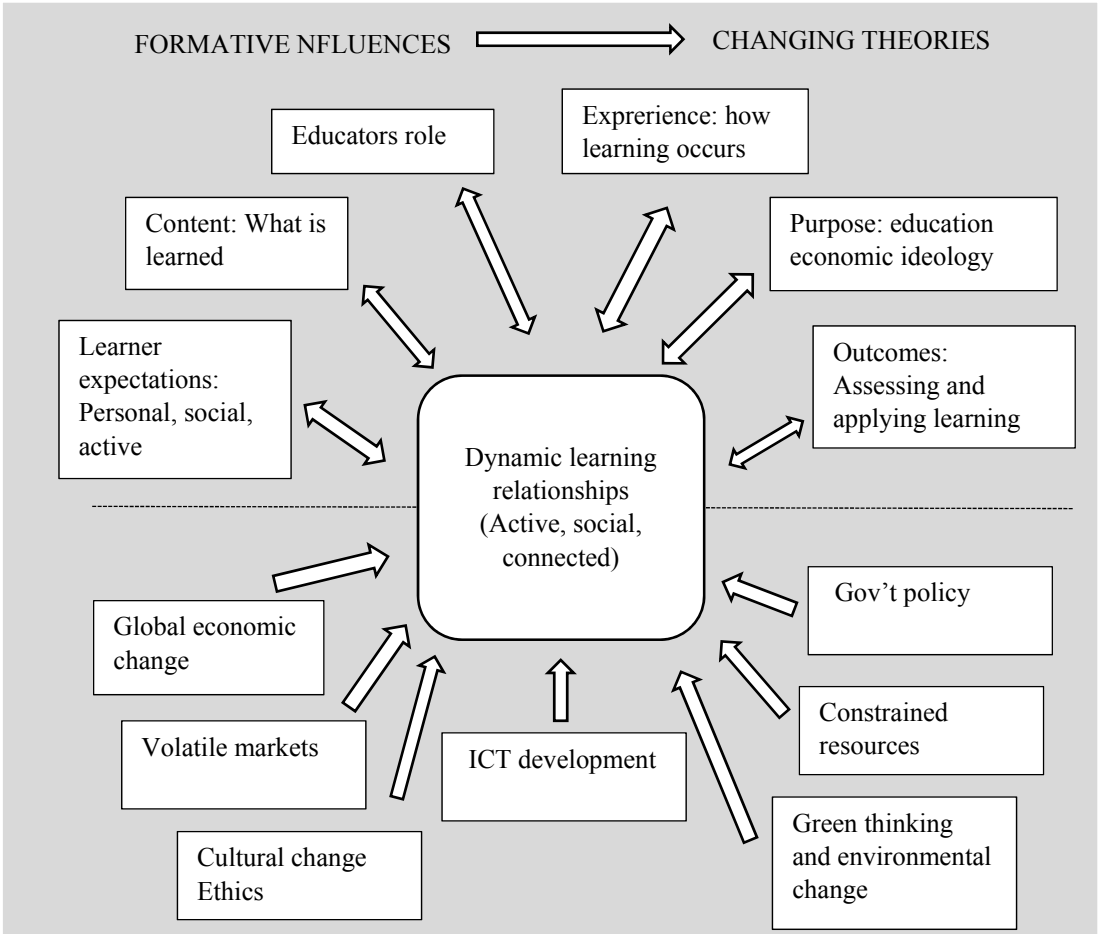

Figure 2.15. The effect of dynamic learning relationships in entrepreneurial education. Adapted from Rae (2010).

In general, optimal distribution of teaching entrepreneurship commonly refers to student-centered, interdisciplinary, process-based, experiential, and socially situated and co-creation oriented approach (Leitch and Harrison, 1999; Harkema and Schout, 2008; Williams Middleton et al., 2014). These approaches, in their turn, correspond to constructivist learning spheres that are closely linked through integrated education, collaborative knowledge creation, as well as, social interaction and immersion (Taylor et al., 1997; Jonassen, 1999). However, the majority of educational establishments still adhere to typical tests, individual work and detached theorisation (Troman and Woods, 2001), that leads to emergence of such problems as students' loss of motivation and early abandonment of schools (Finn, 1989; Marks, 2000).

2.4.4. Cognitive tools in education

Education can be provided through various tools. According to Vygotsky (Rieber and Wollock, 1987) there are three category of intermediary learning tools:

- Material tools
- Psychological tools
- People.

Torres Vigoya (2005) provides twelve main elements of mediation in teaching and learning, based on Feuerstein's mediation criteria, in order to assist students in the development of cognitive strategy:

- *Intentionality and reciprocity* - install the mediation experience purposes within the teaching - learning process.
- *Transcendence* - provide clear, reachable and meaningful objectives and goals and confront students with a variety of real and authentic situations.
- *Significance* – explain the intention of the activities in organised, sequenced and relevant manner.
- *Searching, planning and achieving objectives* - assist students to set up objectives and guide them to achieve the goals.

- *Sense of competence* - create an atmosphere where students have possibilities to develop a positive self-image, high self-esteem and self-confidence.
- *Awareness of change* - inspire students to transform themselves into active, dynamic and autonomous individuals.
- *Novelty and complexity* - facilitate intellectual curiosity, originality, innovation and creativity or divergent thought.
- *Active participation and shared conduct* - encourage students to collaborate with each other to make them socialise, negotiate, agree, respect differences and achieve working in harmony.
- *Regulation and control of conduct* – provide students with all the necessary tools to take control of their own learning and behavior.
- *Individuality and psychological difference* - accept, help and motivate students as unique beings with independent and divergent thought processes with regard to others.
- *Sense of belonging* - promote teamwork with specific and meaningful purposes and create a specific atmosphere where students can interchange academic, social and cultural knowledge.
- *Optimistic awareness* – empower students by helping them to recognise that there is always a solution to any problem.

Van Joolingen (1998) has explored the use of cognitive tools supporting discovery-learning processes, whereas Chen et al. (2008) used cognitive tools to foster students' inquiry-based learning on environmental issues. Cognitive tools usually relate to ICT as computers and mobile handheld devices, which include techniques such as simulation modeling (Resnick, 1987; Jonassen, 2003; Keskin and Metcalf, 2011; Lajoie and Derry, 2013).

Computers are frequently employed as a feature of students' cognitive apparatus to learn and think *"with"* during the process of resolving different tasks (Jonassen, 1995) what may facilitate crucial changes in cognitive skills training ability, and foster higher levels of thinking and engagement (Vygotsky, 1980). In this line, Hogle (1996) considers simulation games, programming games and business management games as cognitive tools.

Kozma (1991) state that the computer is not seen any more as just an intermediate facility of information delivery, but rather as a technology with exclusive capacities to supplement a students' cognition. Jonassen and Reeves (1996) define cognitive tools as *"technologies that enhance the cognitive powers of human beings during thinking, problem solving, and learning"*. According to Pea (1993) learning with computer tools facilitate augmentation of student' cognitive ability, in other words, is what make them smarter. Herrington et al. (2003) argues that implementation of cognitive tools may lead to transformation of classes from static lessons to solving genuine assignments such as those, which are required in real world.

One could thus conclude that, children are able to develop their cognitive abilities starting from pre – school education due to an integration of ICT as informal learning in a form of play. The subsequent roll-out of gamification and simulations as ICT-enabled education tools in secondary and high schools may facilitate students' motivation and their engagement to learning process. Moreover, in case of a proper implementation of gamified business simulations in high school curricula, can foster students' interest in entrepreneurship and enhance motivation for *"Startup"* (Aranda et al., 2016).

In this line, the combination of ICT-enabled education with a systematic framework for entrepreneurship education launched by Ghina et al. (2015) provides innovative learning strategy, enabled by the capacity of ICT in complementing traditional education system oriented on entrepreneurship.

Three aspects determine this framework:

- Fundamental principle is to provide effective learning
- Educational institution coordinates all stakeholders, including itself to accomplish learning goals.
- Educational institution guarantees of students' learning effectiveness.

Figure 2.16. Adapted from Ghina et al. (2015) Provide systematic framework for effective developing of future entrepreneurs.

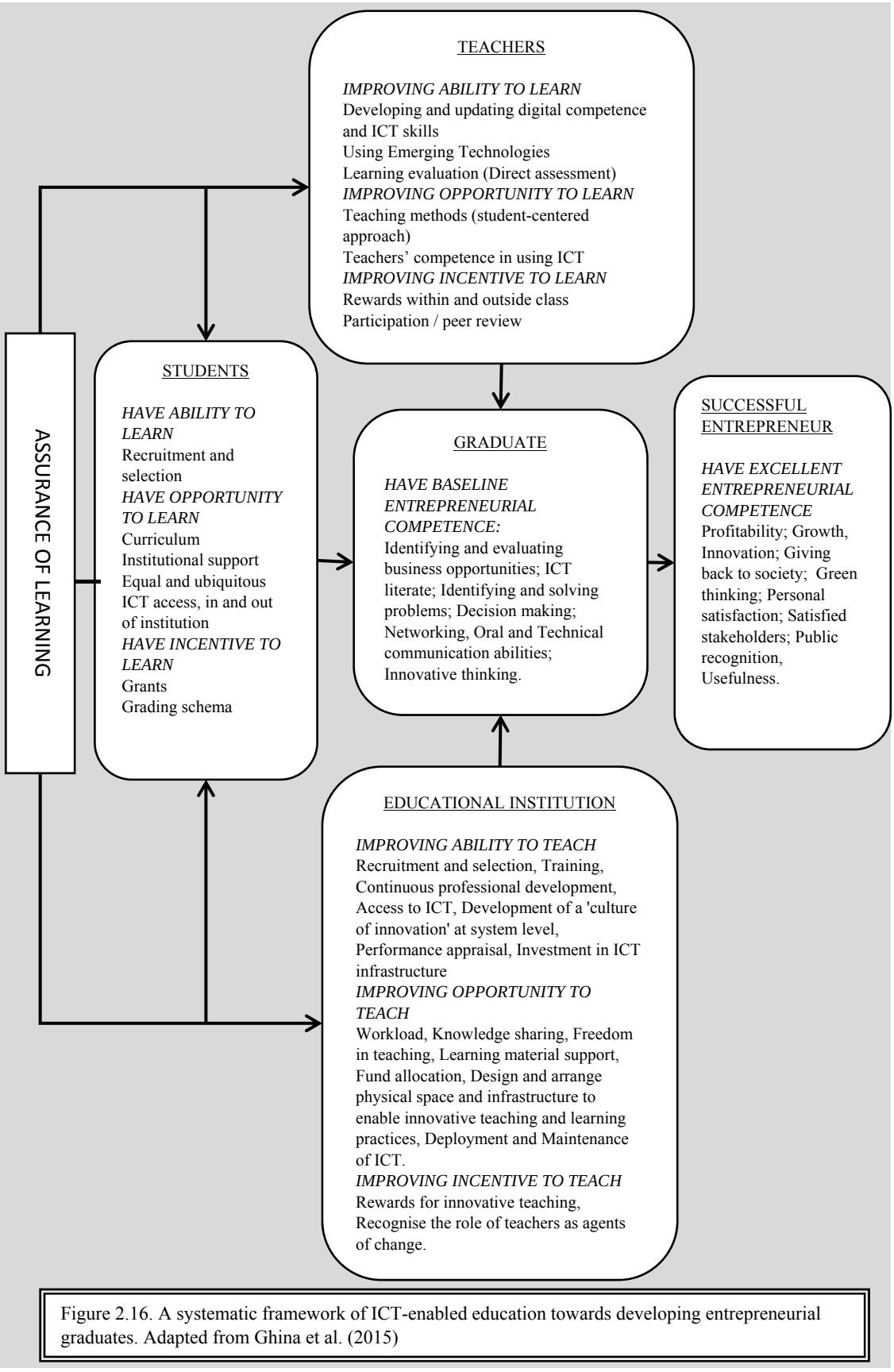

Figure 2.16. A systematic framework of ICT-enabled education towards developing entrepreneurial graduates. Adapted from Ghina et al. (2015)

Chapter 3

Research Methodology and Result

3.1. Methodology and Results

3.1.1. Introduction

Measuring the entrepreneurial inclination of students has been examined by different studies (Scott and Twomey, 1988; Brenner et al., 1991; Robinson et al., 1991). Intentionality as the crucial factor in the entrepreneurship process has received a lot of attention from the perspective of desirability and feasibility of entrepreneurship as well as a propensity to act upon opportunities (Shapero, 1975; Shapero and Sokol, 1982; Siewiorek et al., 2012).

In order to obtain a deeper understanding of the entrepreneurship attitude, many authors have developed different instruments of analysis to assess entrepreneurial attitudes of individuals. In fact, an individual can show a positive attitude towards risk taking that could be modified by educational experiences (Hitt and Tyler, 1991). Robinson et al. (1991) developed a 75-item instrument known as the Entrepreneurial Attitude Orientation scale (EAO) to measure the impact of entrepreneurial attitude for individuals with experience in entrepreneurial firms.

This scale measures four dimensions though the following sub-scales: 1) achievement in business, 2) innovation in business, 3) perceived personal control of business outcomes and 4) perceived self-esteem in business. Each one of these involves three components of attitudes: affect cognition, innovation and cognation. The EAO scale has proved to be a robust instrument to discriminate between non-entrepreneurs and entrepreneurs in different recent studies considering workers and college students in diverse international contexts (Lindsay, 2005; Harris and Gibson, 2008; Roberts and Robinson, 2010).

However, and even though there are evidences proving that entrepreneurship attitude can be configured even from middle and high school education (Eyal, 2008; Fuchs et al., 2008) there is no previous research on how this attitude can be modified through educational tools such as business simulations and gamification. This is where the present study

intends to extend the knowledge frontier of gamified business simulations as entrepreneurship drivers.

The present chapter presents research methodologies and findings of the study called *"Effects of gamified business simulations on entrepreneurial attitude at high school level"*, which by following an empirical analysis examines the entrepreneurial attitude on the basis of the EAO (Entrepreneurship Attitude Orientation) scale through the participation of high school students in a gamified business simulation.

3.1.2. Effects of gamified business simulations on entrepreneurial attitude at high school level

- **Antecedents of the Study**

Today, business simulations and gamification are applied as learning tools in business studies (Anderson and Lawton, 2009; Erenli, 2012; Singh, 2012; Schacht, and Schacht, 2012). As an instructional tool, simulations have proved plenty of advantages over traditional learning methods such as possibilities to put theoretical knowledge in practice in competitive environments, learning conflict management for individual and teams or immersion of student teams in the strategic management process, among others (Seaton and Boyd, 2008). Gamification, it turn, aims to increase students' motivation and their engagement to the study process in general (Lee and Hammer, 2011; De Sousa Borges et al., 2014), as well as self-study (Watson et al., 2013).

In fact, simulations allow participants to acquire a deeper knowledge about the relationships between the different decisions made at the managers' level and the interactions across the functional areas of the firm such as operations, marketing, human resources, etc. (Wolfe and Rogé, 1997). Doyle and Brown (2000) found that the effect of computer simulations on students may go beyond the learning process of the "decision and consequence" cycle to enable a deeper understanding of management as a

whole. This can increase the interest of the participants to undertake future projects, especially when considering international markets usually included in modern gamified simulation programs and applications (Segev, 1987; Heifetz and Laurie, 1997; Bruni et al., 2004; Neck and Greene, 2011).

From one side, gamification provides rewards and competition experience via implementation of the most popular gamification components PBLs (Points, achievement Badges and Leaderboards) to foster motivation for students and increase of their engagement (Hamari, 2014; Erenli, 2012). From the other side simulations allow students to practice entrepreneurship, as it requires them not only using and distributing virtual resources, but also applying and creating capabilities while acting in a proactive manner (Neck & Greene, 2011). In this context, we intend to examine the effectiveness of gamified business simulations by implementing game elements such as points and leaderboards to foster entrepreneurship attitude in high school students that have not yet oriented their professional career towards a specific trail

Figure 3.1. Provide a conceptual research framework of the study, including the key concepts comprised in it.

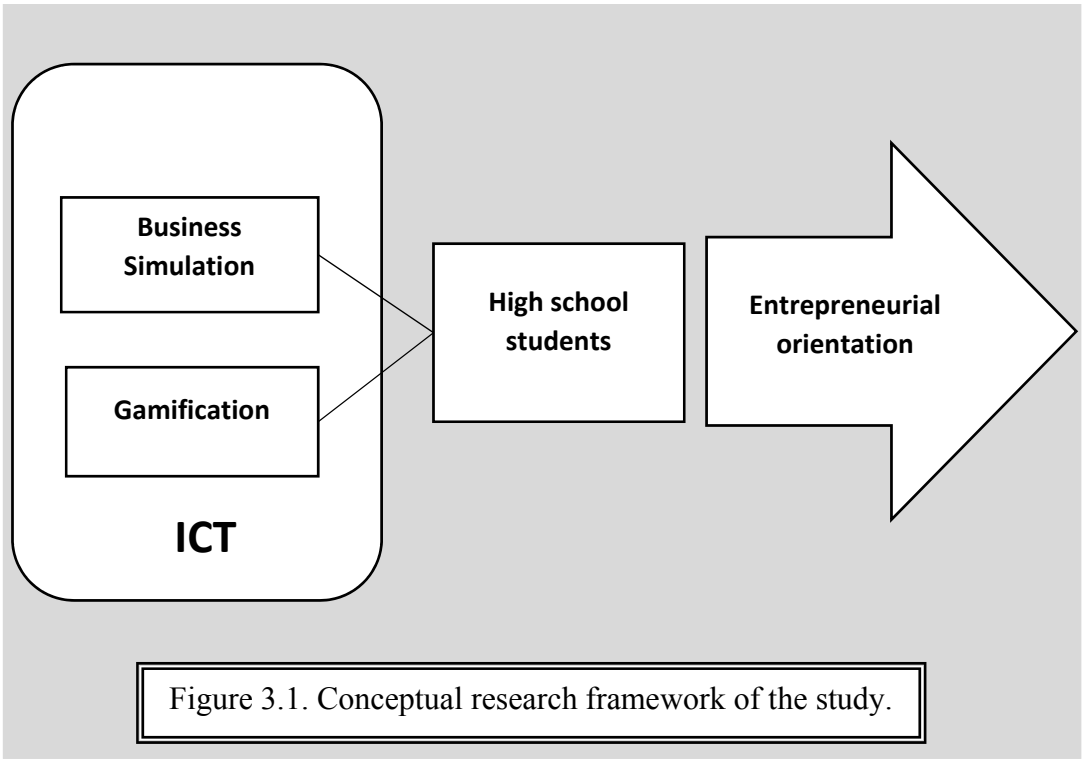

Figure 3.1. Conceptual research framework of the study.

3.1.2.1. Research Methodology

3.1.2.1.1 Sampling

A total of 990 students from 28 public high schools in the province of Granada (Spain) participated in a business simulation from November, 2011 until March, 2012. All students at that moment were taking subjects regarding Economics and/or Business Management at high school level in 11th and 12th grades (according to Spanish education system it is first and second course of Bachillerato).

Participants were grouped as firms that competed in 33 different simulations of 5 firms in each, accounting for a total of 165 virtual firms. Simulations were performed on the dairy products sector in 5 stages using the Praxis MMT 2.0 version specifically designed for non-university students. This simulator has been applied in previous research studies of Arias-Aranda (2007), and Arias-Aranda and Bustinza-Sánchez (2009). It fulfills the minimum requirements for the body of basic knowledge (CBK) according to the American Assembly of Collegiate School of Business (Arias-Aranda, 2007; Arias-Aranda and Bustinza, 2009). It simulates the dairy sector for the milk and yogurt industry with international markets and decisions involving all functional areas of the firm. The percentage of withdrawal for stages one and two was lower than 10 per cent, which indicates an outstanding acceptance of the experience by the participants.

All students were properly informed about the structure of the gamified business simulation competition and different meetings were held with high school teachers so they could incorporate the simulation experience within their subjects of economics and business administration. All teams of students were composed of a minimum of 5 and a maximum of 8 students configuring each team one virtual firm. Virtual firms competed in groups of 5, so the whole simulation had 33 parallel leagues (33 simulations). In each of these leagues, firms were given points according to their position in the ranking of accumulated profit of their financial balance for stages 2 and 3.

In stages 4 and 5, accumulated profit was the ranking indicator. In every stage, participants managed his/her virtual firm for 3 simulated annual

accounting periods. Students had from 1 to 2 weeks to make the decisions for every accounting period except in stages 4 and 5 where time pressure was increased so they only had one hour per accounting period.

Teams Stage 1 served as a proof stage and the results of the firms were not considered for later stages (see Table 3.1.). The five different stages of competition were designed in order to increase time pressure gradually. The first stage was the "proof" stage so participants could really learn and experiment with the simulator while getting used to it with no repercussions for the rest of the competition. Students' teams accumulated points in the rest of stages depending on their position in each league. All students could stay in the competition for stages one, two and three while only the top 25 with the highest scores passed on to stage four and finally the top 5 firms went on to stage five (Final) to fight for victory.

All stages involved in implementing simulation according to Arias-Aranda (2007) were followed. Hence, teachers reviewed in their theoretical classes at school the concepts and techniques of the decision-making process and developed some role-playing activities related to decision making in management. Teachers also described the simulation rules and helped with the materials given to participants to clearly understand the environment and the different categories of decisions to be made in every simulation cycle. Participants were assigned to teams under a random basis. Finally, the simulation was performed having the teachers acting as counselors as complementary activity. At the end, an analysis and evaluation of the simulation was made with the teachers and instructors.

Table 3.1. Provide Score System for stages 2 and 3.

Position	**Stage 2**			**Stage 3**		
	Year 1[1]	Year 2	Year 3	Year 1	Year 2	Year 3
First	65	67	69	421	423	430
Second	53	55	57	390	395	397
Third	39	41	43	369	371	375
Fourth	28	29	31	343	351	361
Fifth	18	19	21	331	333	335

[1]Every year represents one annual accounting period

Table 3.1. Score System for stages 2 and 3.

3.1.2.1.2. Measures and data collection

In order to measure entrepreneurship attitude before and after the competition, two EAO based questionnaires were filled up by a sample of students before (ex-ante) and after (ex-post) the simulation in order to measure whether participation in the simulation experience affects Entrepreneurial attitude. In addition, another group on non-participants students filled up the same ex-ante and ex-post questionnaire at the same time as participants in order to isolate the simulation experience effect from the regular classes' effect. All students were taking subjects of economics and management at school during that period of time. The use of the EAO scale is justified as students have basic theoretical knowledge of economics and management before the simulation and, therefore all of them could express through the questionnaire their ex-ante attitude towards entrepreneurship. The potential change in this attitude is to be measured in this study in order to identify significant differences in the entrepreneurial attitude dimensions.

Most studies on entrepreneurship focus on what happens when entrepreneurs act from a Schumpeterian point of view, why they act from a sociological approach, and how they act (Stevenson and Jarillo, 1990). This last approach studies the specific issues of entrepreneurship based on the entrepreneur's ability to accomplish its objectives. Regarding the use of simulators as entrepreneurship drivers, this study is structured from this perspective of firm creation and development from an innovative point of view.

The decision to become an entrepreneur is a conscious and voluntary decision. This decision is directly related to the individual's attitude towards entrepreneurship (Ajzen, 1991; Krueger et al., 2000). Entrepreneurial attitude is subjected to be positively influenced by challenging individuals to get to know and perform at their best potential through critical thinking and learning over mistakes (Fuchs et al., 2008). From this point of view, entrepreneurship can be analyzed on the basis of the Entrepreneurial Attitude Orientation (Robinson et al., 1991). Attitudes are built on evaluation of alternatives (Ajzen 1982). Specific circumstances can alter attitudes specially when interacting with the environment (Ajzen, 2001). When

attitudes are modified, predispositions of individuals to achieve determined goals change as well (Ajzen and Madden, 1986). Hence, measuring entrepreneurial attitudes based on demographic and personality specific issues turns into a valuable tool to predict propensity to start a business activity in future (Rosenberg and Hovland 1960; Ajzen 1982; Shaver 1987). By using scales to measure entrepreneurial prior attitude, future behaviors towards entrepreneurship can be predicted (Robinson et al., 1991).

Even though different scales have been developed to measure attitude towards entrepreneurship, scales measuring Entrepreneurial Attitude Orientation, or EAO (Robinson et al., 1991) have proved the highest levels of robustness and has been validated along entrepreneurship literature by analyzing those personal characteristics defining an entrepreneur (Collins and Moore, 1970; Brockhaus, 1975; Gartner, 1990). EAO scale works well in simulations studies as the perception of risk is reduced compared to real business as no personal assets are compromised (Arias-Aranda and Bustinza, 2009).

The EAO scale identifies four basic constructs: need for personal achievement (McClelland, 1961), need for control (Levenson, 1973), self-esteem (Crandall, 1973), and innovation (Kirton, 1976). The subscales derived from these constructs are Business success (in terms of performance or results in the creation a new firm), Business innovation (in terms of innovative business activities), Personal control (in terms of personal influence and control over the business) and Personal achievement (in terms of personal confidence and perceived competence) (Robinson et al., 1991).

In order to prepare the study of EAO on high school students participating in the simulation, high school teachers of economics and business administration were properly informed about all the experience and received detailed data about performance of their students as well as questionnaire results of his/her High School teams in comparison with the total average. A total population of 487 students received information to collaborate with questionnaires but only a 63.45% of them decided voluntarily to fulfill the questionnaires, establishing this percentage as a response rate. To evaluate non-response bias, two-tailed t-tests were used to

compare whether there are differences between first respondents and later respondents based on a set of demographic variables (Armstrong and Overton, 1977). At a level of $p < 0.1$, no differences were found, so non-response bias is not significant. As show in Table 3.2., 309 were obtained of participants and non-participants students while 178 were obtained only from participant students. 131 respondents did not participate in the simulation experience but filled up both ex-ante and ex-post questionnaires to act as a control group.

Table 3.2. Show the distribution of the EAO questionnaires.

	EOA Questionnaires obtained			
	Participants + non- participants	Participants	Participants + non- participants	Participants
Males	119	77	38.51%	43.26%
Females	190	101	61.49%	56.74%
11th graders	136	81	44.01%	45.51%
12th graders	173	95	55.99%	53.37%
Total	309	178	100.00%	100.00%

Table 3.2. Distribution of EAO questionnaires.

Gamified business simulations are instruments that allow a clear understanding through practice of managing techniques and direct results of those techniques. This vital training increases the chances for entrepreneurs to recognize market opportunities, implement correctly strategies and become flexible in plans when environment are turbulent. Hence, participating in a gamified simulation experience gives a broader insight of entrepreneurship. This knowledge can modify the attitude towards entrepreneurship. However, this influence can be different in each one of the dimensions of the EAO scale. Therefore:

H1: Participating in a gamified simulation experience influences the entrepreneurial attitude.

H1a: Participating in a gamified simulation experience influences positively the entrepreneurial attitude in the dimension of achievement

H1b: Participating in a gamified simulation experience influences positively the entrepreneurial attitude in the dimension of innovation

H1c: Participating in a gamified simulation experience influences positively the entrepreneurial attitude in the dimension of self-esteem

H1d: Participating in a gamified simulation experience influences positively the entrepreneurial attitude in the dimension of personal control

3.1.2.2. Data Analysis and Results

A 5-point Likert scale from 1 = total disagreement to 5 = total compliance was used in the EAO scale questionnaire according to Robinson et al. (1991). 75 variables are categorized in 4 different sizes: Achievement, Innovation, Self-esteem and Personal Control. The same questionnaire is responded before and after the simulation experience for a sample of participants and non-participant students.

For both groups of ex-ante and ex-post questionnaires, a preliminary analysis was conducted in order to verify the appropriateness of using factor analysis techniques with the indicators. The Kaiser-Meyer-Olkin test is performed to check sampling adequacy, as well as the Bartlett's sphericity test to verify that the factors are uncorrelated across the population (Hair et al., 2001). K.M.O. is higher than 0.6 and Bartlett's Test is statistical significance (<0.5); therefore factorial analysis was suitable for analyzing the EAO dimensions from the questionnaires (Table 3.3.). Principal component analysis is applied to determine whether the load factor of the indicators maintains the same structure as the original dimensions of the variable EAO. This analysis certifies that different items are grouped into different dimensions, just as those of the original EAO variable. Afterwards, we proceed to analyze the internal consistency of the four scales by calculating Cronbach's alpha. The values obtained for ex-ante variables of participant are $\alpha 1 = 0.883$ for Achievement dimension, $\alpha 2 = 0.865$ for Innovation dimension,

and $\alpha 3$ = 0.846 and $\alpha 4$ =0.787 for Self-esteem and Personal Control respectively. The remaining analysis of internal consistency of the scales is positive in all cases with values above 0.7 (Cronbach, 1951), providing sufficient reliability of the scales.

Table 3.3. Provide Factorial analysis

ACHIEVEMENT	**INNOVATION**	**SELF-STEEM**	**PERSONAL CONTROL**
T.V.E=57.125% M.I.C= 0.435 KMO=0.897 $\chi 2_{=}$649.843 (p=0,000)	T.V.E=57.232% M.I.C= 0.394 KMO=0.807 $\chi 2_{=}$244.320 (p=0,000)	T.V.E=66.649% M.I.C= 0.477 KMO=0.805 $\chi 2_{=}$560.859 (p=0,000)	T.V.E=61.148% M.I.C= 0.454 KMO=0.881 $\chi 2_{=}$878.468 (p=0,000)
Legend: Total Variance Explained (T.V.E.): Cumulative % must exceed the recommended level of 50% Mean Interitem Correlation (M.I.C): Must be under 0.5; if it is >0.5 items tend to be overly redundant Kaiser-Meyer-Olkin (K.M.O.): for significance value must exceed the recommended level of 0.6 Barlett test of sphericity: If $\chi 2$ (p>0,05), the factor model is inappropriate			

Table 3.3. Factorial analysis.

A t-test of means difference is performed with the initial 309 questionnaires of participants and non-participant students to study whether there are significant differences between students being selected to participate and non-participant students in the sample. Hence, this test showed no significance between the two groups, neither for gender, age or school of origin. Therefore, there is consistency in the samples and there are no significant differences between the participant and non-participant groups before participating in the simulation experience. A t-test analysis of independent means is performed to determine whether there are significant differences in the EAO dimensions for participant and non-participant students before (ex-ante) and after (ex-post) the simulation experience. This test shows significant differences between them in all EAO dimensions

except in the Personal Control dimension. Similarly, we proceed to quantify the effect of the simulation experience on the EAO dimensions on participating students through a one sample t-test. Results are shown in Table 3.4.

Table 3.4 Present EAO dimensions ex-ante and ex-post. Comparison between participant and non-participant students

		Participant students	**Non- participant students**		
		Mean (D.T.)	Mean (D.T.)	T	P
ACHIEVEMENT	Ex-ante	3.58 (0.49)	3.56 (0.49)	0.11	0.83
	Ex-post	3.98 (0.49)	3.58 (0.48)	2.67**	0.00
	t student	2.93**			
INNOVATION	Ex-ante	3.27 (0.49)	3.28 (0.49)	0.55	0.91
	Ex-post	3.73 (0.49)	3.26 (0.49)	7.17***	0.00
	t student	3.56***			
SELF-ESTEEM	Ex-ante	3.03 (0.49)	3.05 (0.48)	0.00	0.89
	Ex-post	3.32 (0.48)	3.04 (0.48)	3.23**	0.00
	t student	2.62**			
PERSONAL CONTROL	Ex-ante	2.88 (0.50)	2.86 (0.50)	0.15	0.58
	Ex-post	2.87 (0.49)	2.89 (0.49)	0.18	0.53
	t student	0.13			

Level of significance: *p<0.05; **p<0.01; ***p<0.001

Table 3.4 EAO dimensions ex-ante and ex-post. Comparison between participant and non-participant students.

Results prove that participant students score higher averages in Achievement (3.58 to 3.98), Innovation (3.27 to 3.73) and Self-esteem (3.03 to

3.32) dimensions after the simulation. Hence, the simulation experience influences positively in these EAO dimensions. However, there are no significant differences in the Personal Control dimension (2.88 to 2.87) so the simulation experience does not have a significant influence in this matter. This result about Personal Control support previous studies about the perception of this dimension as highly difficult to stimulate for certain types of games (Dempsey et al., 2002). However, these previous studies associate a highly lacking of Personal Control in adult women even in this study no significant differences have found related to gender and ages in EAO dimensions.

Chapter 4

General Conclusions

4.1. Conclusions, Implications and Limitations of the Study and Future Research Lines

4.1.1. Introduction

The current thesis has analysed the role of ICT-enabled education within the two interrelated concepts: Simulations and Gamification, as a tool for enhancing entrepreneurial attitude of high school students. Following that overall objective, the chapter one of the thesis introduces and contextualizes the importance of the research topic, the scope of the research, and the objectives, which are expected to be covered through its development.

Then, in chapter two, there is a vast and detailed theoretical framework, involving the key concepts of the study. Primarily, chapter two analyses commonly the concepts of Information and Communication Technology (ICT-enabled education), Gamification, Simulations and Entrepreneurial Orientation; four underlying subjects that represent the basis of the study.

Chapter three of the thesis provides the research methodology, through which the main study was conducted and showed significant results. The study has been developed to explore the significance of ICT in educational environments and its impact on different levels of education.

Finally, the current chapter presents the main conclusions, implications and limitations obtained as a result from this thesis and concludes with recommendations for further research lines.

4.1.2. General Conclusions of the Study

At all stages of human development stresses the importance of storage, processing and sharing of information in all areas of activity, especially in learning environment. Therefore, certain forms and methods were established in all educational institutions, where until recently the unique source of information was physical libraries and professors. However, with the emergence of computer technology until today, the enormously rapid and continuous process of ICT development encompasses all spheres of

human activity. Lately, the common perception is that the education becomes increasingly important strategic factor in economic development, at a time when businesses are becoming more digitalized. Albeit the variety of companies provide new levels of job training for career development, there is a tendency that employees face new challenges, which are not only limited to ICT literacy, but also require interdisciplinary set of capabilities. It is therefore necessary gradually modernise education system, since the teaching practices of twentieth century are becoming less effective in the current technological breakthrough era (OECD, 2015).

In particular, learning environment have all possibilities to use ICT as a leverage for achieving innovation progress in education, delivering information more effectively, improving educational approach in teaching and learning, as well as increasing students' motivation and prepare them for future workplace requirements, etc. To obtain the latter benefits, this thesis establishes the strategic importance of all stakeholders in education process to facilitate integration of ICT-enabled education into learning environments.

The main goals of European Commission (2013) are the raising ICT literacy of learners and schoolteachers, and further successful integration to a new global economy. To that aim, the study highlights the relevance of ICT-enabled education in preschool environment, elementary, as well as, secondary and high schools.

The growing capacity of ICT-enabled education will lead to more new learning and teaching approaches in high schools to facilitate entrepreneurial attitude in business settings. On this matter, the study introduces such concepts as:

- Gamification, a novel learning strategy that involves the innovation for students' motivation and their engagement into study process with the aim to encourage specific behaviors by implementing game design elements (DomíNguez et al., 2013)

- Simulations, strategies for involving students into a comprehensive experience in specific environments, which are emulated through computer

technologies to facilitate the inclusion of students into close-to-real scenarios (Bell et al., 2008) and to impart competencies such as attitudes, concepts, rules or skills to improve students' performance (Salas et al., 2009).

Overall, present thesis has been elaborated with a robust theoretical framework. In this respect, all chapters contain detailed insights to understand provided concepts by proposing to the interested parties a coherent and comprehensive reading to enable a clear perception of the study. Thus, presented thesis is trying to contribute to scientific literature on the future development of ICT-enabled education.

According to obtained results of the study, this thesis has drawn attention to the importance of introducing gamified business simulations as a complementary course of the learning process in a high school curriculum.

4.1.3. Particular Conclusions, Implications, Limitations and Future Research Lines

The particular or individualized conclusions of this thesis are provided from the results obtained in the individual study included in chapter three.

This study is entitled *"Effects of gamified business simulations on entrepreneurial attitude at high school level"*, and reviews the effects of the concepts of gamification and simulations on students' entrepreneurial orientation.

From this research, both theoretical and practical implications can be extracted. In this analysis, the influence of gamified business simulations on entrepreneurial orientation has been studied for first time in high school students in a comprehensive way. The effect of participating in the gamified simulation experience has been isolated from the possible attitude modification of regular teaching classes by obtaining data from participant and non-participant students in order to make a robust research. The results sustain the main studies performed on individuals involved in business simulations (Arias-Aranda & Bustinza, 2009) from higher education levels and conclude that gamified simulation experiences have a clear impact on

Entrepreneurial Attitude Orientation of high school students. The dimensions of achievement, innovation in business and perceived self-esteem are all positively influenced by the gamified simulation. Only, perceived personal control does not show significant changes after participating in a gamified simulation experience. This dimension has been found hard to stimulate through business games in young people, but the contribution of this research study is showing that there are no differences in Personal Control level by gender in young people, while other studies find differences in gender, but associated to adults facing business games (Dempsey et al., 2002).

There are some issues to consider when taking into account the outcomes of this research. First, high school students may show lower risk aversion compared to university graduate and undergraduate students because of their basic knowledge of the decision making process. This decreases the long term view regarding the real consequences of their management decisions (Brockhaus, 1980). When considering the influence of the gamified simulation in each dimension, there are some issues that are of special relevance for students aged 16 to 18.

First, regarding the achievement in business sub-scale, fear of failure configures an important barrier that gamified simulation can help to increase confidence in the real possibility for participants to start a business in future. This fact is particularly relevant when it refers to enhance the propensity of students to move into a leadership role (Siewiorek et al., 2012).

Secondly, the increase in the innovation dimensions shows a proclivity of participants towards creativity and continuous innovation to explore further opportunities to find a business opportunity. This "thinking out of the box" is one of the key factors for successful future entrepreneurs (Vesper, 1987).

Finally, self-esteem is positively affected by the gamified simulation experience. This is possibly the dimension with a broader impact not only on the entrepreneurial attitude but also all over the personality of a teenager going beyond school performance. In this study, no significant differences have found neither for males and females nor for grades or ages. The present

study proves that gamified business simulations are a powerful tool to foster the entrepreneurial potential that individual at high school level detain to become successful entrepreneurs and lead the way forward in fulfilling the need for future entrepreneurs in the current global economy. Just enhancing entrepreneurial orientation is a first step to turn intention into future action. Thus, inclusion of this type of gamified simulation experiences in high school curricula is highly desirable to, among other positive effects; lower the psychological barriers related to self-esteem or lack of innovativeness that could inhibit individuals from becoming entrepreneurs.

Anyway, the results of this study are not exempted of limitations as the findings relate only to high school students, which face entrepreneurship for the first time. In addition, specific features of high school education system in Spain may differ from other countries, which limit the possible generalizability of the results to other educational contexts in different countries or even regions. That is why future research will be emphasized on analyzing EAO differences in high school students considering other geographical factors and educational systems.

Capítulo 5

Conclusiones del Estudio

5.1. Conclusiones, Implicaciones, Limitaciones y Futuras Líneas de Investigación

5.1.1. Introducción

La tesis actual ha analizado el papel de las TIC en la educación a traves de la interrelacion de dos conceptos: Simulaciones y Gamificación, como herramientas para mejorar la actitud emprendedora de los estudiantes. Siguiendo este objetivo general, el primer capítulo de la presente tesis introduce y contextualiza la importancia del tema de investigación, su alcance, y los objetivos que se espera cubrir a través de su desarrollo.

Posteriormente, el capítulo dos, introduce un marco teórico vasto y detallado, que conecta los conceptos claves del estudio. Principalmente el capítulo dos analiza sistematicamente los conceptos de Tecnologías de la Información y Comunicación (educación a través de las TIC), Gamificación, Simulaciones y Orientación Empresarial; cuatro conceptos subyacentes que representan la base del estudio. El capítulo tres de la tesis proporciona la metodología de investigación, a través de la cual se realizó el estudio principal contenido en esta tesis, elucidando sus resultados significativos. Este estudio se ha desarrollado para explorar la importancia de las TIC en los entornos educativos y su impacto en los diferentes niveles de la educación.

Finalmente, el presente capítulo ofrece las principales conclusiones, implicaciones y limitaciones obtenidas como resultado de esta tesis y concluye con recomendaciones para nuevas líneas de investigación.

5.1.2. Conclusiones Generales del Estudio

En todas las etapas del desarrollo humano se destaca la importancia del almacenamiento, procesamiento e intercambio de información en todas las áreas de actividad, especialmente en el entorno del aprendizaje. Por lo tanto, se ha seguido una forma de proceder en todas las instituciones educativas, donde, hasta hace poco la fuente única de información eran bibliotecas físicas y los profesores. Sin embargo, con el continuo desarrollo de las TIC hasta la actualidad se ha conseguido abarcar todas las esferas de la actividad

humana. Últimamente, la percepción común es que la educación se convierte en un factor estratégico cada vez más importante en el desarrollo económico, al mismo tiempo que las empresas se están digitalizando cada vez más. Aunque las empresas ofrecen cada vez mas nuevos niveles de formación laboral para el desarrollo profesional, existe una tendencia a que los empleados se enfrenten a nuevos desafíos, que no sólo se limitan a la alfabetización de estos en el campo de las TIC, sino que también requieren un conjunto interdisciplinario de capacidades. Por consiguiente, es necesario modernizar gradualmente el sistema educativo, ya que las prácticas de enseñanza del siglo XX se están volviendo cad vez menos eficaces en la era de la innovación tecnológica actual (OECD, 2015).

En particular, el entorno de aprendizaje hace propensa la utilización de las TIC como elemento facilitador para lograr progresos de innovación en la educación, proporcionar información de manera más eficaz, mejorar el enfoque educativo en la enseñanza y el aprendizaje, así como aumentar la motivación de los estudiantes y prepararlos para futuras necesidades laborales. Para obtener estas ventajas, la presente tesis establece la importancia estratégica de todas las partes interesadas en el proceso educativo con el fin de facilitar la integración de la educación a través de las TIC en entornos de aprendizaje.

Los principales objetivos de la Comisión Europea (2013) son el aumento de la alfabetización en el campo de las TIC de los estudiantes y maestros, y una mayor integración con éxito en la nueva economía mundial. Para ello, el estudio destaca la importancia de la educación a través de las TIC en el ambiente preescolar, en las escuelas elementales, secundarias e institutos.

La creciente capacidad de las TIC en la educación dará lugar a nuevos enfoques de aprendizaje y enseñanza en las escuelas secundarias para facilitar la actitud emprendedora. Sobre este tema, el estudio introduce conceptos tales como:

- Gamificación - una novedosa estrategia de aprendizaje que facilita la innovación para la motivación de los estudiantes y su implicación en el

proceso de estudio con el objetivo de fomentar comportamientos específicos mediante la implementación de elementos de juego (DomíNguez et al., 2013).

- Simulaciones - estrategias para involucrar a los estudiantes en una experiencia integral en entornos específicos, que se adoptan a través de tecnologías informáticas para facilitar y mejorar la experiencia de los estudiantes en escenarios cercanos a la realidad (Bell et al., 2008) e impartir competencias como actitudes, conceptos, reglas o habilidades para mejorar el desempeño de los estudiantes (Salas et al., 2009).

En general, la presente tesis ha sido elaborada con un sólido marco teórico. A este respecto, todos los capítulos contienen información detallada para comprender los conceptos proporcionados, proponiendo a los interesados una lectura coherente y exhaustiva que permita una clara percepción del estudio. Así, el estudio presentado intenta contribuir a la literatura científica sobre el desarrollo futuro de la educación a través de lasTIC.

De acuerdo con los resultados obtenidos del estudio, esta tesis hace hincapié en la importancia de introducir simulaciones de negocios gamificados como un curso complementario del proceso de aprendizaje en el currículum de las escuelas secundarias e institutos.

5.1.3. Conclusiones, Implicaciones y Limitaciones Particulares, y Futuras Líneas de Investigación

Las conclusiones particulares de esta tesis se desarrollan a partir del estudio individual incluido en el capítulo tres.

El estudio se denomina "Efectos de los juegos de simulación de empresas y Gamification en la actitud emprendedora en enseñanzas medias" el cual revisa los efectos de los conceptos de gamificación y simulaciones sobre la orientación emprendedora de los estudiantes.

Importantes implicaciones teóricas y prácticas pueden extraerse del presente estudio. Esta investigación ha analizado, por primera vez en

enseñanzas medias, la influencia que la utilización de simuladores empresariales gamificados tiene en la actitud emprendedora del estudiante desde una perspectiva integral. En este sentido, se consigue separar el efecto de la participación en una experiencia de simulación gamificada del efecto de la asistencia del estudiante a sus clases regulares mediante la obtención de datos de participantes y no- participantes en la simulación.

Los resultados están en línea con los principales estudios previos realizados con simuladores empresariales pero en grados de enseñanza superior (Arias-Aranda & Bustinza, 2009), y constatan que las experiencias de simulación gamificadas tienen un claro impacto en la Orientación hacia la Actitud Emprendedora en los estudiantes de enseñanzas medias. Las dimensiones Exito personal, Innovación en los negocios y Control percibido se ven positivamente influenciadas por la participación en la simulación gamificada. Solamente la dimensión Control personal no resulta afectada por la participación en esta experiencia. Esta dimensión se ha encontrado difícil de estimular mediante simuladores como así lo demuestran estudios previos realizados en adultos (Dempsey et al., 2002).

El presente estudio constata estas conclusiones añadiendo que son extrapolables a edades más tempranas. Existen muchos aspectos a destacar de los resultados obtenidos. Primero, los estudiantes de enseñanzas secundarias pudieran presentar niveles de aversión al riesgo inferiores a los que presentan los estudiantes universitarios en base al menor conocimiento de los mecanismos de toma de decisiones. Este aspecto está directamente relacionado con la falta de perspectiva acerca del alcance de sus decisiones en el largo plazo (Brockhaus, 1980). Considerando los efectos de la experiencia de simulación en las diferentes dimensiones, existen algunas cuestiones de especial relevancia al estudiar participantes en edades comprendidas entre los 16 y los 18 años.

En primer lugar, considerando la dimensión Exito personal se demuestra que el miedo al fracaso supone una barrera importante que los simuladores gamificados pueden ayudar a superar ya que incrementan la confianza en las posibilidades reales de los participantes de cara a crear una empresa en el futuro. Este hecho es particularmente relevante ya que se consigue aumentar

la propensión a adquirir roles de liderazgo por parte del estudiante (Siewiorek et al., 2012).

En segundo lugar, el incremento en la dimensión Innovación demuestra que al terminar la simulación el participante es más proclive a la innovación continua y la creatividad a la hora de explorar nuevas oportunidades de negocio futuras. Al acentuar formas de pensamiento desde nuevas perspectivas se consigue incrementar notablemente las posibilidades de encontrar nuevas oportunidades de negocio (Vesper, 1987).

Finalmente, la Autoestima se ve positivamente influenciada por la participación en la experiencia en simuladores empresariales gamificados. Esta dimensión es posiblemente la que tiene un mayor impacto no solo en la actitud emprendedora sino en la propia personalidad del adolescente más allá del propio rendimiento académico.

En el presente estudio no se encuentran diferencias en razón de género, edad o curso académico. Esto demuestra que los simuladores gamificados son una ponderosa herramienta para alentar el potencial emprendedor que los estudiantes de estos niveles educativos presentan pero que pudieran estar inhibidos por diferentes razones. A través del potenciamiento de la actitud emprendedora se consigue dar un primer paso en la intención hacia futuras acciones referentes a la creación de empresas, aspecto de suma importancia en una contexto de economía global como el actual. Es por todo ello que este tipo de experiencias desarrolladas en enseñanzas medias son altamente deseables para conseguir, entre otros efectos positivos, reducir las barreras psicológicas relativas a factores como la autoestima o la falta de espíritu innovador que pudieran inhibir a los individuos a convertirse en emprendedores.

Los resultados del presente estudio no están exentos de limitaciones al considerarse una muestra de alumnos que se abordan decisiones de emprendimiento por primera vez. Adicionalmente, características propias del sistema educativo en el que se ha desarrollado la experiencia pudiesen influir en los resultados obtenidos en otros sistemas educativos tanto a nivel nacional como regional. Esta es la razón por la que futuras investigaciones

deberán enfatizar en el efecto que las diferencias respecto al sistema educativo u otro tipo de factor geográfico pudieran tener en los resultados.

Chapter 6

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