

Article

Examining the Impact of a Gamified Entrepreneurship Education Framework in Higher Education

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Abstract: Entrepreneurship education constitutes a top priority in policy agendas across the globe as a means to promote economic growth, fight unemployment and create social capital. An important premise of entrepreneurship education is that it can be learned and students can be taught to formulate entrepreneurial mentality, skills and competencies, something that can result in the formulation of startups and business initiatives. Given the importance of entrepreneurship, the necessity to formulate efficient entrepreneurship education frameworks and training programs arise. In this work, we present the design of an entrepreneurship educational environment that is based on learning in 3D virtual worlds. Innovative 3D virtual reality technologies were utilized to provide immersive and efficient learning activities. Various topics of entrepreneurship education courses were designed and formulated to offer students the opportunity to obtain theoretical knowledge of entrepreneurship. The 3D virtual reality educational environment utilizes pedagogical approaches that are based on gamification principles, allowing students to study in immersive ways as well as in game-based learning activities on real challenges that can be found in business environments. The game-based learning activities can help students gain necessary skills, helping them to tackle everyday obstacles on their entrepreneurial pathways. An experimental study was performed to explore the learning efficiency of the environment and the gamified learning activities as well as assess their learning impact on student's motivation, attitude, and overall learning experience. The evaluation study revealed that the framework offers efficient gamified learning activities that increase students' motivation and assist in the formulation of entrepreneurship mentality, skills and competencies.

Keywords: entrepreneurship education; virtual reality; learning technologies; gamification; learning efficiency; 3D virtual worlds

1. Introduction

Entrepreneurship is widely recognized as one of the most important activities of our times and has never been more important than it is today. The worldwide economic crisis has created new trends and situations in employment and innovation and has revealed entrepreneurship as a strategic means to reverse this downward turn in economic cycles and provide social capital and development [1]. Entrepreneurship is widely acknowledged to have the potential to boost employment, promote sustainable development, drive economic growth and social prosperity and constitutes a key component in local and globalized market economies [2]. Furthermore, entrepreneurship is seen as a driver for social development that brings innovation and sustainability to regions and countries and higher levels of entrepreneurship in a country are associated with greater levels of economic growth development and innovation [3].

In this context, entrepreneurship education and training constitute a top priority in policy agendas across the globe as a means to promote economic growth, fight unemployment and create social capital.

Entrepreneurship is recognized as one of the most important skills of the 21st century [4]. An important premise of entrepreneurship education is that entrepreneurship can be learned and students can be taught to formulate entrepreneurial mentality, skills and competencies, something that can ultimately facilitate the formulation of new businesses, startups and initiatives [5]. Results of several studies indicate that, although personal characteristics may facilitate the formulation of business initiatives and the management of a new business, the entrepreneurship process can be learned and trained [6,7].

In Europe, the European Commission formulated the entrepreneurship plan “Entrepreneurship Action Plan 2020” which highlights the important role of entrepreneurship education as a key strategy to stimulate economic growth in all sectors at the European level. In this context, entrepreneurship education is a key priority in the EU policy agenda for creating employment opportunities, fighting youth unemployment and social exclusion and also stimulating innovation among young people. The “Entrepreneurship Action Plan 2020” highlights the important role of entrepreneurship education as a key strategy to stimulate economic growth in all sectors at the European level. Short-term and mid-term entrepreneurship education policies can be a way to overcome the economic crisis that has gripped European economic systems. In this light, the necessity to promote the full integration of entrepreneurship education at all educational levels and domains throughout the common curricula of all the Member States is highlighted.

The formulation of efficient and effective entrepreneurship education frameworks is highly desired in order to properly teach, promote and instill entrepreneurship to young students. However, it is considered a very challenging domain. Innovative educational methods like game-based learning, gamification and virtual reality have the potential to enhance and sustain entrepreneurship education. Particularly, gamification methods in virtual reality educational environments and serious games are considered powerful tools in this regard [8,9]. Serious games also have the capacity to demonstrate the association and application of concepts and skills that may be hard and impossible to explain in words and gamification techniques are more and more utilized as they are widely acknowledged to be effective educational approaches and tools [9]. Indeed, this constitutes a fundamental characteristic that is necessary for sustaining the development of entrepreneurship mentality, skills and competencies as well as students’ soft skills too [8].

In this work, we present the design of an entrepreneurship educational environment that is based on learning in 3D virtual worlds—3D virtual reality was utilized to provide immersive and efficient learning activities. Various topics of entrepreneurship were designed and formulated in order to offer students the opportunity to obtain theoretical knowledge of entrepreneurship. The 3D virtual reality educational environment utilizes educational infrastructure and pedagogical approaches that are based on gamification principles, allowing students to study in immersive ways as well as in game-based learning activities on real challenges that can be found in business environments. The scenarios can help students gain necessary skills, helping them to tackle everyday obstacles on their entrepreneurial pathways. The novelty and the contribution of the present work concern the formulation of a concrete framework for entrepreneurship education and also the assessment of the impact that gamified learning activities have on students’ entrepreneurship learning and on their learning experience. In this line, an experimental study was performed to explore the learning efficiency of the environment and the gamified learning activities and assess their learning impact on student’s motivation, attitude, and their overall learning experience. The evaluation study revealed quite interesting results and the findings indicate that the framework offers efficient gamified learning activities that increase students’ motivation and intention and assist in the formulation of entrepreneurship mentality, skills and competencies.

The rest of the article is structured as follows. Section 2 presents background topics on Entrepreneurship education and related work and approaches from the literature. Section 3 presents the educational framework formulated that aims to provide entrepreneurship education, analyzes its characteristics and describes the game-based learning activities integrated into the environment. Section 4 presents the evaluation study conducted and describes the methodology and the measures

utilized. Section 5 discusses the results collected and presents the main findings of the study. Finally, Section 6 concludes the article and discusses future research directions.

2. Background Topics and Related Works

2.1. Entrepreneurship Education

Entrepreneurship education is defined as the process of equipping students (or graduates) with an enhanced capacity to generate ideas and skills to make them happen. Entrepreneurship education equips students with the additional knowledge, attributes and capabilities required to apply these abilities in the context of setting up a new venture or business [10]. Entrepreneurship education, in general, seeks to provide students with the knowledge, skills and motivation to encourage entrepreneurial success in a variety of settings. The context of entrepreneurship education defines the collection of formalized teachings that informs, trains, and educates anyone interested in participating in socio-economic development through a project to promote entrepreneurship awareness, business creation, or small business development [11].

Since 1999, the Global Entrepreneurship Monitor (GEM) studies entrepreneurship and aims to understand the association between entrepreneurship and economic development [12]. The studies and the reports of Global Entrepreneurship Monitor highlight the great importance that entrepreneurship has acquired as a means for the creation of jobs, the generation of wealth and social capital, and indicate that economic development and growth are tightly linked to entrepreneurship [13,14].

Entrepreneurship education is an important topic for all European countries in preparing people who can contribute to the ability of an economy to innovate—to create new businesses and new ideas [15]. The “Entrepreneurship 2020 Action Plan”, developed by the European Commission in 2013, provides a roadmap to promote entrepreneurship in Europe and highlights the importance to teach and practice entrepreneurship from the early kindergarten years up to the university levels. The plan focuses on promoting entrepreneurship education as a way to develop an entrepreneurial culture, leading to further economic development and sustainability [1].

Given the importance of entrepreneurship, the necessity to formulate efficient Entrepreneurship education frameworks and training programs arises. In general, entrepreneurship education aims to refer to the teaching of the domain of entrepreneurship and the training of entrepreneurs. It implies activities directed towards developing the students’ ways of perceiving their world, themselves and others, and how they handle their resources. According to Onu [16], it is the type of education directed towards producing a self-employed and self-reliant person. Okiti [17] describes entrepreneurship education as the gateway to job opportunities and job creation, which would constantly enhance self-reliance and self-employment among university graduates. Moreover, Jones, in [18], points out that entrepreneurship education constitutes a procedure that aims to provide students with the skills to understand and analyze business opportunities, stimulating self-esteem, knowledge, introspection and the ability to act on these strengths. In addition, the work presented in [19] highlights that entrepreneurship education includes any educational program and training procedure that aims to formulate entrepreneurial skills and attitudes. Furthermore, entrepreneurship education is a type of education that aims to assist students in thinking creatively in order to acquire knowledge and develop desirable attitudes and skills for self-reliance [20].

Several studies point out the positive impact of entrepreneurship education programs on participants in terms of the development of know-how, mentality, skills and competencies and entrepreneurship attitude. It is highlighted that people who participate in entrepreneurship education programs develop greater entrepreneurial intent as well as stronger beliefs in their abilities to accomplish entrepreneurial tasks [21,22]. In addition, there is a linkage between the effectiveness of entrepreneurial education and ventures success [23]. Several studies indicate the importance of offering efficient entrepreneurship education programs at higher education levels [24–26].

A main aspect that programs on entrepreneurship education need to include, concerns the formulation of active entrepreneurs that extend the theoretical knowledge of managing a business. In most of the entrepreneurship education programs, traditional methods are utilized and are based on theoretical lectures, something that allows learners to properly grasp theoretical concepts and understand the characteristics of entrepreneurial activities [27]. However, these approaches lack in assisting students to properly understand the consequences of actions and decisions made in the context of formulating and running a business [22].

So, innovative additional teaching approaches and methods need to complement theoretical training and promote students' active learning as well as enhance students' problem solving and social skills [22]. In this regard, it is pointed out that traditional formal learning needs to be complemented with informal learning methods utilizing game-based learning and simulations [28]. Furthermore, studies point out that practice-oriented approaches need to be included in programs as they are more appropriate for teaching and learning entrepreneurship [22]. Finally, from a content point of view, it is pointed out by studies that entrepreneurship education programs need to include three important objectives: (1) teach students to understand the domain of entrepreneurship, (2) learn to act in entrepreneurial ways and (3) ultimately become successful entrepreneurs [29]. In this context, we have formulated an entrepreneurship education framework that aims to address these three objectives defined by [29] Heinonen and Poikkijoki, as well as incorporate innovative educational technologies and approaches that rely on game-based learning and gamified learning activities in a 3D virtual reality educational environment. Regarding the first objective, the framework incorporates theoretical courses that are based on textual and multimedia presentations on various topics of entrepreneurship as well as involves efficient learning activities. Also, to address the second and the third objectives, gamified and game-based learning activities that aim to assist in putting theoretical knowledge into practice are designed and offered to students.

In addition, it is important to highlight that according to the reports of the Global Entrepreneurship Monitor, there are four main entrepreneurial stages. The first stage concerns potential entrepreneurs who intend to formulate a new business in the near future; the second stage concerns nascent entrepreneurs who are already involved in formulating a business; the third stage concerns new entrepreneurs who have started a business; and finally, the fourth stage concerns already established entrepreneurs who have relevant experience and already have and manage an established business [30]. In this line, the role of higher education in this process is significant since higher education needs to stimulate and foster the first and the second stages [31]. In this regard, the entrepreneurship education framework formulated in our work is oriented to higher educational institutes and aims to address the first two stages and cultivate entrepreneurship mentality, skills and competences in young people. What is more, in this context, it aims to inspire, motivate and provide students with proper theoretical and practical skills to formulate and manage new business initiatives.

2.2. Gamification, Game-Based Learning and Virtual Reality in Entrepreneurship Education

It is well highlighted that entrepreneurship education programs need to incorporate new educational technologies in order to enhance their efficiency, attractiveness and most of all their learning outcomes [32,33]. In this line, pedagogical approaches that rely on gamification and educational technologies such as virtual reality constitute strong tools that can play a significant role in the entrepreneurship educational landscape and can have a significant impact on student learning.

Gamification defines the utilization of game design and principles into non-game contexts [34]. It is considered a motivation-based approach that aims to increase target audience engagement and motivation, as well as improve learning benefits and the achievement of desired results via active involvement [35,36]. In general, the rationale for utilizing gamification methods in entrepreneurship education relies on Self-Determination Theory principles [37]. In this context, the use of game-like principles and characteristics in learning activities can formulate immersion in a very similar way to games, where participants can learn inductively and make decisions, something that can result

in enhancing retention and their creativity [9,38]. Specifically, gamification can engage learners in activities and training scenarios that can stimulate their motivation increase their engagement and most of all enhance their learning interest, experience and knowledge construction. In the literature, there are some works on gamification and entrepreneurship education, but the adoption of gamification in entrepreneurship education is considered to be quite residual and little has been done on the multidimensional examination of their interrelation and interaction. Indeed, it is pointed out that gamification and entrepreneurial intentions constitute two relevant topics in the business literature that are still lacking empirical investigation [38]. So, the formulation of a concrete framework for entrepreneurship education that will incorporate gamified learning activities and the assessment of their impact on students' entrepreneurship learning and learning experience is highly desired. In an entrepreneurship education context, gamification is mainly applied in order to motivate learners and engage them with applications, activities and services by making them more attractive, efficient and fun to use [34]. Research studies on the utilization of gamification and serious games in entrepreneurship education point out that learners can perceive simulation gameplay as a very useful exercise that can extend their knowledge on concepts of entrepreneurship [39].

In the work presented in [40], the authors performed a comparative study of serious games for entrepreneurship and report that although game-based learning is an interesting and suitable approach for entrepreneurship education, it has yet to improve its effectiveness in terms of engagement and fidelity. In the work presented in [41], the authors designed and introduced a blended model that relies on the utilization of a serious game in the context of the PNPV project. In the e-platform, learners can play the PNPV serious game [42], a business game possessing contextual help and various learning resources. The introduced model indicates that it is possible to formulate an educational space that stimulates and fosters students' entrepreneurial mentality, skills and competencies via experiential learning. In the work presented in [43], the authors investigate the effects of a serious game on entrepreneurship education. An exploratory study was performed and indicates that serious games can have a substantial influence on the entrepreneurship behavior and the intentions of the learners. Specifically, the findings of the study show that entrepreneurship education serious games can be an efficient mean to be utilized in teaching entrepreneurship concepts, resulting in a significant learning difference between the "players" and "non-players". Similar experience and results are reported by the work presented in [44] that addresses the utilization of game-based learning and serious games in supporting the development of entrepreneurial mindsets. The study was performed in the context of the eSG research project in the Netherlands, Italy and Spain. Therefore, based on the studies, it is concluded that the use of entrepreneurship game-based learning and serious games can have a substantial impact on the entrepreneurial intent, mentality, skills and competencies of the learners.

Virtual reality constitutes a novel educational technology that can be utilized to improve the efficiency of educational procedures and enhance the learning experiences of students [45]. Furthermore, 3D virtual worlds can enable learning experiences that were not previously available and can support a broad spectrum of pedagogical approaches as well as a wide range of learning activities and training procedures [46,47]. Virtual Reality is constantly used in all levels of education and in various thematic topics and offers learners the possibility to explore, practice and build their own knowledge. It can be used to assist teachers in teaching and students in learning and most of all improve the attractiveness and the quality of learning. Recent studies indicate that students can obtain more information and can more effectively utilize learned skills and already obtained knowledge after their participation in 3D virtual reality environments [48], thus making the 3D virtual reality a vital learning medium [49]. However, the exact potential and capabilities of 3D virtual reality environments remains quite an unexplored area [49].

With this in mind, the purpose of this research study is twofold. First, the main aim concerns the formulation of a novel, innovative and efficient educational framework that aims to assist students in learning entrepreneurship concepts in an engaging and efficient way. In this regard, an innovative 3D virtual reality educational environment was formulated to provide immersive and efficient learning

activities. State-of-the-art courses on various topics of entrepreneurship were designed and formulated to offer students the opportunity to obtain theoretical knowledge. In addition, gamified learning activities and training scenarios were designed to offer students the possibility to participate in entertaining and realistic situations where decisions should be made and to assist them in putting theoretical knowledge into practice. The scenarios can help students gain necessary skills, and tackle the everyday obstacles on their entrepreneurial pathways. The second aim of the research study concerns the examination of the efficiency of the virtual reality, game-based learning environment. Therefore, an evaluation study was performed to explore the potentialities of the environment and the gamified learning activities and assess their learning impact on student's entrepreneurship motivation and attitude, as well as their overall learning experience. In this context, the following hypotheses were established and examined:

H1: *Students' entrepreneurial knowledge levels increase after participation in game-based learning activities.*

H2: *Students' self-efficacy levels increase after participation in game-based learning activities.*

H3: *Students' entrepreneurial attitude and intentions for entrepreneurship increase after participation in game-based learning activities.*

The evaluation study aims to explore the aforementioned hypotheses, providing concrete results and conclusions.

3. The Virtual Reality Educational Environment

In this section, we present the virtual reality educational environment for entrepreneurship and analyze its characteristics. The aim of the environment is to formulate a framework in which an entrepreneurial spirit can thrive. In the environment, various courses on entrepreneurship are designed and are available to students. Students can find innovative e-courses with advanced educational material on Entrepreneurship and can select the courses to study. The aim of each of the topics is to support the development of entrepreneurial attitudes and behaviors, as well as building skills and knowledge of an enterprising person [50,51]. The educational content of the courses is available in the form of textual and multimedia presentations and offers students the possibility to study theoretical aspects of the domain. Virtual scenarios and learning activities can engage students in particular situations which simulate real-world conditions. Students can participate in learning activities as individuals or in teams, study the context of the activity and make proper and suitable decisions. The objective is to offer theoretical background topics and entrepreneurship intentions to students as well as the values of entrepreneurial culture and help them to achieve the necessary education that will enable them to materialize their ideas. The courses address a wide range of topics from basic steps to formulate a start-up, to examining financing opportunities, managing and business administration topics, Information and Communications Technologies (ICT), business plan development, Strengths, Weaknesses, Opportunities, and Threats (SWAT) analyses, marketing and many others. Example cases of successful companies, applications, products and entrepreneurs are also analyzed and presented to the students.

In the virtual world, all the users are represented as avatars and have the ability to move within the world in a similar manner to the real world. The utilization of avatars provides participants with a sense of awareness and presence and can improve communication and collaboration among the students and the tutor too. This presence is in general experienced by the sense of space that the virtual environment formulates and also the ability that the avatar has to move and to interact with constructions and contact with others in the virtual environment [52]. In the virtual world environment, several educational facilities were created to support students training. Students can participate in a virtual classroom and attend lectures, take part in individual and group learning activities and also carry out exercises and assessments. In Figure 1, a virtual classroom of the 3D world is illustrated. Students and teachers can visit virtual classrooms, virtual laboratories, virtual libraries and study the

educational materials of the courses as well as participate in learning activities, take exercises and quizzes. The 3D Virtual World environment gives students the ability to participate in gamified learning activities. In addition, the courses can also involve practical gamified learning activities that are based on participative learning. In this context, students can internalize the different course contents either individually or in a group with their peers. We have formulated a mix of action-oriented teaching that encourages active learning and game-based learning too. The approaches that are most often utilized concern text readings, discussion in the class, business plan formulations and the examination of cases of prestigious entrepreneurs [3]. The entrepreneurial course is comprised of various independent and complementary modules that aim to enhance university students' knowledge about entrepreneurship and also encourage them to become job creators rather than job seekers.

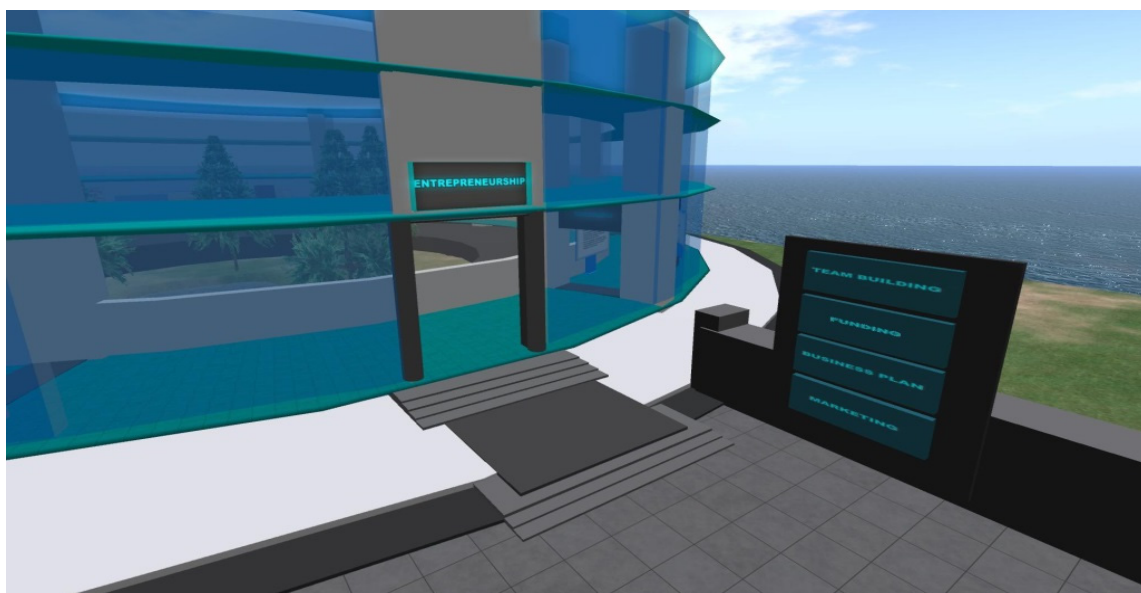


Figure 1. Example virtual area in the 3D world consisting of virtual classrooms.

In the virtual world, all users can connect any time they want from anywhere and study on their own. Even students from different countries can register and connect to the environment and study the educational content in English. Teachers, in line with their in-class lectures, can schedule lectures in the virtual world with their classroom students, and participate in learning activities and implement learning by principles of active learning, experimentation and participation.

The principles and the aim of the designed scenarios are twofold. First, to actively engage students and put theoretical knowledge into practice and obtain a deeper understanding, and second, to learn in an engaging and entertaining way. In general, in the virtual world, the training scenarios and the learning activities were designed in line with students' active learning and they aim to engage learners, offering entertaining ways of learning. In addition, to attain the second objective of learning in the virtual world, the scenarios were formulated in line with gamification principles that "gamify" various real-world problem situations and learning occasions. Gamification can enhance learning activities with motivational affordances in order to invoke "gameful" experiences and further behavioral outcomes [53,54]. In the 3D world, there have been integrated virtual pedagogical agents that are Non-Player Characters (NPC), and which can accompany students during the study and provide them with various game-based learning activities. These embodied agents are designed for pedagogical purposes in order to support student learning in various contexts in the virtual environment (See Figure 2).



Figure 2. An example NPC in the virtual world.

In this context, the students, after having studied the theoretical content of a specific topic of the entrepreneurship domain (Figure 3), have the opportunity to get involved in exercises and in various game-based learning activities. Students can participate either individually or in small groups with their peers. The main purpose of the learning activities is to assist students in putting theoretical knowledge into practice. The students have the opportunity to communicate and interact with the pedagogical agents to obtain exercises and participate in gamified learning activities. After that, the pedagogical agent provides students with a learning activity and the agent accompanies the student during it. The learning activities may request the student to formulate a specific business plan, to decide on aspects regarding the management of a company ranging from the production to the sales and the economic metric of the company. The student, or the team of students, can ask for assistance and the pedagogical agent can give hints, address the related theoretical topics involved in the activity, and guide students on what to do towards completing the activity.

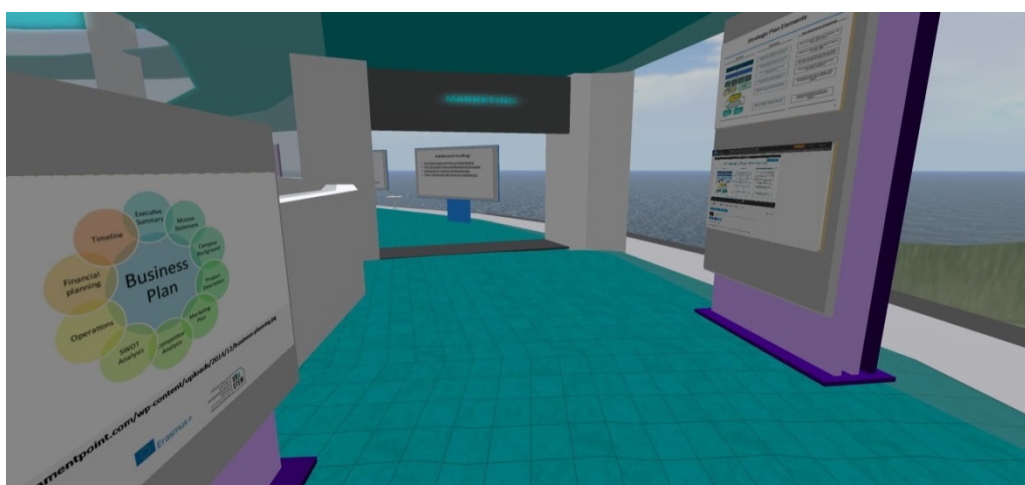


Figure 3. Presentations in the virtual world about the formulation of business plans.

Gamified learning activities for the students include quizzes and assessment exercises to evaluate students' performance and knowledge construction. Tutors and teachers, at all educational levels, utilize quizzes and tests in order to assess student learning and comprehension. The assessments can have a substantial impact and affect later retention [55]. In this context, various quizzes and assessment exercises have been designed and are integrated in the learning activities in the 3D virtual educational environment. In Figure 4, a way in which quizzes are offered to students is illustrated.



Figure 4. Assessment exercises in the 3D virtual world.

In the context of a quiz, the students have the possibility to ask and obtain assistance from the system and appropriate hints and feedback messages are offered to them tailored to their status in terms of performance and errors made. Specifically, after the students complete a quiz, their answers are analyzed and automatically corrected and students receive feedback on their scores and their errors, along with appropriate explanations.

4. Experimental Study and Results

A concrete evaluation study was designed in order to examine the efficiency of the virtual reality environment and the gamified learning activities and assess their impact on students' entrepreneurship learning. The evaluation experiment was conducted in our university and consisted of two main experimental context scenarios. In the first scenario, students participate in the 3D virtual world and can assess the courses and study the theoretical contents in text and multimedia presentations. In the second scenario, students can participate in the 3D virtual world and also have the additional opportunity to interact with the pedagogical agents and participate in various related gamified learning activities for each theoretical topic. In this scenario, the pedagogical agents can provide students with gamified learning activities to fulfill. During a gamified learning activity, the pedagogical agent accompanies the student, allowing the student to interact with it at any time and obtain assistance related to possible errors or guidance on how to proceed in the activity.

Method

In the context of the evaluation study, 86 students were invited to participate in the piloting study. Initially, all the participants were asked to create their personal account in the environment. During registration, personal information such as name, age, year of study, discipline, and contact info are required. After the registration, students can connect to the environment any time they want, from anywhere via their personal info. Students were informed that all their personal information and data will be anonymous and will be utilized only for the aims of the experiment. The primary descriptive analysis indicates that the respondents are distributed by gender, with ratios of 52% male and 48% female, respectively (Figure 5). Also, regarding the respondents' age, it can be observed that the majority of the participants are over 21 years old as illustrated in Figure 6. The primary descriptive analyses revealed a balanced distribution of the participants in terms of gender and age.

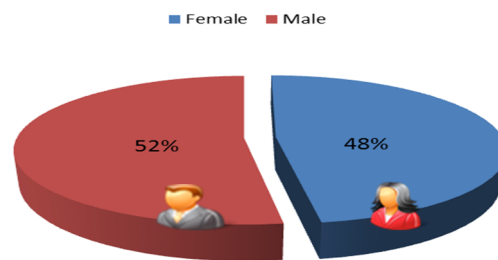


Figure 5. Gender Distribution Result.

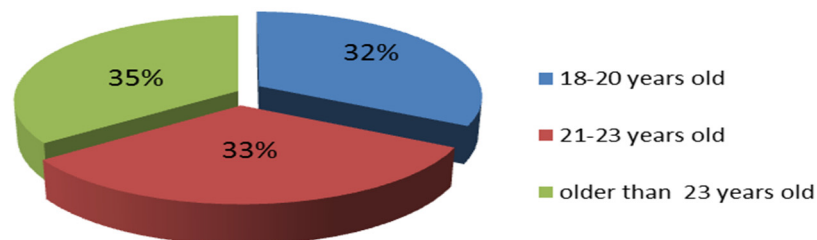


Figure 6. Age distribution results.

In the context of the experimental study, students were randomly divided into two groups of 43 students each. The overall context and the phases of the experimental study are depicted in Figure 7 along with the way it was conducted. Then, one group was randomly selected to serve as GroupA, while the other served as the GroupB. The students of GroupA experimented and studied in an instance of the virtual world environments under the first scenario as explained above and GroupB used the same environments under the second scenario. Initially, all students (GroupA and GroupB) took a pre-test in order to assess their prior knowledge of entrepreneurship concepts. The pre-test consisted of multiple-choice questions on a ten-grade scale and students had 30 min to complete the pre-test.

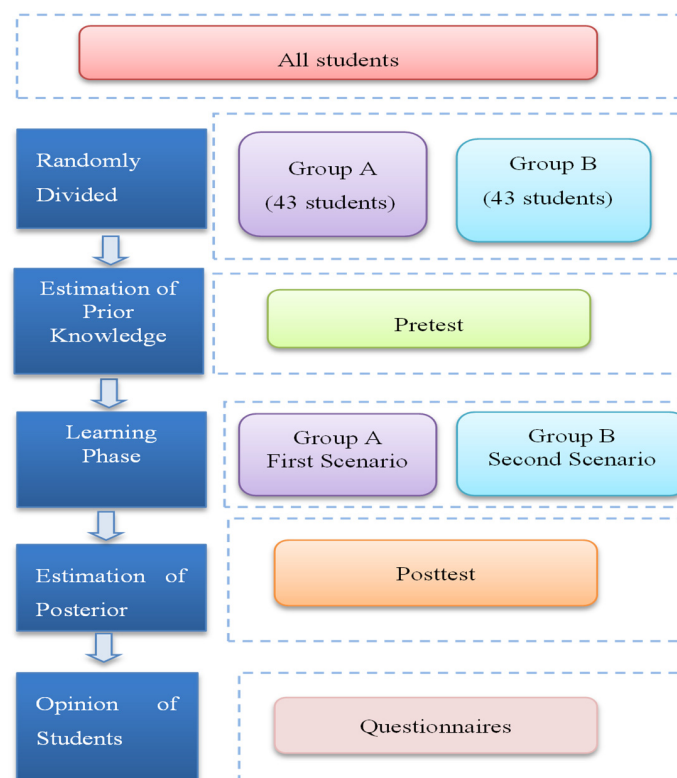


Figure 7. Phases of the experimental study.

In order to analyze the students' performance, the mean value and the standard deviation were calculated for the pre-test. As shown in Table 1, the mean value and standard deviation were 4.197 and 0.524 for the experimental group (GroupA), and 4.361 and 0.726 for the control group (GroupB), respectively. The results indicate that the students of both groups had the same knowledge level before participation in the learning phase.

Table 1. Descriptive statistics of pre-test and post-test.

	Group	N	Mean	Standard Deviation
Pre-test	GroupA	43	4.197	0.524
	GroupB	43	4.361	0.726
Post-test	GroupA	43	6.535	0.581
	GroupB	43	8.558	0.683

After that, the learning phase took place. Students of each group were asked to study for a period of three weeks under different learning conditions and approaches. Specifically, GroupA was selected to study the course topics by using the conventional education material (textual presentations) from the content repository of the course. GroupB was selected to study in the scenario B, where they had the additional opportunity to participate in related gamified learning activities. After the end of the three-week learning phase, all the students took a post-test. The post-test consisted again of multiple-choice questions and was of the same difficulty level as the pre-test. More specifically, it consisted of 20 multiple choice questions that address theoretical aspects, as well as real case scenarios, where students were asked to specify the appropriate decision to be made. The students were given 30 min to complete the post-test and submit their answers.

Descriptive statistics were utilized in order to provide useful analyses, specifying the mean and the standard deviation for the dependent variable (post-test) for each of the two groups. The results for the post-test are presented in Table 1 and in Table 2. As shown in Table 2, Levene's test confirmed the equality of variances of GroupA and GroupB for pre-test ($F = 8.196$, $p = 0.005$) and post-test ($F = 2.385$, $p = 0.126$). Thus, there were clear differences in the mean performances on the post-test of the two groups ($p = 0.000 < 0.05$). A p -value < 0.05 is considered statistically significant. Indeed, the results indicate that after controlling for initial quantitative ability, the differences in the post-test scores are statistically significantly different between the two groups. Thus, it implies that students in GroupB gave more correct answers than in GroupA. So, the results show that students of GroupB learned better than the students of GroupA.

Table 2. Descriptive statistics of pre-test and post-test.

Equality of Variance		Levene's Test for Equality of Variances		t-Test for Mean				95% Confidence Interval of the Difference Lower, Upper
		F	Sig.	t	df	Sig.(2-tailed)	MD	
Pre-Test	Equal	8.196	0.005	−1.191	84	0.237	−0.162	−0.434, 0.108
	Unequal			−1.191	76.460	0.237	−0.162	−0.434, 0.109
Post-Test	Equal	2.385	0.126	−14.789	84	0.000	−2.023	−2.295, −1.751
	Unequal			−14.789	81.904	0.000	−2.023	−2.295, −1.751

The results show an increase in the score, indicating that students have learned in both cases. Students of both groups performed better in the post-test, achieving greater marks than in the pre-test. However, the students of GroupB performed much better than those of GroupA. In the post-test, they made fewer mistakes and get a deeper understanding of Entrepreneurship concepts.

In addition, after the completion of the period of study, all students were asked to fill in Likert scale questionnaires. The purpose of these instruments is to collect and assess students' attitude

towards the educational environment and assess their learning experience. The aim of the Likert scale survey was to enable students to express their agreement with a set of statements. The questionnaire that was formulated included 14 questions in total. Specifically, 12 open-ended questions were based on a Likert scale, with answers ranging from 1 (not at all) to 5 (totally agree).

Initially, the students' answers to the questionnaires were analyzed in order to estimate the reliability and the bias of their answers. In the following table (Table 3), the analyses of the questionnaires are illustrated.

Table 3. Likert scale questionnaires.

Question	GroupA			GroupB		
	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree
The educational environment enhances my engagement	4.65%	18.60%	76.74%	2.33%	11.63%	86.05%
The educational environment enhances my learning interest	6.98%	20.93%	72.09%	4.65%	6.98%	88.37%
The educational environment possesses entertainment	4.65%	13.95%	81.40%	4.65%	9.30%	86.05%
The educational environment enhances my motivation	2.33%	20.93%	76.74%	2.33%	11.63%	86.05%
The educational environment improves my cooperation with peers	4.65%	20.93%	74.42%	4.65%	11.63%	83.72%
The educational environment enhances my self-esteem	6.98%	16.28%	76.74%	2.33%	11.63%	86.05%
The educational environment improves my knowledge in the entrepreneurship field	6.98%	23.26%	69.77%	4.65%	6.98%	88.37%
The educational environment improves my knowledge in the financial field	4.65%	18.60%	76.74%	2.33%	6.98%	90.70%
The educational environment improves my knowledge in the management field	6.98%	18.60%	74.42%	4.65%	9.30%	86.05%
I feel that I have the skills to open my own business	9.30%	6.98%	83.72%	4.65%	6.98%	88.37%
Would you like to open your own business?	11.63%	6.98%	81.40%	4.65%	11.63%	83.72%
Please rate your overall experience	6.98%	11.63%	81.40%	2.33%	4.65%	93.02%

The first part of the discussion concerns the analyses of the Likert questionnaires and the estimation of their reliability. In this line, for assessing the reliability of the questionnaires and securely analyzing the collected data, Cronbach's alpha metric [56] was used. Cronbach's alpha in our questionnaires was calculated to be 0.78 and 0.80, respectively. This indicates that the reliability of the questionnaires is rated as 'good' and thus, we can draw strong, reliable and valid conclusions.

The analysis of questionnaires shows that GroupB students, who had the opportunity to get involved in the gamified learning activities, had a better learning experience. Specifically, the majority of students in GroupB indicated that they had an enhanced engagement with learning activities and reported an improved learning interest and more efficient and entertaining way of learning. It is important to note that students of GroupB also reported that they have a better understanding and knowledge construction of the concepts of entrepreneurship, finance and management via participation in the gamified learning activities. Also, GroupB had a better overall learning experience and the results indicate that they have slightly better intentions to open their own business. Given the results, the main

findings of the study indicate that gamified learning activities have a great impact on student learning and comprehension and increase the self-efficacy levels of the students. Also, they enhance students' knowledge of entrepreneurship concepts to a substantial degree compared to traditional learning approaches based on textual presentations. Finally, the results highlight that students' entrepreneurial attitude and their intentions are increased to a greater degree after participation in game-based learning activities.

5. Discussion

The experimental study revealed quite interesting results regarding student learning and knowledge construction. The results of the study shed light on the efficiency of the entrepreneurship educational environment and learning activities as well as on students' interest, motivation and their overall learning experience.

The first hypothesis (H1) that the present study aims to examine, concerns the examination of students' entrepreneurial knowledge levels and assumes that students' entrepreneurial knowledge levels increase after participation in the game-based learning activities. In this regard, the results of the study revealed that students' knowledge levels on entrepreneurship concepts greatly increased via gamified learning activities which simulate real-world situations and require students to act as professionals, cooperate with their peers, analyze situations and make proper decisions. Students learned better and their performance and comprehension were increased to a greater degree as indicated in the pre-test and post-test results (8.558 score for GroupB vs. 6.535 score for GroupA). In addition, the results of the questionnaires indicate that gamified learning activities offer students better knowledge construction and knowledge in the entrepreneurship field (88.37% for GroupB vs. 69.77% for GroupA) as well as in aspects related to management (86.05% vs. 74.42%) and finance (90.70% vs. 76.74%). The second aim of the study concerns the examination of the students' self-efficacy levels. Specifically, as presented in the aims of the study the second hypothesis (H2) assumes that students' self-efficacy levels increase after participation in game-based learning activities. In this regard, the results of the experimental study show that students' self-efficacy increases to a greater degree through participation in the gamified scenarios. Indeed, students who participated in the learning activities not only achieved higher entrepreneurial knowledge levels but also stated that they feel more confident, have better self-esteem (86.05% vs. 76.74%) and possess the necessary skills to open their own business (88.37% vs. 83.72%). Finally, the third aim concerns the examination of students' entrepreneurial attitude and intentions and hypothesis 3 (H3) assumes that students' attitude and intentions for entrepreneurship increased after participation in the game-based learning activities. The results of the experimental study clearly show that students intentions are increased to a greater degree (83.72% vs. 81.40%) via participation in the gamified learning activities.

The results highlight that gamified learning activities that engage students in realistic situations which require students to put theoretical knowledge into practice have a greater impact on student learning with regard to entrepreneurship concepts and also their comprehension and learning experience. To sum up, the main finding of the study is that a very efficient approach to assist students in learning entrepreneurship relates to activities that require students to get involved in gamified scenarios that simulate real-world situations and require them to act as professionals, cooperate with their peers, analyze situations and make proper decisions. These kinds of activities have a greater impact on student learning and increase their knowledge, their confidence and their entrepreneurship intentions too.

6. Conclusions

Entrepreneurship has never been more important than it is today. Entrepreneurship education constitutes a top priority in policy agendas across the globe as a means to promote economic growth, fight unemployment and create social capital. Given the importance of entrepreneurship, the necessity to formulate efficient entrepreneurship education frameworks and training programs arises.

The formulation of efficient and effective entrepreneurship education frameworks is highly desired in order to properly teach, promote and instill entrepreneurship for young students. However, it is considered a very challenging domain.

Innovative educational methods like game-based learning, gamification and virtual reality have the potential to enhance and sustain entrepreneurship education. In this work, we present the design of an entrepreneurship education environment that is based on learning in 3D virtual worlds and provides immersive and efficient learning activities. Various topics of entrepreneurship were designed and formulated to offer students the opportunity to obtain theoretical knowledge of entrepreneurship. The 3D virtual reality educational environment utilizes educational infrastructure and pedagogical approaches that are based on gamification principles, which allows students to study in immersive ways as well as in game-based learning activities on real challenges that can be found in business environments. The scenarios can help students gain necessary skills, helping them to tackle everyday obstacles on their entrepreneurial pathways. An experimental study was performed to explore the learning efficiency of the environment and the gamified learning activities and assess their learning impact on student's motivation and attitude as well as their overall learning experience. The evaluation study revealed quite interesting results and findings indicate that the framework offers efficient gamified learning activities that increase students' motivation and assist in the formulation of entrepreneurship mentality, skills and competencies. The results highlight that gamified learning activities that engage students in realistic situations which require students to put theoretical knowledge into practice have a greater impact on student learning with regard to entrepreneurship concepts and also their comprehension and learning experience.

There are some directions that future work will focus on. A main direction concerns the examination of gender-related aspects of the entrepreneurship education environment. In this regard, an aim will be to analyze the behavior and the attitude of each gender towards the activities and the framework. Another aspect that future work could examine relates to the study of the efficiency of collaborative learning activities where students participate in teams and have to cooperate and develop communication and soft skills too. This concerns a main direction that future work will examine.

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