Received 21 March 2019
Revised 20 May 2019
Accepted 21 May 2019

Entrepreneurship competencies in energy sustainability MOOCs

Martha de Jesús Beltrán Hernández de Galindo,
Luis M. Romero-Rodriguez and Maria Soledad Ramirez Montoya
School of Humanities and Education, Tecnológico de Monterrey, Mexico City, Mexico

Abstract

Purpose – Massive open online courses (MOOCs) have been gaining popularity as non-formal lifelong learning educational platforms. However, they have been criticized for their low completion rate and low ability for networking. The purpose of this paper is to analyze how incorporating entrepreneurial competencies in MOOCs develops attributes of educational innovation and collaborative projects.

Design/methodology/approach – The research followed a three-stage process: in first stage, a comprehensive literature review was conducted to identify dimensions of entrepreneurial skills and attributes of educational innovation in MOOCs. In the second stage, a quantitative study was carried out, based on the analysis of pre- and post-test surveys taken by a sample of 6,517 participants. In the last stage, the interaction analysis model/computer-mediated communication analysis model was applied through qualitative analysis, using the MAXQDA tool to identify if entrepreneurship opportunities were generated in the interactions within the discussion forums of the MOOCs.

Findings – The results show that the analyzed MOOCs have an overall completion rate of 12.55 per cent, above the average of the rates found in the literature review. However, only 14.29 per cent of the participants expressed at least one opportunity to generate ventures related to the topics of energy in the discussion forums.

Practical implications – This research could help instructional designers and universities to consider the inclusion of entrepreneurship issues in the design of MOOCs' content and to encourage more activities that promote networking among participants, to identify business potential from the educational materials.

Originality/value – This research is one of the very few studies on entrepreneurship competencies in MOOCs to understand how the inclusion of issues related to entrepreneurship in MOOCs can generate a positive impact on participants.

Keywords MOOC, Higher education, Entrepreneurship education, Energy sustainability, Entrepreneurship competencies

Paper type Research paper

1. Introduction

The issue of energy reform is of great importance for Mexico, where energy sources are currently highly polluting and non-renewable, such as coal and oil, generating

This work was supported by the energy sustainability fund CONACYT-SENER through the Project 266632 "Laboratorio Binacional para la Gestión Inteligente de la Sustentabilidad Energética y la Formación Tecnológica" under Grant S0019201401.

Journal of Entrepreneurship in Emerging Economies
Vol. 11 No. 4, 2019
pp. 598-616
Emerald Publishing Limited
2053-4604
DOI 10.1108/JEEE-03-2019-0034

approximately 250 billion kWh per year, of which only 52,000 MW come from renewable geothermal, hydroelectric and nuclear energies. This situation brings to mind the urgent need to educate the population on the use, production, and sustainable distribution of energy. It also highlights the need to create strategies for the development of innovative entrepreneurship projects in environmental and energy markets (EM). Thus, environmental and energy sustainability education is imperative, not only for the development of social and community competencies in the matter but also within the framework of training for the sectors directly involved: governmental institutions, companies and industries, and especially, their technical specialists (Rodrigo-Cano *et al.*, 2019).

Mexico is a country with a population of over 130 million inhabitants, with an energy consumption of 9,249,746 PJ/year, of which more than 98 per cent comes from fuel sources and fossils. According to Manzini *et al.* (2001), if an energy reform is not carried out with some urgency, the emission of greenhouse gases, acid rain precursor gases and environment-energy intensity factors will be highly intensified.

Within the framework of the "Binational Laboratory for the Intelligent Management of the Energy Sustainability and the Technological Formation" project, between 2017 and 2018, Tecnológico de Monterrey (Mexico) launched 12 energy sustainability massive open online courses (MOOCs) (Table III) to comply with the guidelines of the Paris agreements of 2016. This project took into consideration the potential impact and scope of MOOCs. The sustainability MOOCs were based on the movement toward the development of renewable energies -wind, solar, geothermal, tidal and biomass-, and aimed to strengthen energy security based on sustainability principles (Oswald, 2017), all this within the framework of the seventh sustainable development goal of the United Nations.

The need to carry out this study lies in reviewing the application of educational strategies to apply initiatives in the area of energy sustainability. Hence, this study sought to identify development areas of entrepreneurial skills that rise from educational interaction, specifically in the MOOCs designed for these purposes.

MOOCs have revolutionized the online educational scene, as they allow the democratization of access to education, and are an important tools for life-long learning. They also create non-traditional educational offerings – in subjects and pedagogical architectures –, fostering innovation in the construction of instructional models (Hernández *et al.*, 2015). Many universities, research groups, associations, and training centers have launched this type of training, either through platforms such as Edx, Coursera, Udacity or Khan Academy or on custom platforms created by the institutions to share their contents with heterogeneous groups (Borrás Gene *et al.*, 2016).

MOOCs are, among other things, free, ubiquitous and timeless; they represent an educational option for many people regardless of their geographical location or their schedules. Their massive and open character makes them part of the open-access philosophy (Ramírez-Montoya, 2018; Torres-Toukoumidis *et al.*, 2018). While some platforms charge a fee for issuing completion certificates, access to MOOCs must be free, so they should not be considered or analyzed as formal learning platforms, but as means of improving learning and as a guide for the cognitive processes of their participants (Altbach, 2014).

However, as a teaching-learning tool, MOOCs have had their share of detractors. Several academic discussions (Antonaci *et al.*, 2017; Vaibhav and Gupta, 2014) have mainly focused on the low completion rates of MOOCs. In fact, including the first formal MOOC offered by the Massachusetts Institute of Technology (MITx) in 2008, "6,002x: circuits and electronics" where the completion rate was only of 4.62 per cent of the participants (7,157 out of 154,763 enrolled), the average completion rates of MOOCs are between 5-8 per cent (Osuna-Acedo *et al.*, 2018).

Nevertheless, MOOCs should not be evaluated with the same parameters of formal training programs, such as completion rates because of their free, flexible and heterogeneous nature. In fact, the free and flexible quality of these courses represent an important part of the low level of student commitment (Kizilcec *et al.*, 2013), so completion rates should not be used as the only measure of quality or their dropout rates as an indicator of failure (Reich, 2014; Yousef *et al.*, 2014).

The scientific literature points out that the reasons of desertion from MOOCs essentially boil down to the fact that they tend to be long and monotonous, as they follow the same instructional design and the same paradigms of formal-traditional education (Vaibhav and Gupta, 2014; Osuna-Acedo *et al.*, 2018). They often innovate only on technological mediation, resulting in recommendations to integrate innovative strategies that promote innovation, networking, interaction and commitment; in short, to achieve higher engagement (Borrás Gené *et al.*, 2016; González *et al.*, 2016).

The objective of this study is to analyze how entrepreneurial competencies in energy are incorporated in MOOCs to develop attributes of educational innovation and educational projects. The work focuses specifically on two MOOCs: "carbon markets: a way to mitigate climate change" and "EM: business opportunities" (Table III), both with a duration of 35 teaching hours over seven weeks. The final goal of this research is to determine how entrepreneurial competencies should be included in the contents of MOOCs to promote networking among the participants to identify business potential from the educational content.

2. Literature review

Several authors have sought to classify entrepreneurial skills and explain the meaning of the concept. Entrepreneurship competencies combine several aspects, such as attributes of personality, skills and knowledge of a potential entrepreneur and other qualities: leadership, identification of opportunities, creativity, innovation, critical thinking, adaptability and problem solving, all of which have a substantial impact on the motivation of the entrepreneur (Farhangmehr *et al.*, 2016). However, it is not easy to achieve a unique definition of "entrepreneurship", as there are several schools of thought on the topic, such as those that try to define who is an entrepreneur and inquire into aspects of their personality (Frese and Rauch, 2001), and those that focus on the business process as a more complex phenomenon in which situational, social, cultural and economic factors intervene and interact (Smith *et al.*, 2005).

In fact, the explanation and understanding of entrepreneurship is linked to significant differences in the context in which it is applied (Anderson and Obeng, 2017; Anderson and Ronteau, 2017); as it is not the same to analyze entrepreneurship from emerging, highly dynamic economies, such as China (Li and Wang, 2013), and doing so in slower emerging economies, such as those from some African countries (Harbi *et al.*, 2009) or economies of fast transition, such as those in Western Europe (Welter *et al.*, 2016).

Thus, it becomes evident that entrepreneurship has a multidimensional nature (Steyaert and Katz, 2004). From a functionalist perspective, for example, innovation is a critical component of entrepreneurship; from a social and psychological perspective, the entrepreneur is located in a social space and possesses specific skills, competencies and qualities to create a favorable disposition toward their projects (Anderson and Ronteau, 2017); while from an economistic perspective, entrepreneurship is explained as a phenomenon of adaptation of the *homo oeconomicus* to economic changes in their environment (Hjorth, 2013).

Lackéus (2015) states that the term entrepreneurship has two essential definitions, namely, on the one hand, it refers to a narrow perspective focused on identifying opportunities to create companies, generate jobs, take risks, etc; and from a broader perspective, it is oriented toward personal development, self-realization, initiative, creativity and taking actions to reach specific goals. For this same author (*op. cit.*), the entrepreneurship education's pedagogical and methodological approaches are to be decided according to the definition adopted by the institutions that include this educational trend in their curricula.

2.1 Entrepreneurship education

Fayolle *et al.* (2006, p. 702) define education for entrepreneurship as "any pedagogical [program] or process of education for entrepreneurial attitudes and skills." The purpose of entrepreneurship education is to provide students with tools and competencies to improve the chances of success of their businesses and ventures (Garavan and ÓCinneide, 1994; Liñán, 2004; Nabi *et al.*, 2017; Kim and Park, 2018), acknowledging, of course, diverse types of entrepreneurship education depending on the different stages of student development (Jamieson, 1984; Liñán, 2004).

Entrepreneurship education and entrepreneurship training are different concepts, however. The first refers to a series of activities where the objective is for an individual to assimilate and develop knowledge, skills and values to solve problems of entrepreneurship through creativity and innovation in a wide range of activities and areas (Ruskovaara *et al.*, 2015). On the other hand, entrepreneurship training involves planned systematic efforts to develop knowledge and skills through learning experiences focused on a particular field (Fulgence and McCracken, 2015). Hynes (1996, p. 13) explains, through a theoretical model (Table I), the phases of the entrepreneurship education process.

The model proposed by Hynes (1996) (Table I) is focused on the incorporation of entrepreneurial content in non-business disciplines, especially in courses related to engineering and science where business ideas emerge but are often forgotten or ignored because students lack the appropriate competencies and education to implement them. In this sense, the model is proposed as a practical guide for the instructional design of educational activities in formal and non-formal contexts (such as MOOCs).

2.2 Entrepreneurship competencies and skills

Entrepreneurship competencies combine several aspects, such as attributes of personality, skills and knowledge that the potential entrepreneur possesses, and other qualities, such as leadership, identification of opportunities, creativity, innovation, critical thinking, adaptability and problem-solving, which also have a substantial impact on the motivation of the entrepreneur (Farhangmehr *et al.*, 2016). These competencies can be considered as transversal core concepts in the instructional design of non-formal training spaces (such as MOOCs). The NMC Horizon Report (Adams Becker *et al.*, 2017) mentions that the trends where more progress has been made between 2015 and 2017 are the culture of innovation, the redesign of learning spaces and the reformulation of the educator's role. This opens the door to new opportunities in the area of educational innovation, and MOOCs represent a remarkable advance in this field, highlighting specific characteristics of online education such as versatility, asynchrony, free access, lack of admission criteria and participation on a large scale (Cabero, 2015).

The Global Entrepreneurship Monitor identifies two dimensions to measure entrepreneurship, namely, social entrepreneurship and corporate entrepreneurship. The first one involves the detection of a social problem and the creation of a solution that addresses

Inputs students	Process: Content focus	Process: Teaching focus	Outputs
Prior knowledge base	Entrepreneurship defined	Didactic (reading/lectures)	Personal (confidence and communication)
Motivation	Intrapreneurship	Skill-building (case studies group discussions, presentations, problem-solving, simulations, teamwork and projects)	Knowledge (enterprise initiative, self-employment, business, management and marketing skills, analytical, problem-solving, decision-making, communication, presentation and risk-taking)
Personality	Innovation		
Needs/interests	New product development		
Independence	Idea generation		
Attitudes	Market research		
Parental influence	Feasibility of idea	Discovery (brainstorming, personal goal setting, career planning and consultancy)	
Self-esteem	Finance		
Values	Production		
Work experience	Regulations		
	People management		
	Teamwork		
	Business		
	Marketing		
	Management		Career (improved knowledge, broader career options and broader less structured career perspective)

Note: "Environment" includes local learning environment and broader macro environment
Source: Hynes (1996, p. 13)

Table I.
Process model of entrepreneurship education

this problem, while the second one occurs within companies and refers to people that create innovations or startups (Núñez and Núñez, 2016).

There are factors specific to the personality of an individual that characterize them not only as an entrepreneur but also other external factors – such as the educational context – that motivate them to develop these features; that is, they need to train to innovate not only on technical aspects but also on the use of knowledge to solve complex and real situations (Núñez and Núñez, 2016; Robles and Zárraga, 2015). In this sense [. . .] "business competencies are all those skills, knowledge, values [. . .] within the educational context, which seeks to train an entrepreneur capable of generating wealth and social development" (Viloria, 2017, p. 137).

According to Robles and Zárraga (2015, p. 831), the critical competencies, considered essential and influential, that characterize an entrepreneur are: "risk-taking, initiative, responsibility, dynamism, problem-solving, search and analysis of information, orientation toward results, management of change, autonomy/self-determination, and quality of work." These same competencies can be labeled as "cognitive" or "functional and attitudinal." On the other hand, there are other competencies that the literature reports and that as they were developed in educational institutions, could improve the attitude of the entrepreneur and support the organizations, such as "communication, self-confidence and development of social networks/generation of support networks, innovation, integrity, leadership, self-control, social mobility, negotiation and teamwork" (Robles and Zárraga, 2015, pp. 829-831).

In short, entrepreneurship competencies can be classified as "cognitive", understood as knowledge and skills (mental models, declarative knowledge, social and interpersonal skills, learning and strategic skills) and "non-cognitive," which refer to attitudes (entrepreneurial passion, self-efficacy, tolerance to uncertainty, innovation and proactivity) (Table II). The former can be taught and evaluated more efficiently, while non-cognitive competencies are developed with practice, and therefore, are more challenging to develop and assess (Lackéus, 2015).

Topic	Subtopic	Main resource	Interpretation
Cognitive competencies			
Knowledge	Mental models	(Kraiger, *et al.*, 1993)	Knowledge on how to do things without resources, risk models or probability
	Declarative knowledge	(Kraiger, *et al.*, 1993)	Basic concepts of entrepreneurship, value creation, generation of ideas, opportunities, accounting, finance, technology, marketing, risk, etc
	Self-knowledge	(Kraiger, *et al.*, 1993)	Knowledge of the personal adjustment between being an entrepreneur and being a business person
Skills	Marketing skills	(Fisher, *et al.*, 2008)	Conducting market studies, market evaluation, marketing of products and services, persuasion, getting people excited about their ideas, dealing with customers and communicating a vision
	Resource skills	(Fisher, *et al.*, 2008)	Creating a business plan, creating a financial plan, obtaining financing and ensuring access to resources
	Opportunity skills	(Fisher, *et al.*, 2008)	Recognizing and acting on business opportunities, and other types of opportunities, product/service/concept development skills
	Interpersonal skills	(Fisher, *et al.*, 2008)	Leadership, motivating others, managing people, listening, solving conflicts and socializing
	Learning skills	(Fisher, *et al.*, 2008)	Active learning, adaptation to new situations and facing uncertainty
	Strategy skills	(Fisher, *et al.*, 2008)	Establishing priorities (set goals) and focusing on those goals, defining a vision, developing a strategy and identifying strategic partners
Non-cognitive competencies			
Attitudes	Entrepreneurial passion	(Fisher, *et al.*, 2008)	"I want." A need for achievement
	Self-efficacy	(Fisher, *et al.*, 2008)	"I can." A belief in the capacity to perform certain tasks successfully
	Entrepreneurial identity	(Krueger, 2005; Krueger, 2007)	"I am/I value." Deep beliefs, identity of roles and values
	Proactivity	(Sánchez, 2011; Murnieks, 2007)	"I do." Action-based, initiator and proactive
	Tolerance to ambiguity and uncertainty	(Sánchez, 2011; Murnieks, 2007)	"I dare." Being comfortable with uncertainty and ambiguity, adaptive and open to surprises
	Innovation	(Krueger, 2005; Murnieks, 2007)	"I believe." New thoughts/actions, unpredictable, radical change, innovator, visionary, creative and breaks the rules
	Perseverance	(Markman *et al.*, 2005; Cotton, 1991)	"I will win." Capacity to overcome adverse circumstances

Source: Authors, based on Lackéus (2015, p. 13)

Table II.
Entrepreneur competencies and their cognitive and non-cognitive relationships

2.3 Developing entrepreneurship education and training in emerging economies

Entrepreneurship has been globally recognized not only as an economic development strategy, both for the creation of jobs and wealth but also as a driver of innovation and knowledge (Schumpeter, 1934/1983; Acs *et al.*, 2009; Decker *et al.*, 2014; Nyadu-Addo and Benneh Mensah, 2018). Not surprisingly, supranational institutions such as the United Nations, the World Bank, the International Labor Organization and the World Economic Forum have applied entrepreneurship strategies and entrepreneurship education and training (EET) in developing countries, particularly in Africa, Latin America and Asia.

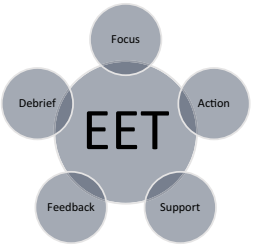
Nevertheless, teaching and acquiring entrepreneurial skills go beyond a simple teaching-learning role, tending to demand more experiential learning, especially in the development of attitudes and skills (Table II) (Barringer and Ireland, 2008; Zimmerer and Scarborough, 2009). The implementation of EET is not easy for educational institutions, as it requires not only economic and time resources but also curricular, paradigmatic and infrastructure changes to create environments and ecosystems of sustainable entrepreneurship, even providing them with seed capital for the creation of their ventures (Akhuemonkhan *et al.*, 2013; Fenton and Gallant, 2016). In the case of Latin America, there are few universities and teaching institutions that promote EET from an experiential learning point of view due to financial limitations, along with the difficult paradigm shift in traditional pedagogical models.

Some authors (Nyadu-Addo and Benneh Mensah, 2018; Ramírez-Montoya and Mendoza-Domínguez, 2017) explain that the model of experiential education for entrepreneurship (EET) from universities and educational institutions in emerging countries should follow the phases proposed by Joplin (1995): focus, action, support, feedback and debrief (Fenton and Gallant, 2016) (Figure 1).

Joplin's model (1995) can be very useful for understanding, particularly in emerging economies, that while it is true that the change from traditional pedagogy to EET requires a series of economic efforts, it is also true that it is based on a paradigm shift. That is to say, a shift to change the vertical teaching dynamics toward a space of knowledge creation under the modality of experiential learning.

3. Context: energy sustainability massive open online courses

In 2015, Mexico's National Council of Science and Technology (CONACYT), along with the Secretariat of Energy (SENER) and Tecnológico de Monterrey, created a strategic initiative to develop proposals for energy reform, bringing together various sectors of society such as academics, businesspeople and communities (Ramírez-Montoya and Mendoza-Domínguez, 2017). This project would later focus on the "Binational Laboratory for the Intelligent Management of Energy Sustainability and Technological Training" (https://energialab.tec.mx/).



Focus	Subject definition and preparation for addressing the challenge that will **be presented** in the action stage
Action	It is the core of experiential learning, and it entails learning by doing, involving direct mental, physical or emotional contact with the phenomenon under study
Support	Verbal, written or physical activity, which ensures that learners have the necessary information to motivate them for effective learning
Feedback	Providing information to participants about their performance, and could take the form of comments
Debrief	Actions that have previously been taken are subjected to questioning, integration and or evaluation to allow the learner to learn from experience

Source: Authors, based on Lackéus (2015, p. 13).

Figure 1.
Phases of EET

Within this macro-project, 12 MOOCs were created, their contents ranging from general topics such as energy saving to more complex issues, such as Smart Grids. These academic activities were offered both in the MexicoX platform (www.mexicox.gob.mx/) and in edX (https://www.edx.org/school/tecnologico-de-monterrey), from January 16, 2017 to September 21, 2018. With 123,124 participants registered, 16,887 completed the courses: a global completion rate of 13,715 per cent (Table III), a rate much higher than the 5-8 per cent found by Osuna-Acedo *et al.* (2018).

These MOOCs followed the traditional instructional design of xMOOCs, similar to conventional e-learning courses, in which the content is presented in a structured way, they have a start and end date and the evaluations focus on multiple-choice tests or co-evaluation exercises (Daniel, 2012; Yousef *et al.*, 2015). The 12 energy MOOCs are shown in Table III.

The present study was conducted on two specific MOOCs, namely, "carbon markets: a way to mitigate climate change" (CM) and "EM: business opportunities" on their first implementation, which had a duration of seven weeks with 35 teaching hours each. The MOOCs were open from September 4th to October 20th, 2017 (CM), and from September 25th to November 10th, 2017 (CM).

4. Method

The objective of this study is to analyze how energy entrepreneurship competencies are incorporated into MOOCs to develop educational innovation attributes and open educational projects (such as MOOCs). A mixed-method was used as due to the nature of the study, both quantitative and qualitative data were analyzed. In the quantitative phase, descriptive statistics were calculated with the IBM SPSS software, while the interaction analysis model/computer-mediated communication analysis model by Gunawardena *et al.* (1997) was used in the qualitative phase, using the MAXQDA tool applied to the discussion forums, to check if the interactions between the participants correctly point toward entrepreneurship opportunities.

4.1 Participants

The total population was made up of the participants enrolled in the two MOOCs (CM *n(e)* = 2,371 and EM *n(e)* = 4,146). The sample was purposive; it represented the participants that

MOOC	*n* (*e*)	*n* (*f*)	C_R (%)
Energy saving	12,929	2019	15.616
Distribution of electric energy	5,549	639	11.515
Smart grid: the electric networks of the future	6,608	821	12.424
Smart grid: technical principles	5,498	743	13.514
Transmission of electric energy	5,961	1074	18.017
Conventional and clean energies and their technology	18,693	2770	14.818
Electric energy: concepts and principles	15,978	1807	11.309
Energy: past, present and future	13,224	2106	15.925
CM	6,710	910	13.561
EM	10255	846	8.249
The new electric industry in Mexico	8975	1224	13.637
The energy reform and its opportunities	12744	1928	15.128
TOTAL	*123124*	*16887*	*13.715*

Notes: *n* (*e*) = number of enrollments; *n* (*f*) = number of finished; C_R = Completion Rates

Table III. Studied MOOCs on energy

completed the courses in their first iteration. Most of the participants were from Mexico (94.00 per cent), while the rest were from various regions of Latin America (Colombia: 1.60 per cent; Argentina and Chile: 0.29 per cent and Guatemala and Bolivia: 0.25 per cent). The total sample was 6,517 participants (Table IV).

The completion rates were of 17 per cent for CM [*n(e)* = 2,371; *n(f)* = 398], and 10 per cent for EM [*n(e)* = 4,146; *n(f)* = 432], considerably above the average completion rates established in the theoretical framework of this study, which often stands between 5-8 per cent (Osuna-Acedo *et al.*, 2018).

4.2 Instruments

Three different instruments were applied in an online environment. In the first place, an initial survey was administered to the participants enrolled in the MOOCs (CM and EM) to determine their interests, motivations and prior knowledge. At the end of the MOOCs, a final survey was applied to collect information about the acquired learning experience (Valdivia Vázquez, *et al.*, 2018).

Exploratory factor analysis (EFA) was first carried out to generate theoretical constructs. These constructs measure, from 1 to 4 (4 being the highest) the degree of agreement with a series of statements of the surveys (Table V). The dimensions of the first survey (pre-test, before taking the course) were conclusive, and the items showed significant loadings in any

Table IV.
Study sample

		CM		EM	
Indicator	Variable	Frequency	(%)	Frequency	(%)
Population	Participants	2,371	36	4,146	64
Certificate	Pass	398	17	432	10
Rates	Completion	403	17	415	10
Gender	Male	1,233	52	2,529	61
	Female	1,138	48	1,617	39
Country of origin	Mexico	2,209	94	4,022	97
Academic level	Professional degree	972	41	1,741	42
	High school	735	31	1,410	34
	Master's degree	285	12	456	11

Table V.
Questions related to energy sustainability entrepreneurship (pre- and post-test)

Pre-test	Post-test
I believe that this course will help to improve my professional development	After having taken it, I am convinced that this course will help to improve my professional development
I believe this course will improve my current or future business or employment opportunities	Having taken it, I am convinced that this course will improve my business or employment opportunities
I believe that this course will help meet the training needs that led me to enroll in it	This course satisfied the training needs that led me to enroll in it
I think this course will make it easier for me to establish professional relationships with people who have interests similar to mine	This course facilitated the establishment of professional relationships with people with similar interests to mine
I am willing to participate in discussion groups with participants who have my level of experience in the subject matter of the course	I actively participated in the discussion groups on energy sustainability ventures

of the four proposed variables. Only one item presented loadings in two dimensions, but given its theoretical justification and Cronbach's highest alpha, remained in the creation of the construct. The AFE data: explained variance = 66.83 per cent, KMO = 0.930, Bartlett's sphericity test: [χ^2 (190) = 63,854.763, $p < 0.001$]. Cronbach's alphas were all positive, above 0.84.

The EFA of the dimensions of the second survey was more problematic, but given the intention to compare constructs equivalent to those used in the first survey (pre-test), and given that Cronbach's alpha also showed high values, we proceeded to the creation of four constructs, namely, course evaluation (Cronbach's alpha: 0.842, items 4-10); acquired digital competencies (Cronbach's alpha: 0.847, items 11 and 13-16); acquired knowledge (Cronbach's alpha: 0.882, items 17-21); and Interaction with colleagues (Cronbach's alpha: 0.871, items 23 and 25). The importance of five types of factors (personal, family, social, design and work) in the successful completion of the course was also assessed among the post-test variables (one being of greater importance and five being less important). The frequency of participation in the forums was also measured (1 = in no units, 2 = in few units, 3 = in several units, 4 = in all units), and three dichotomous items (24, 27 and 28) that could be answered affirmatively or negatively.

The third instrument applied was an analysis of forums rubric with the IAM/CMC model by Gunawardena *et al.* (1997), to analyze the inter-relationships between peers and between facilitator and students, to identify interactions directed toward entrepreneurship in MOOCs.

4.3.1 Interaction analysis model/computer-mediated communication model. CMC technologies have become a fundamental element of online education environments, as asynchronous discussion forums are an elementary part of any virtual educational platform, such as MOOCs. The objective of these interactions (between students and between students and facilitators) is to promote critical thinking, interaction, problem-solving, and the construction of cooperative knowledge.

The IAM/CMC model is a specific qualitative analysis tool for this type of e-learning environment. Gunawardena *et al.* (1997) explains' that this model is applied in five phases:

(1) Phase I: Information comparison:
   - PHI/A: Clarification of terms.
   - PHI/B: Statements of agreement.
   - PHI/C: Corroboration of examples.
   - PHI/D: Clarification of details.
   - PHI/E: Problem definition.

(2) Phase II: Dissonance and inconsistency of ideas:
   - PHII/A: Identify disagreements.
   - PHII/B: Clarify disagreements.
   - PHII/C: Illustrate point of view.

(3) Phase III: Negotiation or co-construction of knowledge:
   - PHIII/A: Clarification of meaning of terms.
   - PHIII/B: Negotiation of arguments.
   - PHIII/C: Identify agreements.
   - PHIII/D: Propose new compromises.
   - PHIII/E: Proposal integration.

(4) Phase IV: Testing and modification:
- PHIV/A: Synthesis test.
- PHIV/B: Test on the cognitive schema.
- PHIV/C: Test on experience.
- PHIV/D: Test on the collected information.
- PHIV/E: Test on literature.

(5) Phase V: Agreements and applications:
- PHV/A: Summarization of agreements.
- PHV/B: Application of new knowledge.
- PHV/C: Enunciation of results.

For this research's analysis, specific topics were selected within the asynchronous discussion forums of the two MOOCs (CM and EM), namely: entrepreneurship, CM and their benefits, benefits of environmental markets and opportunities for business in EM.

One of the first steps to apply this model was the selection of the unit of analysis. According to Gunawardena *et al.* (1997), a message in a discussion forum becomes the unit of analysis because the cognitive activity and construction of the participants in the forum can be observed in it. Each message is coded according to the phases and levels of operation assigning one point in each interaction.

The log was also used as a technique to record event data of the reality observed in the asynchronous discussion forums of the MOOCs. For this log, we took an anecdotal description of specific details found in the development of the courses and the possible innovative contributions that could be proposed based on them.

5. Results

5.1 Trends in the discussion forums' interactions

The initial intention to interact in the forums and the final interaction is significant, positive and moderate [r (3,202) = 0.324, $p < 0.001$]. Along with this quantitative variable, the initial intentions to interact in the forums were significantly higher among those who answered positively in the post-test survey to the questions about whether they answered questions in the forum [t (3,217) = 11.839, $p < 0.001$] and if they provided feedback to other colleagues [t (2884.380) = 9.244, $p < 0.001$]. This was observed through a Student's T-test for independent samples.

The answers obtained from the participants in the final survey (post-test), concerning the interests and motivations for taking and completing the CM MOOC show that over 90 per cent indicated that the course met the training needs for which they enrolled in the MOOC. Likewise, over 90 per cent reported that the MOOC would help them to improve their professional development. On the other hand, over 80 per cent indicated that after taking the MOOC, their business opportunities would be improved. Over 70 per cent reported that the course facilitated establishing professional relationships with people with similar interests. The majority of participants (90 per cent) indicated that the course improved their academic training. Participants showed the necessary constancy and skills to complete the course (over 80 per cent).

The answers obtained by the participants in the final survey, concerning the interests and motivations for taking and completing the EM MOOC, show that 90 per cent indicated that the course met the training needs for which they enrolled in the MOOC. Likewise, 90 per

cent reported that the MOOC would help them to improve their professional development. On the other hand, over 88 per cent indicated that, after taking the MOOC, their business opportunities would be improved. 79 per cent reported that the course facilitated establishing professional relationships with people with similar interests. The majority of participants (89 per cent) indicated that the course improved their academic training. Participants showed the necessary constancy (87 per cent) and skills to complete the course (over 80 per cent).

5.2 Entrepreneurship competencies in the discussion forums

Out of a total of 192 participations in the discussion forums (CM and EM), the highest score was found on Phase I (PHI), "information comparison." This means that the participants focused on three levels, namely, PHI/E "problem definition," PHI/A "clarification of terms" and PHI/D "clarification of details"; these participations were all related to business opportunities. This phase obtained 209/496 points, which is equal to 42.14 per cent.

The Phase III (PHIII), "negotiation or co-construction of knowledge" obtained a total of 134/496 points (27.02 per cent). In this phase the participations were placed at the levels: PHIII/D "propose new compromises," PHIII/E "proposal integration" and PHIII/A "clarification of the meaning of terms." As part of this analysis process, it was interesting to visualize that several units of analysis (messages-participation) could be classified in several phases and levels of the model. Table VI summarizes these results.

As Table VII shows, most of the interactions focused on Phase I (PHI) (42.14 per cent) and Phase III (PHIII) (27.02 per cent). In the case of CM, the interest was more related to the areas of greenhouse gas reduction (23.57 per cent), and only 3.03 per cent of the interactions proposed entrepreneurial skills, as coded in Table II. In the case of CM, the highest interest of the participants was focused on the deregulation of EM – with positions against monopolies –; however, in this MOOC there is a clear interest in business opportunities (11.26 per cent of interactions).

Cod.	∑	(%)	Cod.	∑	(%)
PHI/A	48	9.68	PHIV/A	3	0.60
PHI/B	8	1.61	PHIV/B	3	0.60
PHI/C	30	6.05	PHIV/C	11	2.22
PHI/D	50	10.08	PHIV/D	12	2.42
PHI/E	73	14.72	PHIV/E	0	0.00
Subtotal	209	42.14	Subtotal	29	5.85
PHII/A	4	0.81	PHV/A	4	0.81
PHII/B	6	1.21	PHV/B	39	7.86
PHII/C	67	13.51	PHV/C	4	0.81
Subtotal	77	15.52	Subtotal	47	9.48
PHIII/A	21	4.23			
PHIII/B	2	0.40			
PHIII/C	11	2.22			
PHIII/D	58	11.69			
PHIII/E	42	8.47			
Subtotal	134	27.02			

Notes: Total: f = 946 interactions (100%); ∑ participants = 192

Table VI.
Results of the discussion forums' interaction with the IAM/CMC model

Although the proposals of the forums of Topic 3 (economics of climate change) and Topic 4 (CM) of the CM MOOC directly encouraged the participants to create team projects (networking) with the other participants and to come up with proposals and venture projects to reduce greenhouse gas emissions, only 3.03 per cent of the contributions presented business and entrepreneurship ideas.

This also happened, although to a lesser extent, in the forums of Topic 2 (compared attributes of competitive markets and regulated EM), in which 11.26 per cent of the interactions raised business ideas, mostly regarding smart grids and solar panels. Some excerpts of these proposals in the forums are mentioned below:

Q: Having reviewed all the materials related to the carbon market and energy markets, what entrepreneurial or business proposal would be suitable in the Mexican market today?

"In areas where the sun is mostly not obscured by clouds, such as Acapulco, it would be possible to experiment with renewable energy, like solar power. It could allow them to be self-financing and sell the surplus to individuals, it is clean energy, inexhaustible, if possible, I think they could go into the business of clean and renewable energy production" (PHIII/E).

"As part of the demand, you could participate as a Qualified User, which is a final user with large charge centers that could be registered as Qualified User before the CRE or those charge centers under contract. Qualified Users are free to participate in the Wholesale Electricity Market (WEM) either directly or through a Qualified Service Provider. Participating in the market means that they can buy electricity in the day market in advance or in real time, and sign contracts with generators that allow them to acquire electricity at an agreed price. SENER will define how charges from different charge centers can be added to reach the 2 MW of consumption currently required to participate in the WEM as a Qualified User, which must register with the CRE and sign a contract for connection with CENACE. The registration is optional; the user can purchase their electricity directly from a Basic Services Provider in case of not wanting to participate in the WEM" (PHIII/A/D).

"Participating in the market means that they can buy electricity in the day market in advance or in real time, and sign contracts with generators that allow them to acquire electricity at an agreed price" (PHI/A).

"I feel that in businesses for people who do not venture into large consortiums the dry gas market is an option because in our country there are large population centers that still use coal and lye to prepare their food. If there is a possibility of investing in it, for me, it is the right thing because there are still small monopolies in the commercialization of LP gas." (PHI/E).

6. Discussion

After analyzing the results, these show that both MOOCs' completion rates are well above the 5-8 per cent found by Kizilcec *et al.* (2013), Reich (2014), Yousef *et al.* (2014) and Osuna-Acedo *et al.* (2018): CM, with an $n(e) = 2{,}371$ had an $n(f) = 398$, placing its completion rate at 17 per cent, while EM, with an $n(e) = 4{,}146$ had an $n(f) = 432$, with a completion rate of 10 per cent.

However, a "zapping" type of behavior was detected, as many of the enrollees (approximately 50 per cent in both cases) did not even participate in the first two activities of the courses.

These average rates not only because of the fact that the design of the MOOCs promoted innovation through the generation of projects and proposals, and the incorporation of elements such as gamification but also because they incorporated networking spaces (such as interactive discussion forums) following the recommendations by Borrás Gené *et al.* (2016) and González *et al.* (2016), to increase the interest – ergo, the engagement – of participants.

Secondly, although the initial intention (pre-test) of the participants to interact in the discussion forums [r (3,202) = 0.324, $p < 0.001$] was significant – between positive and moderate –, only 192 participants interacted in them, which means 2.94 per cent of the total sample (*n(f)* CM + *n(f)*EM = 6,517). However, in the post-test survey participants answered affirmatively to the questions on whether they had answered questions in the forum [t (3,217) = 11.839, $p < 0.001$] and if they gave feedback to other colleagues [t (2884.380) = 9.244, $p < 0.001$]. These results highlight what Kizilcec *et al.* (2013) noticed: that this type of courses has a low level of student commitment, which may be because of its non-formal methods, its free access or the heterogeneity of its participants' profiles.

Regarding the inclusion of elements of entrepreneurship competencies in the MOOCs, both courses included in their discussion forums two exercises related to formulating entrepreneurship and business projects in their instructional planning. However, most of the interactions focused on Phase I (PHI) (42.14 per cent) and Phase III (PHIII) (27.02 per cent) of the IAM/CMC model by Gunawardena *et al.* (1997). In the case of CM, the interest was more related to the areas of greenhouse gas reduction (23.57 per cent), and only 3.03 per cent of the interactions proposed entrepreneurship competencies. In the case of EM, the highest interest of the participants was focused on the deregulation of EM, although there was a higher interest in creating business opportunities and networking (11.26 per cent of interactions) (Figure 2).

It is striking, in this regard, that in the CM post-test survey over 70 per cent of the participants indicated that the course facilitated the establishment of professional relationships with people who have similar interests, while in EM over 88 per cent reported that, after taking the MOOC, business opportunities would improve, and 79 per cent indicated that the course facilitated the establishment of professional relationships with people who have similar interests.

The qualitative analysis shows that most of the business and entrepreneurship proposals in energy matters were about smart grids, solar panels, energy accumulation systems, sales of surpluses to individuals and participation by individuals in the Mexican electricity market and dry gas investments.

Initial intention of interaction	*N*	Mean	SD	Std. error mean
Answered questions				
Yes	1,004	3,4973	47,145	01,488
No	2,215	3,2778	49,434	01,050
Provided feedback to other works				
Yes	1,826	3,4176	48,234	01,129
No	1,371	3,2544	50,262	01,357

Table VII. Trends in the discussion forums' interactions

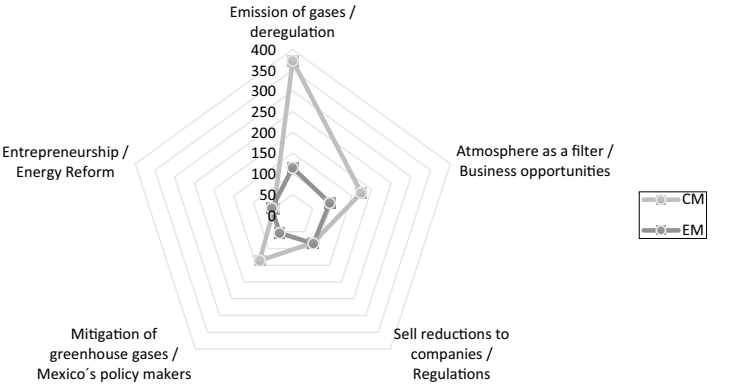


Figure 2.
Topics of interaction in the MOOCs

7. Conclusions, limitations and scope for future research

From the study, several conclusions can be made. First, that the MOOCs' instructional design affects the engagement level of the participants. This means that if a MOOC is designed with the traditional educational formula of online classes, without alternative spaces such as gamification, networking, discussion forums, learning based on projects and problems or interactions, it is possible that this will result in a low level of commitment from students. However, considering that the effectiveness of MOOCs as educational spaces should not be evaluated in relation to their completion rates, achieving a completion rate greater than 5-8 per cent could mean they have been effective, in light that because of the characteristics of this type of courses (such as free access, heterogeneity of participants and "zapping" behavior) completion rates are, on average, low.

A second conclusion is that there is a high initial tendency (pre-course) to participate in discussion forums and to create networks to analyze entrepreneurship and business proposals. However, the participation rate in this type of interaction spaces was very low (2.94 per cent of the sample), even in those exercises in which participants were encouraged to propose ventures. Something of note occurs in the post-test survey, where the participants of both MOOCs answered affirmatively to the questions on whether they had answered questions in the forum and if they gave feedback to other colleagues, when in fact only a few participants interacted in them. This situation may be because, either the participants did not want to participate (for reasons of time, lack of extrinsic motivation, etc.) or because specific modules on entrepreneurship competencies were not included as part of the MOOCs.

In this regard, future research could include modules or specific topics from the field of entrepreneurship in MOOCs, in which knowledge, skills and attitudes can be developed (Table II), to subsequently create a networking space for the exchange of business and entrepreneurship ideas. Presenting this activity as mandatory, with a high grade, could extrinsically motivate student participation.

If the objective of a MOOC is to generate ideas, networking and calls for action toward entrepreneurship, it is necessary to follow the steps set by Joplin (1995): focus, action, support, feedback and debrief (Figure 1). Given the characteristics of MOOCs, another conclusion is that the inclusion of these EET strategies was insufficient (it only included the focus phase and partly the action phase). Hence, the results demonstrate a low level of interaction and a low level of commitment to the objective of developing a space with ideas for ventures.

In this sense, we coincide with Akhuemonkhan *et al.* (2013) and Fenton and Gallant (2016) in the need for a paradigm shift to create environments and ecosystems of sustainable entrepreneurship. This could be done in MOOCs by continuing the steps explained by Joplin (1995), as follows:

- *Focus*: presenting a particular situation -such as the need to have means of sustainable energy production-, to create an idea of sustainable entrepreneurship.
- *Action*: through a specific business plan, related to all the elements of the venture explained in Table II (Business plan, marketing plan, financing plan, economic planning, etc.).
- *Support*: MOOCs could have a tutor, administrator or course curator, who motivates the students to develop their entrepreneur plan.
- *Feedback*: evaluation may be carried out by the teacher, tutor or through group feedback activities (discussion forums, videoconferences, peer evaluation, etc.).
- *Debrief*: debate of ideas and comments, which could also be carried out as a group activity through video conferencing platforms.

A future line of research could analyze the different tendencies in dealing with entrepreneurship issues correlated with the level of academic training and the knowledge field of the participants, to differentiate the way of approaching entrepreneurship issues among people with training in economics, administration, management, business, etc., and participants with training in other areas. Also, from this study, the need arises to verify whether the inclusion of entrepreneurship phases in EET (Joplin, 1995) has the same positive effects on MOOCs as it does on formal education.

References

Acs, Z.J., Braunerhjelm, P., Audretsch, B.D. and Carlsson, B. (2009), "The knowledge spillover theory of entrepreneurship", *Small Business Economics*, Vol. 32 No. 1, pp. 15-30.

Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C. and Ananthanarayanan, V. (2017), *NMC Horizon Report: 2017*, Higher Education Edition, The New Media Consortium, Austin.

Akhuemonkhan, I.A., Raimi, L. and Sofoluwe, A.O. (2013), "Entrepreneurship education and employment stimulation in Nigeria", *Journal of Studies in Social Sciences*, Vol. 3 No. 1, pp. 55-79.

Altbach, P.G. (2014), "MOOCs as neocolonialism: who controls knowledge?", *International Higher Education*, No. 75, pp. 5-7.

Anderson, A.R. and Obeng, B. (2017), "Enterprise as socially situated in a rural poor fishing community", *Journal of Rural Studies*, Vol. 49, pp. 23-41.

Anderson, A.R. and Ronteau, S. (2017), "Towards an entrepreneurial theory of practice; emerging ideas for emerging economies", *Journal of Entrepreneurship in Emerging Economies*, Vol. 9 No. 2, pp. 110-120.

Antonaci, A., Klemke, R., Stracke, C.M. and Specht, M. (2017), "Gamification in MOOCs to enhance users' goal achievement", in *IEEE Global Engineering Education Conference (EDUCON), Athens, Greece, 2017*, *Springer*, *Cham*, pp. 1654-1662.

Barringer, B.R. and Ireland, R.D. (2008), *Entrepreneurship: Successfully Launching New Ventures*, 2nd ed., Pearson Education Inc., Upper Saddle River, NJ.

Borrás Gené, O., Martiñez-Núnez, M. and Fidalgo-Blanco, A. (2016), "New challenges for the motivation and learning in engineering education using gamification in MOOC", *International Journal of Engineering Education*, Vol. 32 No. 1, pp. 501-512.

Cabero, J. (2015), "Visiones educativas sobre los MOOC", *RIED*, Vol. 18 No. 2, pp. 39-60.

Cotton, J. (1991), "Enterprise education experience: a manual for school-based in-service training", *Education+ Training*, Vol. 33, pp. 6-12.

Daniel, J. (2012), "Making sense of MOOCs: Musings in a maze of myth, paradox and possibility", *Journal of Interactive Media in Education*, No. 3, pp. 1-20.

Decker, R., Haltiwanger, J., Jarmin, R. and Miranda, J. (2014), "The role of entrepreneurship in US job creation and economic dynamism", *The Journal of Economic Perspectives*, Vol. 28 No. 3, pp. 3-24.

Farhangmehr, M., Goncalves, P. and Sarmento, M. (2016), "Predicting entrepreneurial motivation among university students. The role of entrepreneurship education", *Education + Training*, Vol. 58 Nos 7/8, pp. 861-881.

Fayolle, A., Gailly, B. and Lassas-Clerc, N. (2006), "Assessing the impact of entrepreneurship education programmes: a new methodology", *Journal of European Industrial Training*, Vol. 30 No. 9, pp. 701-720.

Fenton, L. and Gallant, K. (2016), "Integrated experiential education: definitions and a conceptual model", *Canadian Journal for the Scholarship of Teaching and Learning*, Vol. 7 No. 2.

Fisher, S., Graham, M. and Compeau, M. (2008), "Starting from scratch: understanding the learning outcomes of undergraduate entrepreneurship education", in Harrison, R.T. and Leitch, C. (Eds) *Entrepreneurial Learning: Conceptual Frameworks and Applications*, Routledge, New York, NY.

Frese, M. and Rauch, A. (2001), "Psychology of entrepreneurship", in Smelser, N.J. and Baltes, P.B. (Eds), *International Encyclopedia of the Social and Behavioral Sciences*, Pergamon, Oxford, pp. 4552-4556.

Fulgence, K. and McCracken, M. (2015), "Assessing the status of entrepreneurship education courses in higher learning institutions: the case of Tanzania education schools", *Education + Training*, Vol. 57 No. 2, pp. 239-258.

Garavan, T.N. and ÓCinneide, B. (1994), "Entrepreneurship education and training programmes: a review and evaluation–part 1", *Journal of European Industrial Training*, Vol. 18 No. 8, pp. 3-12.

González, C.S., Collazos, C.A. and García, R. (2016), "MOOC design challenges: Incorporating collaboration and gamification aspects", *Revista de Educación a Distancia (RED)*, No. 48, pp. 1-23.

Gunawardena, C., Lowe, C. and Anderson, T. (1997), "Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing", *Educational Computer Research*, Vol. 17 No. 4, pp. 397-431.

Harbi, S., Amamou, M. and Anderson, A.R. (2009), "Establishing high-tech industry: the Tunisian ICT experience", *Technovation*, Vol. 29 Nos 6/7, pp. 465-480.

Hernández, E.E., Romero, S.I. and Ramírez-Montoya, M.S. (2015), "Evaluation of digital didactic skills in massive open online courses: a contribution to the Latin American movement", *Comunicar*, Vol. 22 No. 44, pp. 81-90.

Hjorth, D. (2013), "Public entrepreneurship: desiring social change, creating sociality", *Entrepreneurship and Regional Development*, Vol. 25 Nos 1/2, pp. 34-51.

Hynes, B. (1996), "Entrepreneurship education and training – introducing entrepreneurship into non-business disciplines", *Journal of European Industrial Training*, Vol. 20 No. 8, pp. 10-17.

Jamieson, I. (1984), "Schools and enterprise", in Watts, A.G. and Moran, P. (Eds), *Education for Enterprise*, Ballinger, Cambridge, pp. 19-27.

Joplin, L. (1995), "On defining experiential education", in Warren, K., Sakofs, M. and Hunt, J.S. Jr (Eds), *The Theory of Experiential Education*, Kendall/Hunt Publishing Company, Boulder, CO, pp. 15-23

Kim, M. and Park, M.J. (2018), "Entrepreneurial education program motivations in shaping engineering students' entrepreneurial intention: the mediating effect of assimilation and accommodation", *Journal of Entrepreneurship in Emerging Economies*, available at: https://doi.org/10.1108/JEEE-08-2018-0082

Kizilcec, R.F., Piech, C. and Schneider, E. (2013), "Deconstructing disengagement: analyzing learner subpopulations in massive open online courses", in *Lak'13 Learning Analytics and Knowledge, Leuven, Belgium*, ACM, New York, NY, p. 10.

Kraiger, K., Ford, J.K. and Salas, E. (1993), "Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation", *Journal of Applied Psychology*, Vol. 78 No. 2, pp. 311-328.

Krueger, N.F. (2005), "The cognitive psychology of entrepreneurship", in Acs, Z.J. and Audretsch, D.B. (Eds) *Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction*, Springer, New York, NY.

Krueger, N.F. (2007), "What lies beneath? The experiential essence of entrepreneurial thinking", *Entrepreneurship Theory and Practice*, Vol. 31 No. 1, pp. 123-138.

Lackéus, M. (2015), *Entrepreneurship in Education, What, Why, When, How*, OECD-European Commission, Brussels.

Li, H. and Wang, S. (2013), "The role of cognitive distortion in online game addiction among Chinese adolescents", *Children and Youth Service Review*, Vol. 35 No. 9, pp. 1468-1475.

Liñán, F. (2004), "Intention-based models of entrepreneurship education", *International Journal of Entrepreneurship and Small Business*, Vol. 3 No. 1, p. 1135.

Manzini, F., Islas, J. and Martínez, M. (2001), "Reduction of greenhouse gases using renewable energies in Mexico 2025", *International Journal of Hydrogen Energy*, Vol. 26 No. 2, pp. 145-149.

Markman, G.D., Baron, R.A. and Balkin, D.B. (2005), "Are perseverance and self-efficacy costless? Assessing entrepreneurs' regretful thinking", *Journal of Organizational Behavior*, Vol. 26 No. 1, pp. 1-19.

Murnieks, C.Y. (2007), "Who am I? The quest for an entrepreneurial identity and an investigation of its relationship to entrepreneurial passion and goal-setting", [Doctoral Thesis], University of Colorado, Denver.

Nabi, G., Liñán, F., Fayolle, A., Kruger, N. and Walmsley, A. (2017), "The impact of entrepreneurship education in higher education: a systematic review and research agenda", *Academy of Management Learning and Education*, Vol. 16 No. 2, pp. 277-299.

Núñez, L. and Núñez, M. (2016), "Notion for entrepreneurship in school entrepreneurial skills training", *Revista Latina De Comunicacion Social*, No. 71, pp. 1068-1089.

Nyadu-Addo, R. and Benneh Mensah, M.S. (2018), "Entrepreneurship education in Ghana – the case of the KNUST entrepreneurship clinic", *Journal of Small Business and Enterprise Development*, Vol. 25 No. 4, pp. 573-590.

Osuna-Acedo, C., Marta-Lazo, C. and Frau-Meigs, D. (2018), "From SMOOC to TMOOC, learning towards professional transference: ECO European project", *Comunicar*, Vol. 26 No. 55, pp. 105-114.

Oswald, U. (2017), "Seguridad, disponibilidad y sustentabilidad energética en México", *Revista Mexicana de Ciencias Políticas y Sociales*, Vol. 62 No. 230, pp. 155-196.

Ramírez-Montoya, M.S.Y. and Mendoza-Domínguez, A. (Eds) (2017), "Innovación y sustentabilidad energética. Formación con MOOCs e investigación educativa", *Narcea*, Madrid.

Ramírez-Montoya, M.S. (2018), "Open, interdisciplinary and collaborative innovation to train in energy sustainability through MOOCs and educational research", *Education in the Knowledge Society (Eks)*, Vol. 19 No. 4, pp. 11-30.

Reich, J. (2014), "Learner intention recasts 'low' MOOC completion rates", available at http://harvardx.harvard.edu/news/learner-intention (accessed 22 February 2019).

Robles, L. and Zárraga, M. (2015), "Key competencies for entrepreneurship", *Procedia Economics and Finance*, Vol. 23, pp. 828-832.

Rodrigo-Cano, D., Picó, M.J. and Dimuro, G. (2019), "The sustainable development goals as frame for the action and social and environmental intervention", *Retos Revista de Ciencias de la Administración y Economía*, Vol. 9 No. 17, pp. 25-36.

Ruskovaara, E., Pihkala, T., Seikkula-Leino, J. and Järvinen, M.R. (2015), "Broadening the resource base for entrepreneurship education through teachers' networking activities", *Teaching and Teacher Education*, Vol. 47, pp. 62-70.

Sánchez, J.C. (2011), "University training for entrepreneurial competencies: its impact on intention of venture creation", *International Entrepreneurship and Management Journal*, Vol. 7 No. 2, pp. 239-254.

Schumpeter, J.A. (1934/1983), *The Theory of Economic Development (Theorie Der Wirtschaftlichen Entwicklung) (Trans. by R. Opie with New Introd. by J.E. Elliott)*, Transaction Publishers, New Brunswick, NJ.

Smith, H., Glasson, J. and Chadwick, A. (2005), "The geography of talent: 13 entrepreneurship and local economic development in Oxfordshire", *Entrepreneurship and Regional Development*, Vol. 17 No. 6, pp. 449-478.

Steyaert, C. and Katz, J. (2004), "Reclaiming the space of entrepreneurship in society: geographical, discursive and social dimensions", *Entrepreneurship & Regional Development*, Vol. 16 No. 3, pp. 179-196.

Torres-Toukoumidis, A., Ramírez-Montoya, M.S. and Romero-Rodríguez, L.M. (2018), "Assessment and evaluation of games-based learning (GBL) in e-learning contexts", *Education in the Knowledge Society (Eks)*, Vol. 19 No. 4, pp. 109-128.

Vaibhav, A. and Gupta, P. (2014), "Gamification of MOOCs for increasing user engagement", *IEEE International Conference on MOOC, Innovation and Technology in Education (MITE), Thapar, India*, pp. 290-295.

Valdivia Vázquez, J.A., Ramírez-Montoya, M.S. and Valenzuela-González, J.R. (2018), "Motivation and knowledge: pre and post assessment of MOOC participants from an energy and sustainability project", *International Review of Research in Open and Distributed Learning*, Vol. 19 No. 4, pp. 116-132.

Welter, F., Baker, T., Audretsch, D.B. and Gartner, W.B. (2016), "Everyday entrepreneurship-a call for entrepreneurship research to embrace entrepreneurial diversity", *Entrepreneurship Theory and Practice*, Vol. 41 No. 3, pp. 311-321.

Yousef, A.M.F., Chatti, M.A., Wosnitza, M. and Schroeder, U. (2015), "A cluster analysis of MOOC stakeholder perspectives", *Rusc. Universities and Knowledge Society Journal*, Vol. 12 No. 1, pp. 74-90.

Yousef, A.M.F., Chatti, M.A., Schroeder, U. and Wosnitza, M. (2014), "What drives a successful MOOC? An empirical examination of criteria to assure design quality of MOOCs", in *14th IEEE Int. Conf. Adv. Learn. Technol. ICALT 2014, 2014*, pp. 44-48.

Zimmerer, T.W. and Scarborough, N.M. (2009), *Essentials of Entrepreneurship and Small Business Management*, 5th ed., Prentice Hall, Upper Saddle River, NJ.

Further reading

Borrás Gené, O., Martínez Núñez, M. and Fidalgo Blanco, A. (2014), "Gamification in MOOC: challenges, opportunities and proposals for advancing MOOC model", in *TEEM'14 Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality, Salamanca, Spain, 2014, ACM, New York, NY*, pp. 215-220.

Li, J. and Wang, L.M. (Eds) (2014), *China's Economic Dynamics: A Beijing Consensus in the Making*?, Routledge, London.

Corresponding author

Luis M. Romero-Rodriguez can be contacted at: lromero@tec.mx