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## **Problem-based Gamification on sustainable energy´s MOOCs**

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### **Abstract**

Open Access Education is a movement that is growing in strength as a way of promoting innovation in schools. Such it is the case of the Massive Online Open-access Courses (MOOCs), which, in addition, promotes the democratization of learning. The present research is part of a national wide strategic project on energy sustainability, funded by the Mexican CONACYT-SENER (Agreement: S0019-2014-01). The project consists in developing MOOCs to train on both energy and sustainability topics in the use of innovative educational strategies such as the Gamification based on mechanics challenge (GBC). Three teams have been working in this process: a group of experts on energy and sustainability, another group of experts in educational innovation and research, and finally, a group of experts in technical production. The aim of the present study is to verify what would be the impact of GBC when it is used in the design of MOOCs by the three groups of experts. The study was developed through a qualitative methodology. For such purpose is attended to three meetings from which is carried to our observations not participating. Three categories emerged from the analysis: previous experience on design of content in MOOCs, previous experience on gamification and previous experience on problem-based learning. Results from the research described that the majority of the 'Energy and Sustainability' expert group had never used the MOOCs design of content, translating into a positively significant support from the 'Courses Creation and implementation' expert group. In addition, it was also found that the same team had limited knowledge regarding gamification despite they were familiar with problem based learning methodology as they used it in their lessons. Secondly, the support of educational innovation and research team was significant as well. The study shows how interdisciplinary work is highly relevant to the development and improvement of open innovation resources and methodologies. These results can be taken into the account to assist in the design of futures MOOCs, particularly xMOOCs, in a way to promote more active and less traditional types of learning.

Keywords: Gamification based challenge, MOOCs, sustainable energy

## **1 INTRODUCTION**

Open Access Education is a movement that is growing in strength as a way of promoting innovation in schools. Such it is the case of the Massive Online Open-access Courses (MOOC), which, in addition, promotes the democratization of learning. So take advantage of the massive and the democratization of learning that are implied in the MOOC [1], the Federal Electricity Commission (CFE), the National Council of Science and Technology (CONACYT) and the Tecnológico de Monterrey (ITESM) have undertaken the project 266632 "Binational Laboratory for the Intelligent Management of the Energy Sustainability and the Technological Formation" (Agreement: S0019-2014-01) [Laboratorio Binacional para la Gestión Inteligente de la Sustentabilidad Energética y la Formación Tecnológica], which aims

to impact the social, business and academic communities of Mexico and Latin America, creating awareness about sustainable energy options. Expected to present large-scale energy issue contributing to their dissemination, reflection and development, as part of the main industrial activities in the country. Likewise, is want to contribute in the area of technology education including elements innovative as the gamification [2,3] in order to promote the motivation and learning of the participants.

The present study aims to show the development of collaborative work [4] and interdisciplinary [5] for the creation and development of open innovation environments [6], as the MOOCs. The project involves three groups of experts: one in the area of energy and sustainability, another expert group in the area of educational innovation and research, and the third in production of MOOCs courses. Figure 1 shows the instructional model.

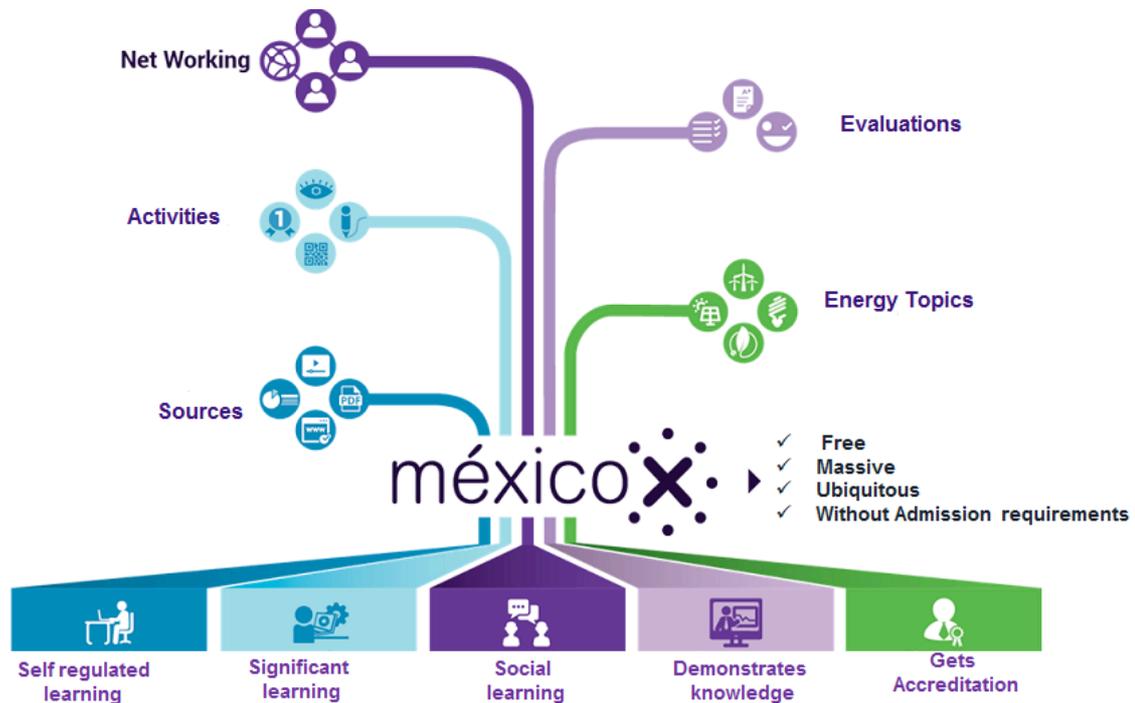


Fig. 1 Model instructional of the courses MOOCs of the project Binational Laboratory for the Intelligent Management of the Energy Sustainability and the Technological Formation (Agreement: S0019-2014-01).

The plan of the project consists of three phases of the summer of the 2015 to the summer of the 2018. In the first phase five of ten agreed massive courses will be developed so they are released in January of 2017 through the platform MéxicoX (<http://mx.televisioneducativa.gob.mx/>) which form part of the platform edX (<https://www.edx.org/course>). In the second phase of the analytical data of appropriate adjustments will be made as part of the investigation process, also the publications of research generated by the project will be carried out. In parallel is will develop the five courses MOOCs remaining to be launched between May and June of the 2017. During the third stage, improvements will be made to the last five MOOCs according to the results of the investigations and will continue with the publication of the same.

## 2 TEORICAL FRAMEWORK

### 2.1 Collaborative and interdisciplinary work.

Innovation goes beyond the launch of new products or to use the latest technology launch [6]. Innovation processes arise from challenging in a community or organization, in the process, creative, human and material resources are integrated to produce a solution that generates better quality of the environment [7] . For [8] the incorporation of new materials, new behaviours and new beliefs and

conceptions are inherent to innovation changes that generate a transformation of knowledge whose benefits may be individual or collective and of different nature.

According to the Organization for Cooperation and Economic Development, the innovation is the cornerstone for the economic development of countries, even can be the means to solve economic problems emerging from globalization. This has been key to emerging countries such as China, Korea, and Brazil [9]. By this way can appreciate that it innovation is an element crucial to the growth and development of any type of organization, already is educational, business, medical, industrial, among others [10]. Said growth and development will impact at the same time to the entity in which is found.

Thus, the innovation as a topic for an organization carries inherent collaborative work, and the understanding that is synonymous of combining efforts having as common denominator the achievement of results [4,11]. For its part, [5, 12] proclaim that in addition to collaborative innovation should be interdisciplinary to enhance innovation, nanotechnology and biotechnology illustrate clearly converge innovation, collaboration and interdisciplinary. Of this form we can see how the progress, scientific and technological have acted as engines of the interdisciplinary and it will continue to do [13]. Currently, the collaborative and interdisciplinary are appearing in educational, business, social and industrial, perhaps not naturally although in a more complex manner.

## **2.2 Los MOOCs como parte del movimiento de innovación abierta**

On the other hand, the connectivity plays a crucial role to shorten distances between interdisciplinary groups what is favoring collaborative work [11]. The greatest diversity of digital resources is strongly promoting open innovation, although some organizations have a reserved attitude on the issue, companies such as Netflix and General Electric have invested large amounts of money to develop creative ideas through open innovation, collaborative and interdisciplinary work. For example, Netflix launched to the public the challenge to get the best algorithm to recommend movies to its customers, offering \$ 1 million to the winner [14] while General Electric (GE) has created an online system through academics, businessmen and anyone wishing to submit their ideas [15].

By way similar, the National Aeronautics and Space Administration (NASA) has promoted the creativity and innovation among their followers through a series of challenges as the Astronaut glove challenge that consists in getting innovations of functionality in them gloves used by them astronauts in the space [16]. Thus, the Government of United States has found in this program a way of giving solution to problematic complex through the proposed of innovation generated by them citizens.

This shows that open innovation is a source of proposals that spread to develop knowledge [6,17,18] thanks to its open access and collaborative and interdisciplinary participation of diverse communities [19] thus contributing to the international competitiveness of a country, in such a way that innovation could become the constant that determines the level of development of Nations [9,10]

Similarly, in the educational area, the MOOC are a space for open innovation that has been taking importance in recent years. In the year 2013, the Massachusetts Institute of Technology (MIT) launched the first course MOOC of the history through the platform EdX and since then the growth has been exponential in various universities around the world [20]. MOOC courses represent an opportunity to democratize both to the education as the development of the architecture technology and of them models pedagogical [21].

MOOCs are a relatively new educational phenomenon and framed by distance education, which allows students to have access to a variety of free educational resources, promoting also the interrelations between people from all parts of the world [22]. Another advantage of the MOOCs is contributing to the training of personnel in the organizational area, thanks to the online format makes it possible for employees follow the course from anywhere, anytime [23]. A fundamental aspect of the open courses is that the participants must be able to initiate and complete the studies according to their needs.

Currently there is a variety of MOOCs and different platforms. Generally speaking, there are two types, the xMOOCs and the cMOOCs [24]. The xMOOCs emerged in 2011, are self-directed interactive multimedia such as videos and text-based, they are characterized by: behaviorists, formal training focused on content, evaluation consists in: test, evaluation by peers, partial evaluations and

end of immediate feedback. As for the cMOOCs, authors like [25,26] believe that the cMOOCs have a greater contribution in the cognitive development of participants thanks to the network of collaboration and monitoring of those who manage the courses. Even [27] are in favor of a combination of xMOOCs and cMOOCs, they consider that each course has its advantages and disadvantages according to the formative strategy, approach to learning and assessment.

## **2.3 Gamification on MOOCs**

The growth and use of massive online courses are leading to put in motion the integration of innovative strategies in this type of courses. Some researchers such as [27, 28] considered that include resources such as the gamification in the xMOOCs could contribute to increase motivation, terminal efficiency and the improvement of the learning or the level of performance.

The gamification is an innovative educational strategy which takes elements of the game in contexts that are not gaming [29]. Its purpose is placed in the student in scenarios simulated that involve the achievement of attractive challenges, so increase your level of engagement and competitiveness [30]. The gamification is a trend that arose many years ago, for example, badges and ranks were used in the military, even leaders of the old Soviet Union used elements of the game to motivate and recognize the good performance of its militants [31].

Years later, the gamification is extended to business, marketing, health and education recently. Companies like Starbucks, Amazon, eBay, Heineken and Nike, among others, have dabbled in the gamification to increase the loyalty of your clients [32]. As well as in business, the gamification has been gaining ground on education, to a large extent that takes elements and mechanics of the games, to the digital age in which we live and the benefits that the game itself it has [33].

The gamification uses elements that favor the motivation intrinsic and extrinsic, for example the offering of badges favors to its extrinsic while the challenge of passing of a level to another, is a mechanism that favors it intrinsic [34]. Also offers the opportunity to experiment with the rules, emotions and social roles [3]. For these reasons the gamification is a strategy that can motivate to the students to learn better.

On the other hand, a gamification system according to [35] model consists of dynamics and mechanical components. Dynamics are the contexts in which the gamification develops, the mechanics are activities within the dynamics and components are used within the mechanical objects [36]. [3,37,38] have found that in a gamification system, in the area educational, must involve has three dimensions: cognitive, social and affective. In this way, a dynamic affective based on mechanisms of challenges and that use components attractive as badges, points or trophies, can favor the motivation and the learning [39, 40, 41].

## **2 METHODOLOGY**

The methodology of this study was qualitative to know deeply the dynamics of interaction between some members of the groups of experts [42]. This type of methodology is holistic, the scenery, the people and groups are not reduced to variables but that they are part of the. For such purpose is attended to three meetings from which is carried to our observations not participating [43].

The instrument that is used was a grid of observation previously designed for such purpose, which focuses on three categories: experience prior in the design of their MOOCs, perceptions on the gamification and the learning based in challenges. The data collection process was developed through a systematic observation [43] in which the above mentioned axis categories were present.

For this study was selected the course entitled: "The energy reform in Mexico and its opportunities", the course explains the major changes and new business opportunities which facilitates the energy reform in Mexico. Is chose this course by their impact in the generation of innovative business ideas in the sector energy under a perspective of sustainability.

### **3 RESULTS**

The objective of this work is to show the development of work collaborative and interdisciplinary for the creation and development of environments of innovation open (e.g. MOOCs). The results are displayed based on the categories and perspectives given by the three interdisciplinary groups.

#### **3.1 Prior knowledge in the design of courses MOOCs**

For expert content, it was the first time that it was facing an experience in the development of the MOOCs and although its experience on the subject of the energy reform is no doubt found that he had to make an effort to adapt to the use of templates which require a high capacity of synthesis and realization. In this regard the development and production of MOOCs group played an important role since oriented content expert to better develop its function.

Development of MOOCs also was an experience new for the expert in innovation and research, although in the group there are people that already formed part of the development of one or several courses masses in Coursera, for all, including to the Group of experts in the production and development of MOOCs, the use of the platform Mexico X is something new. In this regard a series of discussions have resulted in both groups because the platform does not provide the analytical of data for the development of the previously agreed research. As a result of these discussions has been to hire an expert in science data that can automate the processing of information from the Mexico X platform in analytics data that can be processed by the group of innovation and research.

#### **3.2 Previous knowledge in gamification**

The role of the team innovation-research and development-production equipment, has been crucial to the organization of the system of gamification within the MOOCs courses. Despite the technological limitations of the Mexico X platform in the game design, the use of badges or Leaderboards has been established agreements to optimize the resources in order to obtain an innovative instructional design. Innovation and research group expect that from the results of investigations to push for more technological resources that help to innovate even more MOOCs-SENER courses.

It was the first time that content expert heard the term gamification, both expert groups, innovation - research as production development, have worked collaboratively with the purpose that the gamification activities contain educational intentions according to MOOCs-SENER courses instructional model.

#### **3.3 Knowledge previous in learning based on challenges**

Although the expert in content does not have a knowledge methodological on CBL, the term was more familiar that the of gamification. Then, the design challenges have been more fluid than the gamification activities, however the support of the group of innovation-research as production-development continues to be crucial to the project.

On the other hand, as a result of the massiveness of the course (around of 12000) MOOCs-SENER courses will be self directed, which has generated arguments among the innovation-research group and production-development group. The first team considered educationally important that participants can socialize results of their proposals and feedback by the content expert. As a result of these discussions it was agreed content experts to develop automatic responses to the ideal proposal according to your expert point of view.

#### **3.4 Perception of the process of innovation**

A fourth category arose from the observation of the other three major categories, this is the perception of innovation by the three groups. The expert in content sees to the course MOOC as an opportunity of massively the learning on themes of energy and sustainability, also those participating can access of way free. At the same time generating an environment from which can arise innovative ideas for the resolution of challenges with this theme. The group innovation-research and production-development team considered that include strategies didactic as the gamification and CBL improve the process of learning and the motivation.

### **4 DISCUSSION AND CONCLUSION**

The study shows how interdisciplinary work is highly relevant to the development and improvement of open innovation resources and methodologies. These results can be seen in the three categories observed. Which makes resonance with what was said by [5,12] whom claim that the collaboration

must also be interdisciplinary, something that complements [13] when he says that technological advances, in this case of connectivity, are the engines of the interdisciplinarity. In this same line, [4] highlighted the importance of collaboration in the development of innovations as well as the importance of technology in the collaborative process [11]. Thus, this study evidence as the expert group on content of energy and sustainability, the group of production and development of MOOCs and the expert group on innovation and research are working collaboratively and interdisciplinary for the successful achievement of this project.

The process of innovation is perceived by the three groups as the way to improve what is done, besides the group of innovation and research suggests that through the research is to assess the impact of educational innovations in the MOOCs-SENER courses. This coincides with what was said by [6,8,17] in the sense that innovation must be assessed to be placed in a process of continuous improvement. It is therefore very positive that the three groups have an affine vision of the innovation process.

Finally, in spite of the fact that the expert in content is not familiar with the didactic strategies gamificación and learning based on challenges had an open stance and collaboration thanks to the help and guidance of the other two groups. The expert in contents recognizes that such strategies can promote the design of the MOOCs-SENER courses. [3,34,35,36,37,38,39,41] assert that the gamificación offers the opportunity to experiment with challenges, rules, emotions and social roles, so that this strategy can motivate students to learn better. Thus, the three groups are in agreement that the gamificación with mechanical challenges is a didactic strategy that innovates the xMOOCs.

Although the collaborative process of the project has been complex as a natural result of the interdisciplinary which has been exacerbated by the limitations of the Platform Mexico X, especially among groups of innovation-research and production-development. This is a process that has been enriching for the participants. Without a doubt, these results can be taken into the account to assist in the design of futures MOOCs, particularly xMOOCs, in a way to promote more active and less traditional types of learning

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