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Challenge-based gamification as a teaching' Open Educational Innovation strategy in the energy sustainability area

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ABSTRACT

The purpose of this paper is to show a PhD dissertation research plan-and its current status- about the use gamification to promote Challenge-Based Learning through online teaching (MOOCs). The research question specifically aims at measuring the relationship between the impact of challenge-based gamification in online teaching on the level of educative innovation in terms of solving problems related to sustainable energy. This dissertation is part of the Strategic Initiative of Energy Project that was started by the National Council for Science and Technology in Mexico (CONACYT), the Energy Ministry (SENER) and the Tecnológico de Monterrey, which aims for massive training on the topics of energy and sustainability. For this purpose, there are being designed ten MOOCs (massive open online courses), which should include innovative teaching strategies such as gamification and challenge based learning. The gamification is an innovative educational strategy whose purpose is to place the student in scenarios or simulations involving achieving attractive challenges so as to increase their level of commitment (engagement) and competitiveness. Around 1,000 participants will take the MOOC and will constitute the study sample of this study. Questionnaires, open-ended interviews, and challenge-base learning tasks will be delivered to participants. A mixed method research analysis for both quantitative and qualitative data will be conducted. Intended results may probably point to differences between those participants who use gamification and those who do not in terms of being more successful in solving real-life energy problems. At present, only the theoretical framework and the instruments have been developed.

Keywords

Gamification, Challenges, MOOCs, Open Innovation, Energy

1. CONTEXT AND MOTIVATION THAT DRIVES THE DISSERTATION RESEARCH

In Mexico, the National Council for Science and Technology (CONACYT), the Secretariat of Energy (SENER) and the Tecnológico de Monterrey launched the *Strategic Energy Initiative* Project to develop energy reform in 2015 , which aims to impact the academic, business, and social communities in Mexico and Latin America; creating awareness about sustainable energy options through open innovation.

The purpose of this paper is to show a PhD dissertation research plan-and its current status- about the use gamification to promote Challenge-Based Learning through online teaching (MOOCs). The present research work is linked to this project as an opportunity to study the areas of massive courses and educational strategies, such as challenge-based gamification, to assess the level of innovation achieved in solving the issues around the sustainable energetic options. In front of this pedagogical, technological, innovative, and massive opportunity, it is appropriate to ask: What is the relationship between challenge-based gamification and the innovation levels achieved by participants regarding sustainable energy options in Massive Open Courses of the Energy Sector? At present, only the theoretical framework and the instruments have been developed.

2. STATE-OF-THE-ART

Digital resources increasingly being more accessible to citizens enables connectivity and, consequently, they open new ways for innovation. For example, General Electric (GE) and the National Aeronautics and Space Administration (NASA) have created an online system contest in which anyone and anywhere in the world can submit innovative projects [17,21]. Undoubtedly, this shows that open educational innovation may lead teachers to developing knowledge [14, 29] through open access, collaborative learning [13] and interdisciplinary participation in diverse communities [35] 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.

Similarly, in education, MOOC courses are means for open innovation. In 2013 the Massachusetts Institute of Technology (MIT) launched the first MOOC course of history through the edX platform, and since then the growth has been exponential in various universities around the world [39]. This is so because MOOC courses are an opportunity to democratize education and to develop technology architecture and pedagogical models [19]. There is currently a variety of MOOCs and various platforms [3], for example, the edX platform is characterized by not being profitable, while xMOOC by its massiveness and by the emphasis on a traditional learning and teaching [8] where participants watch videos and then perform exercises in form of examinations, this has been one of the most common critiques to this course style.

Criticisms have led to the integration of innovative strategies in MOOCs. [5, 6, 15] committed to include innovative teaching strategies in MOOCs, such as gamification, in order to enrich and encourage motivation. The gamification is an innovative educational strategy [27,33] whose purpose is to place the student in scenarios or simulations involving achieving attractive challenges so as to increase their level of commitment (engagement) and competitiveness [1,25,36]. In this regard, challenge based learning [2,22,24] can be an element that complements gamification and vice versa, converging in what has been called challenge-based gamification. As gamification motivates student engagement [18] and challenge based learning motivates their creativity determining the level of innovation achieved [1,2,24].

The challenge-based gamification strategy has been integrated to encourage open innovation in business, government, and educational institutions. For example, companies such as Lego, Harley-Davidson, or Netflix (among others) have formal innovation programs consisting of the open release of challenges in order to obtain a large number of proposals from all over the world. [21] claim that open innovation creates a positive synergy between school, business, research, and science; whose benefits will also impact society [23].

3. HYPOTHESIS

This research proposes the following hypothesis of study:

Null hypothesis: The challenge based gamification developed in a massive open environment does not enhance higher levels of innovation to solve real problems associated with self-sustainable energy options

Alternative hypothesis: The challenge-based gamification developed in a massive open environment enhances the highest levels of innovation to solve real problems associated with self-sustainable energy options.

4. RESEARCH OBJECTIVES/GOALS

The objective of this research is to assess the impact of gamification and challenge based learning in four massive open courses of the energy sector, and the innovation levels reached by the participants. This will be done with the goal to solve the problems associated with the self-sustainable energy options in order to propose a model of challenge based gamification that promotes open innovation in MOOCs.

The specific objectives are as follows:

- 1) To contrast various models: [12,16,31,37,38] of both educational innovation and enterprise to determine the appropriate profile for the CONACYT-SENER MOOCs.
- 2) To design and implement challenge based gamification activities to assess the levels of innovation achieved by participants of the CONACYT-SENER MOOCs.
- 3) To propose a model of challenge-based gamification that encourages open innovation in MOOCs.

5. YOUR RESEARCH APPROACH AND METHODS, INCLUDING RELEVANT RATIONALE

For the development of this research, we will use the mixed research method. [9,20] consider this methodology as a third paradigm, it is characterized by gathering quantitative and qualitative data that when combined allow a better understanding of the studied problem. This methodology will allow observation of the big picture of the relationship between challenge-based gamification and innovation levels achieved by participants, making it possible to go from the general to the particular to assess the impact on the level of innovation achieved in solving problems related the self-sustainable energy options. The design to be used in this investigation will be sequential CUAN -> CUAL as each step will strengthen the one before [28]. First, a quantitative analysis and data mining will be performed of the information obtained from the MOOCs variables. Then it will be deepened through qualitative instruments such as interviews and analysis of comprehensive challenges.

Population and sample: The study population we'll address are the total number of participants from four massive open courses that will be released within the Strategic Initiative project of CONACYT-SENER Energy next fall 2016. The study sample will consist of around 1000 participants who have already completed high school, older than 17 years and who want to be up to date or be trained on energy sustainability issues. A probabilistic sampling method will be used to select the sample (quantitative data). Contrarywise, sampling will be intentional for qualitative data [9]. Both approaches will be worked on participants who complete 100% of the course.

Study variables:

- 1) Innovation levels: this is an indicator based on organizations or participants' potential to devise, plan and develop innovations out of the available resources [31, 37]. This gives better educational practices as a result [32]. [12] proposes four levels: the first level adapts and improves, the second level has a change, the third level involves a transformation and the fourth has an impact over the environment.
- 2) Challenge based gamification: this methodology makes use the videogame dynamics and its elements to achieve missions or challenging tasks in order to get the students' attention [11]. The objective is to keep them engaged [4,24, 30].

Instruments and techniques:

- 1) Survey: MOOC participants will take a survey. This way, we will know sociodemographic indicators, such as gender, educational level and either or not the participant belongs to the energy sector (open innovation levels).
- 2) Questionnaire: MOOC participants will take a pre and a post test, in order to compare sample participants results against the performance of challenge based gamification activities.
- 3) Participant dashboard (progress log in the system): the participants' level of achievement will be analyzed using the database in order to measure their commitment (engagement) in the gamified activities (challenge based activities).
- 4) Products from the comprehensive challenges developed by the participants: the products will be analyzed using a rubric to decide innovation levels of achievement.
- 5) Exams: participants will test their knowledge in contextualized situations during the examinations. They will take partial exams when finishing each topic and a final exam when finishing the course.
- 6) Interviews: About 5% of the participants that conclude MOOC will be interviewed to know their beliefs about challenge based gamification. This information will be compared against the performance shown in the participants' dashboard and the products of the comprehensive challenges.

Information sources:

- 1) Participants: the students from four MOOCs about the energy sector will provide information about their performance, their participation in the challenge based gamified activities, and the level of innovation achieved.
- 2) Artifacts: four courses MOOC developed for the energy sector. The instruments used in this research will be implemented within these courses.
- 3) Digital material: Scopus (a digital database of peer-reviewed literature), books, videos and journals, to be up to date with the state of the art regarding the variables involved the present study. The reviewed material will be of much use for comparing and validating obtained results.
- 4) Productions developed through the challenge-base gamification: The analysis rubrics will be employed for deciding the innovation level achieved by the participants.
- 5) Participants dashboard: this artifact will be used to analyze the students' participation level.

Data collection and analysis:

- During the first delivery of one of the MOOCs, we will implement the following instruments: the survey, the questionnaire, the participants' dashboard, the productions developed through the challenge base gamified activities and the interviews.

- The necessary improvement of the tools implemented in the pilot study will be made.

- In the first phase, the survey will be applied to collect socio-demographic and academic information from participants, this is they will answer a questionnaire. Information from both instruments will be analyzed using the SPSS software. Through the Orange develop software for data mining, records of the participants in terms of challenge based learning and their respective dashboard will also be analyzed.

In the second phase, starting from the quantitative analysis, participants who have reached the minimum percentage to be able to pass the course will be selected in order to do the interview. The interview questions will be based on the fundamental analysis theory by [34]. Participants' products will be analyzed taking into account the analysis rubric. The information from these instruments will be processed and analyzed through NUDIST NVivo software.

Data analysis: The mixed methodology allows us to jointly analyze the results from the quantitative and the qualitative methodologies. Data collection will be doing jointly as well as the result analysis afterwards [10]. For this study, it will be of great value to apply the mixed methodology as it will deepen our understanding of the phenomenon of study through methodological triangulation of information gathered from the survey, the questionnaire, the challenge based gamification activities and panel participants. These results will be compared with the results of qualitative instruments, such as the interview and productions of the participants [7].

Regarding the ethical aspects, the necessary arrangements between the participants will be done to observe and obtain information from the MOOCs. Their identity will be protected.

Means and Resources:

- 1) SPSS: software for developing statistical analysis.
- 2) MOOC: means through which MOOCs CONACYT-SENER courses are delivered, and in which the challenge based gamification will be applied.
- 3) Google Forms: application software for designing and delivering questionnaires.
- 4) Academic programs: these will permit us to see the contents and with this in mind, the challenge based gamification will be designed.
- 5) Google Docs: these will allow the communication between professors concerning new ideas and improvements of gamified activities.
- 6) NUDIST Nvivo: it will make interview analysis easier.
- 7) Weka: it will allow the data mining to analyze the roads of association and obtain the rules of association that give us more focused information about the development of a student inside the MOOC.

6. RESULTS TO DATE AND THEIR VALIDITY

At present, MOOC courses are being successfully implemented in a number of higher institutions worldwide. Three groups collaborate in the project: experts in energy and sustainability, experts in MOOC courses production and experts in educational innovation. The three expert groups have collaborated in the development of the instruments and efforts have been done to request the instrument inclusion into the courses.

7. DISSERTATION STATUS

To date, we have been progressing with the theoretical framework. Besides, we have already decided upon which instruments will be used in the pilot study and in the first edition of the MOOC CONACYT-SENER courses, particularly on the course: *The energetic reform and its opportunities*.

8. CURRENT AND EXPECTED CONTRIBUTIONS

During the present investigation, we expect to assess the impact of incorporating innovative strategies in the MOOCs, especially the challenge-based gamification. The impact will be measured in the innovation level achieved by the participants. Also, we expect to develop an educational model to incorporate the challenge-based gamification strategy into the production, management, and assessment schemes of massive open courses.

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