

## **MOOC and Serious Game An Educational Approach on Transfer and Action**

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Keywords: MOOC, Serious Game

### **INTRODUCTION**

IFP School is a specialized engineering school that offers applied graduate programs in engineering for the energy and transportation sectors. The school provides students and young professionals with education in the fields of energy which meets the needs of industry and the demands of society with particular emphasis on sustainable development and innovation.

The unique aspect of IFP School is that it is an applied and industry-oriented school. The educational approach is based on the application and development of "know-how" and of adapted behaviours in a professional context: it is "learning-by-doing"! The school already uses a lot of learning activities to facilitate development of skills, such as, collaborative exercises, practical work, projects, real case studies from the industry, and role playing scenarios. In this context, IFP School decided to apply the same approach to its first Massive Open Online Course (MOOC), entitled "Sustainable mobility".

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## **1 “SUSTAINABLE MOBILITY” MOOC**

### **1.1 MOOC description and objectives**

The subject of the first IFP School MOOC was “Sustainable mobility: technical and environmental challenges for the automotive sector”. The objectives of the course, taught during four weeks of lectures, included the acquisition of technical skills in economics, fuels, refining, engines (internal combustion, hybrid, electrical), and air pollution. As an applied engineering school, it was important to create a course where this knowledge could be put into practice.

From the school’s standpoint two main goals were pursued: first, to enhance the school’s reputation and visibility in order to attract highly motivated students from all around the world; and second, to innovate and experiment new technologies through the implementation of a Serious Game on a MOOC platform with a view to attracting younger people and improving the students’ motivation, guarantee the acquisition of the required skills, and finally put these skills into practice.

### **1.2 MOOC context**

MOOCs started in the United States in 2008. A MOOC is an online course open to all participants and is completed during a limited period. The M for Massive means that the course can welcome a large number of participants, the O for Open means that the course is open to everyone, regardless of their origin or level of studies. Finally, O and C refer to Online Courses, as the course and its activities are fully online. A MOOC is split into separate weeks, each divided into lessons containing different resources. There are three different types of resources: learning aids (videos and texts), support resources (syllabus, FAQs) and community resources (forums and weekly emails).

Although MOOCs are considered to be a small revolution in secondary schools (because only 5% of secondary schools have already produced a MOOC), they are, without a doubt, a breath of fresh air in current learning methods, placing the emphasis on teaching through digital technology. There are, however, two main critiques which concern the business model and the completion rate. Regarding the business model, it is difficult, for now, to compare the visibility brought by the MOOC to the production costs. In the case of the IFP School MOOC on “Sustainable Mobility”, we have made the choice to reuse a part of the learning aids and the serious game in our campus-based teaching. For instance, the videos are used, in different masters, in several basic teaching units, or for non-specialists and, the serious game is used as a simulator in different lectures. Thus, these learning aids contribute really to the abilities of our graduates. As for the completion rate, it is difficult to summarize learning as the totality of the different resources consulted. As a reminder, the completion rate is defined as the number of participants who earned a certificate of completion over the total number of learners. The low completion rates are related to time constraints, learning context (MOOCs offer a huge freedom in a structured environment), and generally participant motivation rather than learning content as such. In that respect, IFP School and its «Sustainable mobility » MOOC try to boost participants’ motivation by proposing different gamification processes, in order to maintain attractiveness during the 4 weeks of courses.

### **1.3 Technical integration of a Serious Game in the MOOC**

The implementation of the Serious Game in the MOOC environment sparked further technical challenges and developments. Indeed, the game, developed by aPi-learning, based on web technology HTML5 was integrated in the open source CANVAS LMS platform, hosted by Unow. The choice of HTML5 allowed a greater

compatibility across devices and operating systems. As a result, the game runs on PCs and tablets, whether Android or iOS systems, with no need for any plugin installation. As a consequence, the market coverage is optimal to guarantee an access anytime and anywhere.

Besides, the users accessed the game directly from the LMS, making no difference from any other course activity. The whole experience is extremely user friendly. In addition, integrating the game to the LMS (Learning Management System) allowed us to send scores to a student's grade book. In order to achieve these results, a new integration standard used for tiers applications was followed in the field of educational software. This standard is called LTI or Learning Tools Interoperability. The principle is to be able to run a tiers application and to identify a user from the LMS: the LMS sends the information regarding the users' identity, their role, and the context to the tiers application. Then, the tiers application sends a result or a grade back to the LMS.

Consequently, the online courses are no longer restricted to quiz activities to assess learner's learning. The use of more dynamic exercises is now possible, with greater interaction such as drag&drop, simulations, and direct manipulations. This innovation challenges the current MOOC practices [1].

## 2 SERIOUS GAME CHARACTERISTICS

### 2.1 Serious game design

The serious game was designed by a team of 5 professors from the Centre for Engines and Hydrocarbon Utilizations and the Centre for Refining, Petrochemicals and Gas, with the help of the instructional designer and developed by aPi-learning, an e-learning editor specialized in engineering & science education and training. The objective of this immersive learning is to raise awareness amongst the players of the challenges facing the energy sector by bringing to life the theoretical concepts addressed in the MOOC.

The story of this video game begins ... Once upon a time, John, a new employee at MOOCenergy ... After getting to know his new workplace, in the first scene which takes place in a refinery plant, his first assignment is to draw up specifications to produce a tank of gasoline and a tank of diesel (Fig. 1). These tanks are for a European automaker, one of MOOCenergy's clients.



Fig. 1. Serious game scene 1

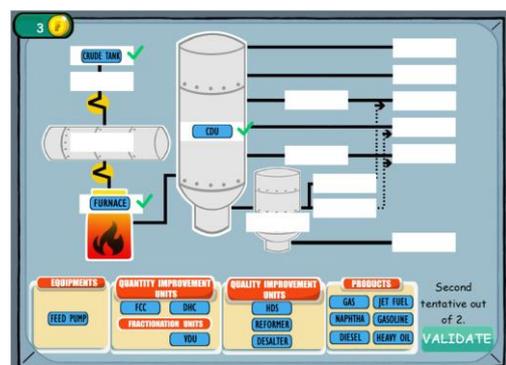


Fig. 2. Serious game scene 1

Having successfully completed his first assignment, John is promoted to Head of Production! His job is to optimize the production unit's operating parameters and blends to obtain the products requested, whilst keeping in mind to be "eco-efficient" (Fig. 2).

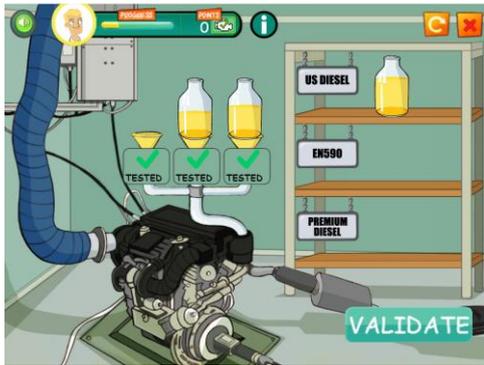


Fig. 3. Serious game scene 2



Fig. 4. Serious game scene 3

The second scene takes him to the test bench center (Fig. 3) to examine the diesel fuel he has just produced. Immersed in a realistic test bench unit, he has to measure the quantity of fuel consumed, the noise levels, and the rate of particulates produced by the fuel. Finally, John's exceptional day draws to an end. It's time for him to go back home, limiting his impact on the environment. In the third and last scene, he has to choose a car (Fig. 4), the type of fuel and the source of primary energy to limit the CO<sub>2</sub> emissions he will produce.

Despite being virtual, the whole game is based on the kind of real assignments that IFP School students may be confronted with in their future careers. It helps transfer the knowledge into practice.

In the MOOC, the serious game was the main part in terms of offered activities. The total duration of the serious game is approximately 1 hour (scene 1= 30 min, scene 2= 15 min, scene 3= 15 minutes).

## 2.2 Theoretical approach for the Serious Game design

Many scientific studies have been done on the impact of instructional games and the serious game proves that games are effective for learning and a good way to maintain the learner's motivation [2]. That is why we decided, for the first time in a MOOC, to include a serious game for our online course. We designed the serious game taking into account some research on the subject. The idea was to put into practice the results of these studies to reach the MOOC objectives described in paragraph 1.1.

Vogel [3] presents in his meta-analysis studies that higher cognitive gains are observed in learners utilizing interactive simulations or games versus traditional teaching methods. Ke [4] shows that the effects of learning with games was positive in 52% of the studies he examined in his meta-analysis study. Instructional games seem to facilitate motivation.

Hays [5] reminds us, in his review of the literature on serious games in 2005, the main importance of instructional objectives to design the instructional game. The efficiency of the game is directly linked to the specification of the instructional objectives to be met. He pinpoints that the game should be embedded as a part of a global program which includes debriefing and corresponding feedbacks. The same conclusion was drawn in Sitzmann's [6] meta-analysis. In this way, the learner understands how the game supports the instructional objectives of the lecture. The efficiency of the game is also higher if hints on how to use the game are directly included in the game to help the learner understand how to play.

Vogel found that the level of picture realism in the game does not seem to have an impact on the game efficiency.

A clear external rewards system will increase the intrinsic and extrinsic motivation. Points are not only extrinsic tokens, they can provide feedback and data on the performance of the learner.

Concerning avatars, literature recommended strategy for attempting to influence behaviour; several studies have been conducted showing the effectiveness of avatars for influencing behaviour.

In addition, providing learners with unlimited access to instructional games improves learning.

We designed the serious game to take into consideration all these theoretical aspects to meet our objectives:

- a. The learner can choose his avatar at the beginning of the first scene of the game. This point requires a communication system to be constructed between the serious game and the MOOC LMS (CANVAS). This way, the learner selects his avatar only once at the beginning of the game.
- b. We implement a different rewards system for each scene. This rewards system is clearly explained and in line with the objectives of the MOOC. This rewards system is designed to take into account the extrinsic motivation (such as obtaining the best scores) and the intrinsic motivation (such as increasing the students' knowledge on mobility and obtaining the final certification of the School).  
The learners were evaluated at the end of each week by quizzes and the serious game. They must obtain a score of 60% to collect a badge.
- c. The picture design selected is a comic strip style, realistic enough for the learner to be immersed in the game.
- d. The game is completely embedded in the MOOC courses. Each scene has specific objectives designed by the professor of the sequence. All the scenes and the teaching aspects are detailed in a story board. In addition, the game is introduced within the MOOC during the professor's lecture (video).
- e. In the game, the learners can play as much as they want.
- f. The motivation of the public targeted is taken into account. Our population is quite homogeneous – students from engineering schools and universities or young professionals interested by the subject. Thus, we can think that the intrinsic motivation of this group of learners is favourable for learning the subject itself and for obtaining the IFP School certificate at the end of the MOOC.
- g. Use levers to promote extrinsic motivations : interactivity, graphic design, rewards, badge collection, diverse gameplays (goals and means).

### **2.3 Serious Game classification**

The game embedded in the MOOC is a serious game because it combines both serious and game dimensions. The concept of the "Serious Game" was defined by Sawyer (2002). In Sawyer's (2002) definition a "Serious Game is based on the idea of connecting a serious purpose to knowledge and technologies from the video game industry". We can find in literature different types of classification for serious games. The first classification is according to the type of game. The different types of games are, for example, advergames, businessgames, edugames, exergames, green games, healthcare games, newsgames, simulation and immersion,... Our serious game is clearly an edugame with the intention of broadcasting an educational message. In addition, during the first scene, a part of the game has another purpose, it becomes a "Training and Simulation Game" with the aim of training the learner in a realistic environment.

Alvarez and Djaouti [7] [8] proposed another way to classify games. Using the Game play/Purpose/Scope - GPS model of Alvarez and Djaouti, we can classify all games into this classification shown in Table 1. To try to retain a maximum of our targeted public, all along the MOOC, we decided to select, depending on the scene of the Serious game, different gameplay means and different purposes, including training and simulation in the first scene. Table 2. presents the 3 scenes of the serious game following the GPS model.

Table 1. GPS model of Alvarez and Djaouti

GPS Model	
<b>Gameplay</b>	<ul style="list-style-type: none"> <li>Type: Game-based / Play-based</li> <li>Goals: Avoid / Match / Destroy</li> <li>Means: Create / Manage / Move / Random / Select / Move / Write</li> </ul>
<b>Purpose</b>	<ul style="list-style-type: none"> <li>Message broadcasting: Educative / Informative</li> <li>Training: Mental / Physical</li> </ul>
<b>Scope</b>	<ul style="list-style-type: none"> <li>Markets: Education / Corporate / Ecology / Scientific research / Advertising</li> <li>Public: General Public / Students / Professionals</li> </ul>

Table 2. The 3 scenes of the serious game following the GPS model

GPS	Scene 1 "At the Refinery"	Scene 2 "At the test bench"	Scene 3 "On the road"
<b>Gameplay</b>	Game-based Match Move / Select / Write / Manage	Game-based Match Move / Select	Game-based Match Select
<b>Purpose</b>	Educative Message <b>Training and simulation</b>	Educative Message	Educative Message
<b>Scope</b>	Education General Public <b>Students</b> <b>Young Professional</b>	Education General Public <b>Students</b> <b>Young Professional</b>	Ecology <b>General Public</b> Students Young Professional

### 3 OUTCOMES

#### 3.1 Qualitative outcomes

The results obtained within this first MOOC are interesting compared to the average numbers observed in other MOOCs in France:

49% of the students enrolled were under 25 year olds (the average for other MOOCs is between 15 and 19%). As explained previously, the target population was students in third level education interested in the energy sector, of which 3099 participants enrolled. It is impossible to deny the strong impact the Serious Game had on this MOOC. Some learners have really pinpointed the interest of the Serious Game to learn and put their knowledge into practice, as in the following examples extracted from the final evaluation form:

- "The serious game enables us to put what we just learned into practice. Therefore, we get a better understanding of the course. The fact that we can re-play them as much as we want removes the stress. It is both a pleasure and a great way to learn."
- "The serious games were the most enjoyable part of this MOOC because it is an alternative way of testing. That way a participant does not feel the subconscious anxiety and pressure that a normal test provokes but it is a more relaxed and comfortable way of testing that ensures better performance."

- “The serious game could be far more developed and replace the quiz’s that are very academic and not really interesting.”
- “The serious game was great because you work like on a real job”
- “The serious games were very enjoyable ! Learning while having fun!”

With such great results, IFP School has already planned to offer this MOOC again in November this year. Some improvements in the serious game are already under discussion to make it more real and to include different types of exercises.

### 3.2 Quantitative outcomes

The completion rate was 31% compared to the total enrolment. This is already a very high value considering that the average completion rate for MOOCs is around 15%. The completion rate was 59% if only the active participants are considered (an active participant is a participant that completed at least one of the assignments).

We have analysed the answers obtained from the questions asked to the participants at the beginning and at the end of the MOOC, and the demographics. 53% of the users think the Serious Game helped them to have a better understanding of the lecture videos and 43% think it increased the interest in the course. The two populations are exclusive, meaning that 96% overall think the Serious Game had a positive effect on their learning.

Then, we compared two groups of learners (*Table 3*). The groups are created from the question “Which activities and topics in the MOOC was the most enjoyable or fruitful?”. The “SG” group which is the group where the Serious Game is written in the answer (38,4% of the answers) and “Not SG” group is the group where the SG is not mentioned (61,6% of the answers).

If we analyze the learners inside these two groups, we notice that :

- no significant difference exists between professionals and students.
- no significant age difference is seen between the two groups. This observation is interesting and contradicts the currently admitted statement that the “digital natives” are more interested by computer games.
- women are more numerous in the SG group (25% versus 20% in the Not SG group).

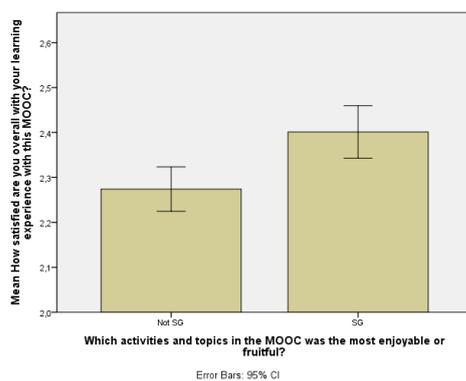


Fig. 5. SG and Not SG learning satisfaction

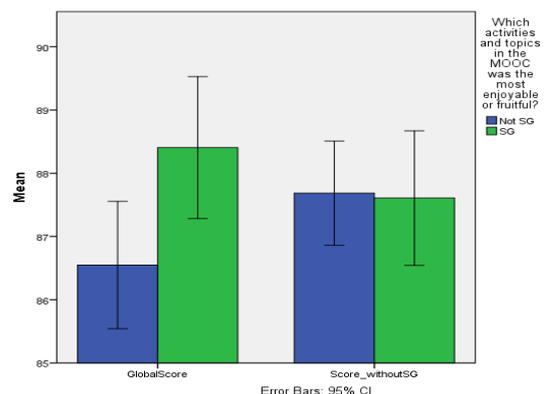


Fig. 6. SG and Not SG scores

Concerning the global learner satisfaction, a correlation exists between the global satisfaction with the MOOC and playing the serious game. The learners who found that the serious game was the most interesting activity (SG group) are more satisfied with the MOOC (*Fig. 5*). We can conclude that the serious game is a real motivational tool.

The learners in the group SG obtained a better global score compared to the learners in group Not SG. However, when we subtract the serious game score from the global

score, we do not have any difference between the two groups (*Fig. 6*). It means that the SG group performed better on the Serious Game activities but no transfer of knowledge occurred towards other activities. This can be explained by the fact that the quizzes and the serious game were focused on completely different subjects and objectives. It is also interesting to remember that the exercises proposed in the serious game are more difficult, interactive, and immersive compared to the other activities proposed, such as the quizzes.

#### **4 CONCLUSIONS**

From the results collected during the MOOC, we can see a clear relation between the integration of the Serious Game in the MOOC and the motivation and global satisfaction of learners. The high motivation and satisfaction rates observed in the qualitative and quantitative analysis are correlated to the high completion rate obtained by this MOOC. In addition, this MOOC attracted a lot of students and young professionals. This population is often difficult to capture and satisfy during the 4 weeks of a MOOC.

#### **Acknowledgments**

The authors would like to thank all the faculty team, Unow and aPi-learning for their technical support.

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