

# Learning by doing: Integrating a serious game in a MOOC to promote new skills

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## ABSTRACT

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Playing is associated with pleasure and fun whereas academic learning is associated to effort and hard work. Much research has shown the benefits of introducing games in academic teaching as a way to improve learning. Curiosity is also important when learning. Indeed, when curiosity is awakened, people learn without resistance. In order to improve the learning experience, a serious game was integrated in a MOOC. The use of a serious game as a form of evaluation in a MOOC is a true innovation in education: students played a video game where different situations were presented and they had to solve problems related to the courses. Innovating in education is certainly a challenge. Although integrating a serious game in the MOOC platform needed a considerable amount of technical effort, it was an absolute success: the completion rate was high (31%) with a great percentage of young students (49%) following the courses.

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## Context

The past few years have seen the exponential growth of the number of MOOCs. Many universities made the move mostly to address institutional visibility and to keep the leadership in education and new learning techniques. Additionally, MOOCs are used in flipped classes, some programs attribute credits to students who complete the courses. Nonetheless, the components used in a MOOC are still pretty much the traditional ones: lectures with videos, and evaluations with quizzes. This system has the well-known advantages and disadvantages of traditional teaching methods: a large amount of subjects can be addressed in a reduced amount of time to a large public but there is no application of the acquired knowledge. Besides, motivation can quickly fade even for students that are highly motivated at the beginning of the courses. Evidence of this fact can be found in the average completion rate of current MOOCs: only around 10% of the students enrolled obtain the certificate of completion.

Faced with this situation, it seems important to develop, propose and try out new developments within the context of MOOCs to help the students maintain their motivation from the beginning to the end of the courses, because "motivation is the most important factor that drives learning...". In this context, IFP School proposed to insert a Serious

Game as a learning and evaluation device within its first MOOC.

Considerable research has shown how Game-Based Learning (educational games) can be a more practical and effective approach to motivate and promote learning (1, 2, 3). Compared to both traditional environments and other computer-based learning environments, learners' intrinsic motivation toward a Game-Based Learning environment is higher, and learners using the game tend to be more involved and intrinsically motivated when actively solving problems. Games provide a more proactive environment for learners to interact with, as compared to books, audio or video. In particular, video games provide a meaningful context and an interactive visual representation that makes learning material not only useful and relevant but also fun. Video games are especially efficient to get students involved, promote an interest in and a positive behavior toward the topic, and consequently increase their knowledge. In terms of learning outcomes, it has been proven that video games are effective to develop a wide range of cognitive skills, including procedural knowledge, declarative knowledge, and higher thinking skills (4,5). This is particularly true for video games featuring open-ended environments where users can experiment, learn from their mistakes, and update

their knowledge accordingly. Such environments are especially conducive to higher thinking skills required in third-level education. However, the development of such video games in education generally involves high development costs.

Unless the games have already been developed commercially, the cost factor usually dissuades educators and developers to develop or use them.

Taking into account this research, and as an applied engineering school for the energy and transport sectors, in November 2014, IFP School launched its first MOOC called “Sustainable Mobility: Technical and environmental challenges for the automotive sector”. When building this MOOC the challenge was to implement current pedagogical practices to improve interaction and to develop an environment where the students can experiment and practice the skills learnt from the lessons. A Serious Game was designed and implemented over a three week period of the online course. This pedagogical innovation facilitated knowledge transfer through situational learning (6,7). The Serious Game allowed students to put knowledge into practice: students were faced with situations to solve industrial problems as a real engineer would do in a working environment.

This paper explains IFP School’s experience regarding the production of the Sustainable Mobility MOOC, including the development of the Serious Game as a part of the evaluation process within the MOOC. The subject of the technical challenge that represented the development and the integration of a Serious Game in a MOOC environment will also be addressed. Finally, a brief feed-back will be presented regarding the students profile and the satisfaction and completion rates.

## IFP School and The Sustainable Mobility MOOC

IFP School is an engineering school that offers applied graduate programs, providing 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 energy industry is facing unprecedented challenges in the 21st century. This is especially true in the transportation field, where global demand is growing exponentially and shows no sign of letting up. Oil and gas are non-renewable resources that will not meet this demand indefinitely. However, no alternative energy solution is currently available to serve as a rapid and comprehensive substitute. At the same time, finding a solution to the issue of global warming is becoming increasingly urgent. To address these various challenges and achieve sustainability, our

societies need to develop clean and renewable energies. This means creating the conditions necessary for a progressive and balanced transition. Diversifying our energy sources will enable us to limit the impact on the environment while we search for new alternative energies.

These subjects were the core of the courses developed in the MOOC. The learning goals included the acquisition of technical skills in economics, fuels, refining, engines (internal combustion, hybrids, electrical) and 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 with new technologies through the implementation of a Serious Game in a MOOC platform with a view to improving the students’ motivation, guarantee the acquisition of the required skills, and finally put these skills into practice. The Serious Game allowed us to combine a fun and dynamic environment to improve the learning experience. Since the target population was very narrow (young students wishing to develop a career in the energy engineering sector) the Serious Game was also a way to attract younger people.

The Serious Game was entirely integrated in the MOOC platform. It was used to evaluate the students during the MOOC but will also be used during the lectures of the graduate programs of the school. The Serious Game was designed by a group of 5 lecturers, technically assisted by the educational engineering team, developed by aPi-Learning, and introduced in the MOOC platform by Unow. To limit the costs of the Serious Game, the complete Story board was designed directly by IFP School. This immersive learning is part of an effort to improve the players’ awareness of energy issues, trying to give meaningful practice to the theoretical concepts seen during the MOOC videos.

The story of this video game starts with... *Once upon a time, John, a new employee of the company “MOOCenergy”...* After a brief introduction of the work environment, the first task that John needs to do is to prepare the specifications for the production of a barrel of gasoline and a barrel of diesel. Both barrels are needed for a European car manufacturer who is a client of “MOOCenergy”. This happens in a refinery control room as shown in Figure 1.

Once the first task is achieved, the player is promoted to production manager. He is now in charge of optimizing the operational parameters of the blends units so he can produce the products by using processes that are “ECO-efficient”. After this

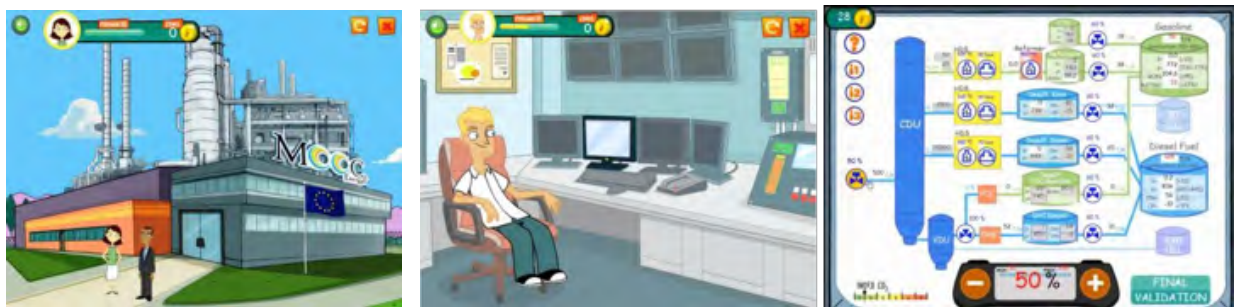


Figure 1. The Serious Game: during the second week of the MOOC.

task is performed, in the third week, the player is taken to the engine test facility so that he can test the fuels that he has just produced. In the engine test bench, he is asked to measure the fuel consumption, the noise level and the particulate emissions produced by the diesel fuel. Finally, in week 4, this amazing journey ends. John is going back home but he needs to limit his environmental footprint. So he is asked to choose the car, the fuel and primary energy source to limit the global CO<sub>2</sub> emissions (Figure 2). Even though this is a video game, the game is based on real tasks that students at IFP school might have to solve in a future job.

The advantages of this Serious Game are multiple:

- Each proposed step enables students to acquire knowledge. Students need to do a synthesis and practice in a realistic environment, in a refinery or in an engine test bench. The students are put into action, or in other words it is “Learning by doing”.
- The educational approach is *student-centered* and not *subject-centered*. This helps associate the “action” and “emotion” dimensions of education by making the learning attractive through a fun environment. Students are in the core of the game, it is they who are the masters of the environment.

- The video game produces a challenge. The students need to progress, earn points, keep up the motivation.

The playful side also relieves the learning effort from the lectures.

- “To play is to experience”. This Serious Game allows a progressive learning by “trial and error”. The more the students play, the more the skills are developed.
- The problems to solve are complex. The student successfully learns the subjects of the courses in a particular context. Recent research conducted by Harvard shows that reflection on learning improves understanding, or in other words, it is “Learning by Thinking” (8). The game helps learners to develop their self-awareness of their learning process and the corresponding effectiveness (metacognition)

The Serious Game was considered a positive asset of the MOOC by 96% of the students. Moreover, it was a good complementary tool for practical work in a massive learning structure.



Figure 2. The Serious Game during third and fourth weeks of the MOOC .

## The Technological Challenges

The implementation of the Serious Game in the MOOC environment implied further technical development (9). 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 PC and tablets, whether Android or iOS systems, with no need for any plugin installation. Doing so made it possible to cover a large population of users for access anytime and anywhere.

Besides, integrating the game in the LMS (Learning Management System) allowed us to send scores to student's grade books. On top of that, the users accessed the game directly from the LMS, making no difference with any other course activity. The whole experience is user friendly.

In order to achieve these results, a new integration standard used for tier applications was followed in the field of educational software. This standard is called LTI or Learning Tools Interoperability (10). The principle is to be able to run a tier 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 tier application. Then, the tier application sends a result or a grade back to the LMS.

Consequently, the online courses are no longer restricted to quiz activities to assess learners. 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.

## Outcomes and Perspectives

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.
- 3099 participants enrolled. The completion rate was 31% compared to the total enrollment. This is already a very high value considering that the average completion rate for MOOCs is around 10%. 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).

Even though the numbers that are presented are a result of multiple factors, 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 games enable 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 games was great because you work like on a real job"
- "The serious games were very enjoyable ! Learning while having fun !"

With such a good results, IFP School has already planned to propose 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. Additionally, another MOOC focused on Oil&Gas is under development. This second MOOC will be launched in May 2015. In this MOOC all the traditional assessment quizzes will be replaced by small interactive games based on the technology developed with the Serious Game.

## Conclusion

Multiple studies have shown the benefits of using games in education. In particular, video games can trigger learners' motivation for learning. They can also provide authentic learning experiences for learners. The Serious Game in IFP School's first MOOC was designed to attract a young public. The drawings were done from real life environments. The exercises reflect the real work of a process engineer in a refinery or an engine engineer in a test bench facility. Even if the students are solving real life problems, the playful side helps create a favorable environment that motivates the learners.

All these positive aspects are key factors for the success of the first edition of this MOOC: half of the participants enrolled were under 25 years old and 59% of the active participants completed the courses.

The introduction of a Serious Game in a MOOC emphasizes the new possibilities offered by technologies using a MOOC within an applied school environment such as IFP School whose aim is to develop skills by putting knowledge into practice.

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