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The Use of Flipped Classroom and Gamification in Applied Powertrain Related Programs

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Abstract

The growing needs for individual mobility creates new challenges for future powertrain engineers. Tomorrow's powertrain engineers, besides being talented, they need to know how to apply these skills according to a system approach while working in international teams with multicultural environment. To prepare these future "global" powertrain engineers, it is necessary to develop new educational approaches based on the transfer of knowledge. As an applied Engineering School, our learning goals include not only the acquisition of technical skills, but most importantly, the ability to put this knowledge into practice. Therefore, the pedagogical approach and the interactive tools used in our classrooms are chosen to implement a "Learning by doing" approach. In this paper, we will present different approaches that have been developed at IFP School and that are currently successfully applied in the Powertrain Department. In particular, we will explain how we introduced pedagogical approaches focused on interactive learning activities in order to increase the interest and the motivation of the students, and consequently to increase their learning capability. The integration of these activities requires a different organization of the lectures and a specific development: the use of e-learning with flipped classes must be integrated so that the teachers have free time in the classroom to explore new activities.

Two examples are in particular described:

First, the use of a serious game as a learning tool. This innovative idea uses real engine models integrated in a fun game-style environment. The idea is that the students need to apply the acquired knowledge to solve industrial problems (like the fuel consumption or pollutant emission's reduction). Second, the use of a virtual reality environment to explore engine test benches. In this case, with special glasses and a smartphone, the students are able to explore a complex environment in the classroom. Finally, we will describe the activities oriented to the understanding of the impact of the cultural background to communicate and work efficiently. In our experience, all these new educational approaches are really necessary and very efficient to improve motivation and to prepare international students to become a global powertrain engineer.

1. Introduction

The growth of commuting and travel along with the growth of consumption in general will increase the need for transportation for both individuals and goods. Three main factors explain this growth [1,2]: the demographic growth, urbanization and the economic growth. It has been largely discussed. This means that new types of mobility with diversified vehicles type and usage will appear in the future, trying to accommodate the increasing needs of mobility with the economic constraints and the environmental restrictions. Interesting challenges will come in a near future for the powertrain engineers.

At IFP School we prepare our students to face these new challenges. Students are admitted with an Engineering degree and looking for a specialization that makes them ready-to-work on industrial subjects. The "Leering by doing" approach [3] provides the most adapted techniques for teaching: it provides the means to put the knowledge into practice. One of our biggest challenges is to implement pedagogical practices that improve interaction and to develop an environment where the students can experiment and practice the skills learnt from the lessons. At the same time, we want our courses to be motivating and fun to learn. It is known that when curiosity is awakened, people learn without resistance. Considerable research has shown how game-based learning can be more practical and effective approach to motivate and promote learning [4,5,6]. Several serious games were developed to facilitated the knowledge transfer through situational learning while keeping up the motivation. Additionally, IT developments and the digitalization provide a new range of possibilities that can be helpful to improve motivation. In this context, the development of new pedagogical approaches seem essential. Some examples and its results will be described in the following sections.

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2. New pedagogical approaches focused on interactive learning activities

In order to increase the interest and the motivation of the students, we need to rethink the whole structure of our lectures. The flipped classroom has the advantage of providing time in the classroom to explore the subject in different ways, as for example with gamification.

2.1 Flipped classroom

What is a flipped classroom? This concept appeared about ten years ago and some people summarize it to “Lectures at Home and Home Work in Class” [7]. Flipped classroom is a pedagogical approach that reverses the traditional educational scenario by delivering the lectures, often online, outside of the classroom. It moves activities such as exercises and teamwork into the classroom, with the help of the teacher. In a flipped classroom, content delivery may take a variety of forms: video lessons, digital research, text readings or e-learning modules. In-class activities accompanying flipped classroom may include traditional homework problems or dedicated teamwork. The goal is to engage students in the content, thanks to collaboration, research, and build knowledge with the help of their teacher and peers. The teacher's interaction with students in a flipped classroom is more personalized and less didactic, and students are actively involved in knowledge acquisition and construction as they participate in and evaluate their learning.

In IFP School, we have introduced several flipped classrooms and especially one dedicated to the fundamentals of the combustion on chemical kinetics. In our Powertrain engineering Master programs, we have a teaching unit dedicated to combustion. The first part of this teaching unit concerns the fundamentals of the combustion. And the second part, more applied, is focused on the combustion in spark ignition engines and in compression engines. In the fundamentals of combustion, we tackle chemical kinetics and thermodynamics basics of the combustion as a way to level all the students with different backgrounds. First of all, we developed an interactive e-learning, which duration is about 30 minutes. This e-learning tackles the main concepts of chemical kinetics and it proposes some exercises to be sure that students acquire these concepts (Figure 1).

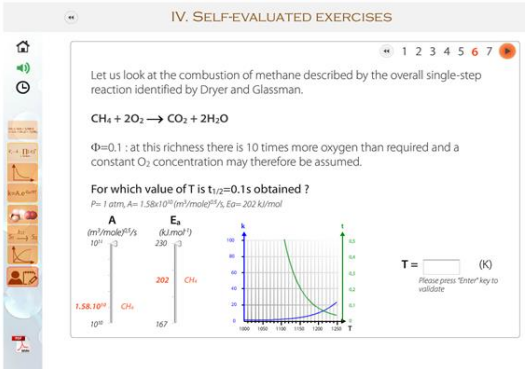


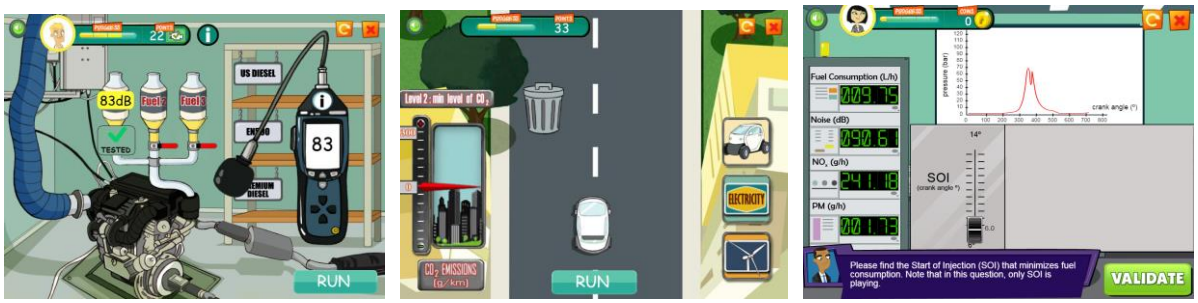
Figure 1: Screen shot of an exercise of the e-learning “Chemical kinetics”.

Moreover, we used a “Learning Management System” LMS where we put this e-learning [8]. Thanks to our LMS, we can follow the ratio of students who performed the e-learning and how they succeed in the exercises. Then, the teacher asked the students to read a chapter of his book and to prepare some exercises at home. Next steps are the in-class activities where the teacher answers to the questions and with the help of the students, proposes a correction of the exercises. Consequently, the students apply theoretical concepts, and they “learn by doing”. To develop this flipped class, we used two special tools: an e-learning and our LMS platform. The flipped class is mainly based on the teacher’s investment and motivation. He has to think his lecture under a new approach. The teacher is well rewarded for his efforts as the students are strongly engaged in the subject matter and they better understand the interest of this fundamental field.

2.2 Gamification

The gamification is a pedagogical approach, where a fun aspect is proposed for a training session This pedagogical approach has a high success with the new generation of students who are highly connected and are used to play with games consoles. Of course, a serious game is one of the possible tools for the gamification (figure 2). In this case, after studying the concepts of combustion optimization, students are asked to perform a simplified engine calibration. Behind the serious game, a real-engine model build from real engine test runs to simulate the behavior of the engine. Students are

in this way asked to find the settings that provide the lowest fuel consumption or pollutant's emissions. This exercise prepares them well for the practical work: since engine testing is very expensive, we make sure they get the most out of it by making the exercise with the game before actually going to the test bench.



Figures 2: Serious game for powertrain

We have also used other tools such as quiz boxes or a paper chase. At the beginning of our Powertrain engineering Master degree programs, during the first month of training, we propose a paper chase in our engines exhibition room (Figures 3). Students have pictures and names of around one hundred engine parts and they have to find their location in the room in a given time. This game is a very good introduction to the mechanics of the engine and it is highly appreciated by the students. They work by teams and it is a strong time of exchange between them and the teachers.

Figure 3: The engine room and quiz boxes.

The quiz boxes provide a fun activity that help the teachers get feedback on the learning acquisition. The teacher needs to prepare the quiz in advance and the names of the students need to be registered so a personalized follow up of each student can be done. In case where the teacher wants simplified logistic, the Kahoot platform offers other possibilities (https://getkahoot.com/). In this case, the quiz is recorded in the Kahoot platform and the students log in the game with a game pin. The game can be played with any device with an internet connection (smartphone, tablets, PC). Since all of our students have a smartphone nowadays the logistics is simplified with the additional advantage of increasing the student's attention.

Figure 4: Kahoot Quiz

2.3 Virtual Reality

Finally, one of the latest activities developed is a virtual reality visit of our engine test benches. In this case, the course is about the equipement and the measurements done in a test bench. This course helps understanding how the measurements in the test bench are done. Some of the lectures were transformed into e-learning to free some time in the classroom (flipped classroom). The virtual reality activity is made of several 360° pictures of our test benches. The main equipements were highlighted inside the picture. The students use their smartphones and special 3-D glasses (provided by the school). This activity, besides being extreamly exciting for the students, help us introduce the whole environement without being there: by clicking a link they can be inmersed in the test bench environment. It was designed to be flexible: in case the glasses are not available or the smartphone is not compatible, the students can use their computer to explore the picture. Different types of contents can be added in the 360° picture (like videos or quizes), if we need to go beyond this simple introduction to the new environment. We are still exploring the possibilities that this kind of activities can offer. So far, the feedback from the students is highly positive.

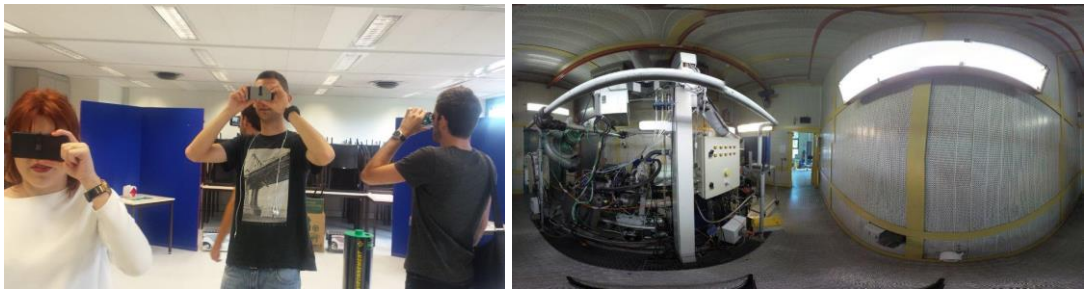


Figure 5: Virtual reality visit of a test bench

3. Working across different cultures

Since our engineers will work in a multicultural environment, it is of extreme importance to prepare them to work in a global environment. There is a specific teaching unit for this called “Automotive powertrain market and intercultural management”. The international dimension of the class (figure 6) is the first parameter that helps them to naturally develop the intercultural skills: the students come from 14 different countries and are forced to work in teams on projects with professionals from all over the world.

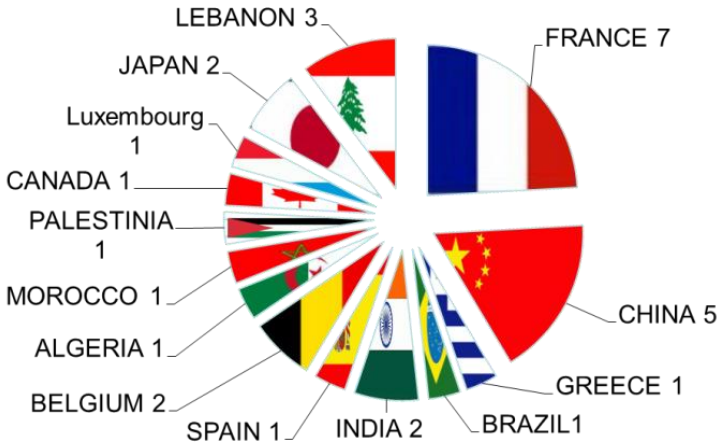


Figure 6 : Students nationalities in the 2016-2017 IFP School Powertrain Engineering Master

Additionally, activities aiming to develop intercultural skills (intercultural sensitivity and communication) are proposed to fully understand how the core values operate within their culture and to make them realize how this core values are different in other cultures. The goal is to make them realize how cultural differences can be seen as an iceberg: our own values are implicit behaviors shaping our

vision of the world and our understanding of each culture. The more we can know and understand other cultures, the more we are able to see things from multiple perspectives [1].

4. Conclusion

In this paper, different approaches implemented in our Powertrain programs at IFP School were presented. All these innovative and interactive educational approaches are necessary to improve the learning experience and the motivation: a real improvement in the feedback from the students was observed over the last couple of years together with better results. A better understanding of the subjects was achieved while we are all having more fun. These approaches have proven to be very efficient to prepare our students to become a global automotive powertrain system engineer. They are particularly well adapted and meet great success with our new generation of highly connected students who likes this way of learning. The skills learnt can be applied to solve real industrial problems which is our main concern. We provide the industry with a ready-to-work man force. The powertrain industry seems highly satisfied of our students: 100% of the students graduated in 2016 found a job before the end of the master program.

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