Application of Artificial intelligence to high education: empowerment of flipped classroom with just-in-time teaching

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Abstract

In the so-called society 4.0, Artificial Intelligence (AI) is being widely used in many areas of life. Machine learning uses mathematical algorithms based on "training data", which are able to make predictions or take decisions with the ability to change their behavior through a self-training approach. Furthermore, thanks to AI, a large volume of data can be now processed with the overall goal to extract patterns and transform the information into a comprehensible structure for further utilization, which manually done by humans would easily take several years. In this framework, this article explores the potential of AI and machine learning to empower flipped classroom with just-in-time teaching (JiTT). JiTT is a pedagogical method that can be easily combined with the reverse teaching. It allows professors to receive feedback from students before class, so they may be able to adapt the lesson flow, as well as preparing strategies and activities focused on the student deficiencies.

This research explores the application of AI in high education as a tool to analyze the key variables involved in the learning process of students and to integrate JiTT within the flipped classroom. Finally, a case of application of this methodology is presented, applied to the course of Energy Markets taught at the Polytechnic University of Valencia.

Keywords: Artificial Intelligence, Machine learning, Flipped classroom; Just-In-Time teaching; High Education, Methodology.

1. Introduction

Artificial Intelligence (AI) has been defined as "the ability of a system to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019). Global technology advancements in the field of the AI have allowed its expansion in multiples areas. From the medical treatment, industrial processes to the business sector, the introduction of AI tools has strongly impacted on our society from a social, economic and ethical point of view (Hussein, 2018). In the latest decades, the AI technology has been strongly introduced in the field of higher education. Hundreds of relevant studies testify as AI can contribute to the innovation of the higher education and how it has already strongly impacted on administrative teaching tasks, guidance and support of students and educational software programs (Hinojo, Aznar-Diaz, Cáceres-Reche, & Romero-Rodriguez, 2019) (Stefan & Kerr, 2017).

Although there is no doubt that the fourth industrial revolution of the higher education (HE 4.0) would be powered by AI, investigations and innovative teaching methods are still required to overcome the distance between people and science technology (Xing & Marwala, 2017). Among the emerging teaching methods, the flipped classroom (FC) model has been implemented more and more in Universities and educational institutes worldwide. Among them, the Polytechnic University of Valencia (UPV) stands out and from 2014 it is actively investigating on barriers and factors that could favor FC acceptance and its correct development (Montuori, Alcázar-Ortega, Vargas-Salgado, & Bastida-Molina, Evaluación del nivel de aceptación de la metodología de docencia inversa entre los alumnos de la UPV, 2020).

Among the methods that emphasize the student work at home previous to the class, Just-in-Time Teaching (JiTT) was developed by Gregor Novak and colleagues and was first applicated to the physics education (Novak, 1999). JiTT blended learning method consists of sending homework to the students before the class. Students study the topics, solve problems or reply questions before the class. The answers will be sent in advance to the teacher, which helps him to prepare the class and the feedback accordingly to the results achieved by the students at home (Hinojo, Aznar-Diaz, Cáceres-Reche, & Romero-Rodriguez, 2019). In previous studies, the synergy between FC and JiTT has demonstrated to improve students learning by increasing their personal commitment (Monnie, Stokes, & Nadolsky, 2016) (Jensen, Kummer, & Godoy, 2015) (Martin, y otros, 2018). Furthermore, the integration of JiTT with FC has the potential to become a strategic tool for the educator for preparing classes that perfectly fit students" academic exigencies (Jensen, Kummer, & Godoy, 2015).

In this framework, this paper explores the application of AI in high education as a tool to analyze the influencing variables involved in the learning process of students and to integrate JiTT within the flipped classroom. Finally, a methodology for the implementation of this tools is presented and is applicate at the Polytechnic University of Valencia.

2. Educational Empowerment Methodology

An innovative methodology for the empowerment of the flipped classroom with the JiTT teaching, integrating AI tools, has been implemented. The phases of the methodology are indicated in figure 1.
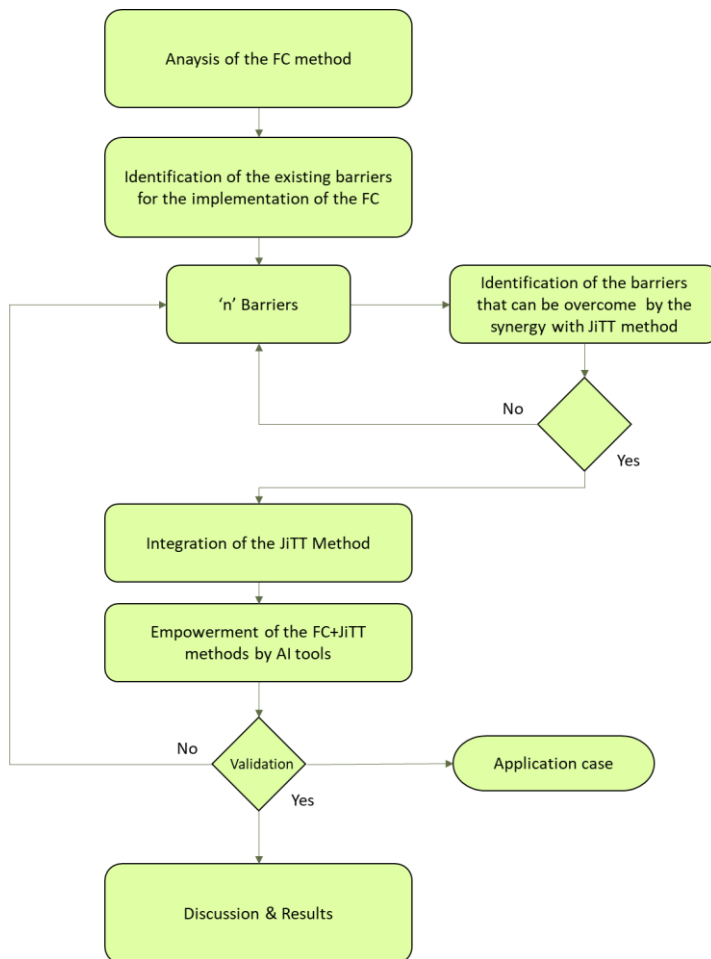

Fig. 1 Educational Empowerment Methodology

3. Application case

Following, the methodology presented in the previous section is applied to the course on "Energy Markets", corresponding to the Degree in Energy Engineering at the Polytechnic University of Valencia**.**

3.1. Application of the Flipped classroom method

The inverted class (flipped classroom or reverse teaching) arises within the framework of blended teaching as a learning system in which students acquire new knowledge through the visualization of educational videos at home (online) to subsequently carry out the activities, problems and debates in the classroom with the support of the teacher. According to the FC pedagogical model, the teacher combines direct instruction with constructivist methods, increasing student engagement and involvement with course content, and improving their conceptual understanding. For the case of application to the course "Energy Markets", the teacher has incorporated the visualization of videos previous to the class in order to free up class time and improve participation of the students through questions, discussions and interactive activities that promote creativity and application of ideas. Figure 2 describes the different phases of the FC implemented for this course.
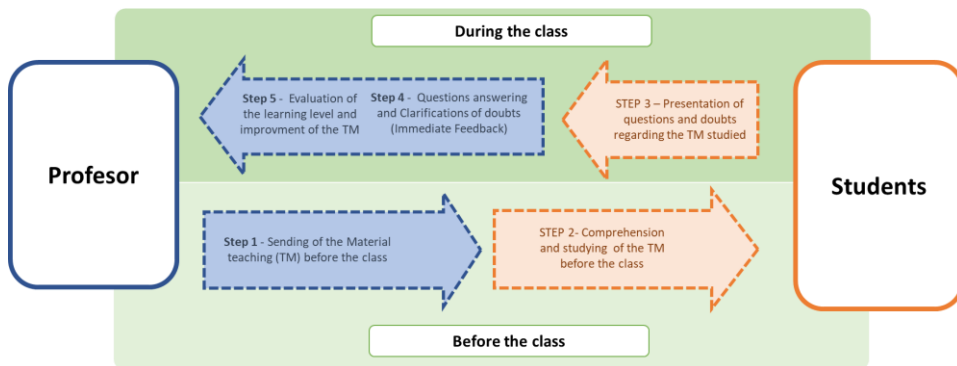

Fig. 2 Application of the FC to the course "Energy Markets"

3.1.1 Analysis of the main barriers of the flipped classroom

In previous studies, the analysis of the existing barriers for the implementation and diffusion of the FC methods has been investigated (Montuori, Alcázar-Ortega, Vargas-Salgado, & Bastida-Molina, Evaluación del nivel de aceptación de la metodología de docencia inversa entre los alumnos de la UPV, 2020).

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Major limitations identified for the success of the FC implementation are summarized in the following factors:

- The pedagogical method should prefer more practical classes based on problem solving than theoretical classes (98% of the students).
- The 90% of the student identifies as crucial receiving an immediate feedback from professors.
- Furthermore, the 73% of students regret not having received immediate feedback from professors.
- Promote the use of IT tools for encourage learning (40% of the students).
- Educational materials are so schematic that need a deeper explication by the professor (23% of the students).

3.2. Integration of Just-In-Time teaching

Barriers presented in the previous paragraph can be overcome by integrating the flipped classroom with the Just-in-time teaching. The JiTT allows professors to receive feedback from students before the class, so they can adjust class activities and the lesson flow according to students" needs before the class takes place. Furthermore, educational strategies can be adopted according to the results of homework already done by students before the next class. In addition, more activities focused on student deficiencies may be prepared thanks to the immediate feedback received and the constant interaction between students and educators.

To integrate the JiTT with FC, teaching materials will include not only videos and slides, but also short exercises, test of multiples choice regarding the topics just studied. The support of IT tools is fundamental at this point. In this application, students will use the tool „exams" of Poliformat (the ERP platform developed by UPV for educational purposes). On the other side, for the resolution of short problems, a continuous learning tool will be provided as designed by (Alcázar-Ortega & Alvárez-Bel, 2018).
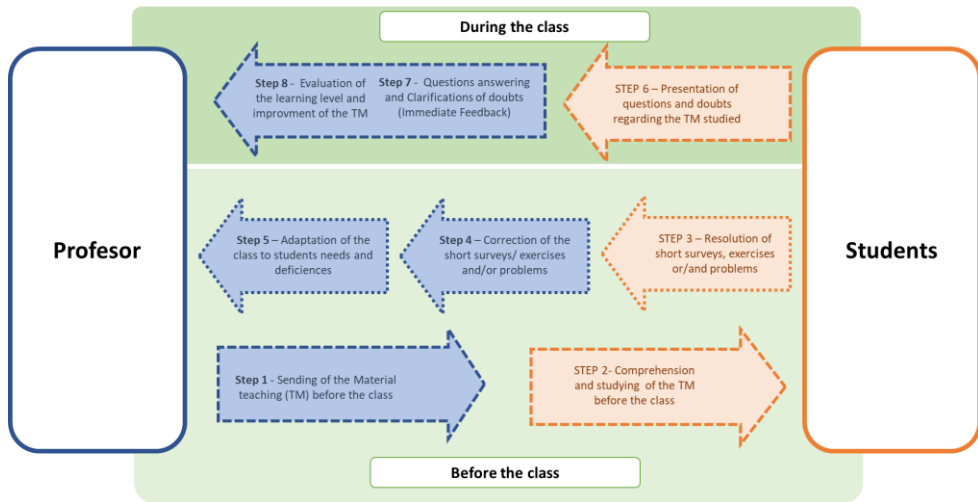
Fig. 3 Application of the JiTT to the course "Energy Markets"

This tool has been successfully applied to previous courses on Energy Market. This tool facilitates the performance of personalized problems while it provides a semi-automatic correction to the student to facilitate their learning and to carry out a continuous follow-up throughout the course. For the course "Energy Markets", the JiTT has been implemented by adding to the FC process the following steps, as shown in Fig. 3:

- Step 3: Students are asked to solve a short problem or an online survey before the class by IT tools already in use (e.g. Poliformat)
- Step 4: The professor proceeds with the revision of the homework
- Step 5: The professor adapts the class to the student needs and deficiencies emerged from the revision.

3.3. Empowerment by AI tools

The pedagogical method that combines FC with JiTT has been empowered by using AI. The learning process has been modified as shown in the Figure 4:
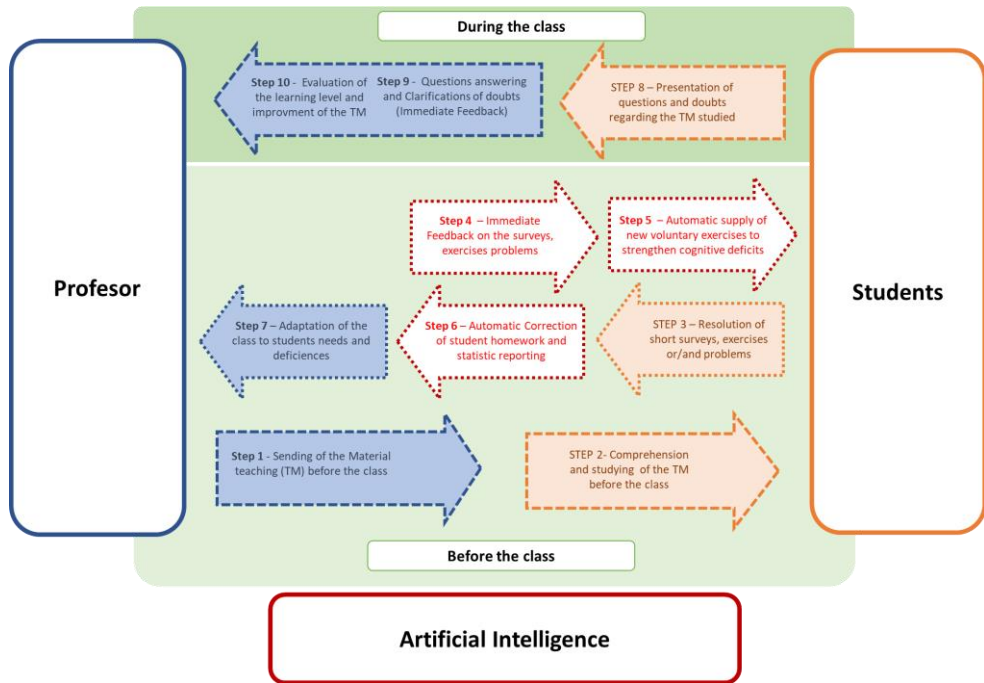
Fig. 4 Empowerment of the FC and JiTT methods by the AI tools

Professor''s point of view:

- Step 6: The correction of the student homework becomes an automatic process that will be carried out by the AI tool. The automation of this process will be done by interacting with the existing IT tool and it will create an historical data base.

Students'' point of view:

- Step 4: The existence of this historical database of the errors committed by students will make possible to personalize the feedback for each student, providing recommendations and suggestions.
- Step 5: Furthermore, based on the results of each students and taking into account their misconceptions and mistakes, the AI tool will automatically provide students with new exercises and questions that they voluntary could resolve to improve their knowledge.

4. Results and Discussions

Results of the integration of the JiTT with the FC increase the effectiveness of the learning during the class. Results are applicable to both face-to-face and virtual classes. The assigned tasks to solve short problems and surveys before the class have two fundamental benefits on FC barriers: encourage the students to read and study the teaching material and give the possibility to early detect misconceptions and doubts. The possibility to know in advance the difficulties that students have found while studying give to the professor the chance to personalize and adapt the class. Thus, the time of the class can be focused on the concepts that have generated the major doubts. In addition, more problems and practical exercises may help students to straightening the knowledge. Finally, the empowerment of the FC and JiTT with the use of AI tools may determine a revolution into the higher education. The quickness allowed by machine learning drastically reduces the waiting time of students for feedback. At the same time, the workload of the professor is drastically reduced. If IT tools such as Poliformat, Kahoot, Doodle, etc. can process data regarding a single exam, problem or test, machine learning can give the possibility to create a centralized database, processing millions of historical data, allowing algorithm selection and hyperparameter tuning. The introduction of AI tools automates the academic revision process and free up the professor giving him more time to analyze results and understanding students" needs. On the other hand, AI tools can automatically generate a regression model to predict students" trend and iterate over many combinations of algorithms until the best educational model is found. In this way, each student can obtain a personalized education according to his needs. Finally, the methodology implemented can support the e-learning education during a pandemic crisis or emergency state like suffered nowadays, enhancing the interaction between the professor and students and reducing the feeling of isolation thanks to the possibility to receive real time and personalized feedback.

5. Conclusions

This article proposes an innovative methodology that allows integrating FC with JiTT, empowering it through the integration and application of AI principles. The main benefit of this methodology allows to overcome the existing barriers of implantation of FC, such as the lack of immediate feedback to students. Furthermore, the application of AI tools reduces the load work to professors involved in this kind of education, so they may use more time to personalize the activities related to following up students" needs. This

methodology has been applied to the course on Energy Markets at UPV where its implantation is on-going at present.

Acknowledgments

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