



Study of implementation of the Flipped Classroom methodology (Just In Time Teaching) in the Inorganic Materials elective course of the Chemistry Degree at University of Barcelona

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1. ABSTRACT:

The Flipped Classroom (FC) strategy was implemented in an elective course of the Chemistry Degree at UB under its Just In Time Teaching approach. The methodology includes a self-studying activity, an assessment of students' initial level, the on-site FC session, and a verification of their achievements. The results evidenced some deficiencies in the assessment of student's achievements. Nevertheless, students highly appreciated the methodology, which helped them to develop self-learning skills.

2. KEYWORDS: 4-6

Flipped classroom, JITT, Chemistry degree, elective course



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3. DEVELOPMENT:

The Inorganic Materials subject is an elective course of the Chemistry Degree of the University of Barcelona (UB). It is usually performed during the 7th or 8th Semester of the curricular path, when students have passed most of the mandatory specialized courses of the different Chemistry areas. It represents a total of 3 ECTS which imply 30 hours of on-site class plus 30 additional hours of autonomous learning and 15 hours of guided work. The on-site classes are carried out throughout seven weeks. This academic year 2019-20 there have been a total of 26 students registered, from which 23 perform Continuous Evaluation. The assessment of the students learning is provided by means of a final written exam that stands for 60% of the final mark, while the remaining 40% is obtained from the average mark upon the realization of different tests and/or exercises during the course. The course is conducted in English language and in the form of mater classes, where the professor is the only responsible for the transfer of knowledge to the students, although a few bibliographic sources are suggested to the students for their better understanding. The course offers a comprehensive view of most important types of inorganic materials, including a description of their physical properties, synthetic methods, characterization techniques and main applications, divided in a total of 14 different lessons.

The course includes a significant amount of topics and concepts that need to be reviewed in a very short time, which forces the students to focus their attention in a different aspect over the seven weeks of on-site class. My previous experience indicates that students' attention usually suffers a significant drop during the last three weeks of the course. Most likely this is due to the accumulation of an important amount of knowledge in a compressed time lapse, which they did not assimilate yet, while there is still more theory to come that is not strongly linked to the previous one. All in all I had the feeling I needed to involve and recaptivate students, by making them part of the knowledge searching and data harvesting processes. This would also help the students to successfully achieve some of the abilities pursued during this course such as: i) organizing and planning self's work, ii) self-solving doubts and questions and iii) analysis and communication of data. This was the main motivation to undertake this proposal in this particular course by following the strategy described below.

The Flipped Classroom model (FC) pretends to encourage students to learn new contents in advance outside the classroom, by exploiting available online Information Technologies, in order to be able to perform later more personalized activities during the lessons (Figure 5.1).¹ In this way, the time dedicated in the classroom for the knowledge consolidation step of the learning process is ideally much longer compared to that dedicated in traditional models, in which most of the time is needed for simple knowledge communication from the professor to the students. In particular, the Just In



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Time Teaching (JITT) version of the FC consists in offering the students a guided studying activity and an on-line test that they perform at home previous to the FC session.²⁻³ Based on the results obtained in the on-line questionnaire, the professor prepares the face-to-face FC session with the goal to address those issues and deficiencies identified among the different answers, and prepare the student to consolidate and extend knowledge further. After the FC session, an activity to check their achievements is performed.

From the full list of topics included in the subject, I selected the lesson on Semiconductor Materials for the development and testing of the FC session. The high impact that such type of materials show in all past, present and future technologies was assumed to become a strong motivation for the students to undertake this self-studying activity. The evaluation of the knowledge achieved through the FC activities should be quantified within the 40% of the final mark, but taking into account that it will be based on just one out of a total of 14 lessons, we considered it should not exceed 15%. Thus, the evaluation includes a pre-FC on-line test and a post-FC activity with a 7.5% weight each.

The preparation of the guided pre-FC activity required the selection of appropriate studying material for the students. Among the different sources a portion of a related chapter from a text book was selected, together with a comprehensive and very educational video on the topic of interest published in You Tube. Based on the information that the students could find in these sources, the on-line test was prepared by stating ten unfinished sentences in which each of them was followed by three or four possible endings. The students had to identify those appropriate endings and those that are erroneous or inaccurate in each case. Additionally, a guide for the students concerning the FC-related activities was also elaborated, in which the aim of the strategy was highlighted together with some practical instructions for its appropriate development, as well as the corresponding timeline. The timeline indicated the first and last day (seven days) of on-line availability of both the studying material for the self-studying guided activity and the test previous to the FC session, clearly stating the deadline for submitting the answers to the on-line test. It also indicated the precise days (2 days) in which the FC face-to-face session would take place, emphasizing that a post-FC activity would also be carried out on the second day. The timeline precisely indicated the % weight of both pre- and post-FC activities on the final mark of the course.

The correction of the pre-FC on-line test was performed before the face-to-face FC session, so that those concepts that were generally well assimilated after the self-studying guided activity were identified. The results of the test also evidenced those parts of the lesson that represent a harder challenge for the students and that consequently required further work in order to be understood and consolidated. Based on these results I prepared the material for the on-site FC session: the first slides included an overview of the well assimilated basic concepts, which were reviewed briefly by showing the high



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degree of success in the related sentences of the on-line test. Next, the most challenging concepts were illustrated in several slides, each of them preceded by the corresponding sentence of the on-line test, in such a way that the connection between the theoretical concepts explained and the pre-FC exercise performed was straightforward. This was the methodology followed during the face-to-face FC session of the first day, during which the students were encouraged to ask their doubts and participate in the discussion to select or refuse the different options available in the test. On the second day of the FC session, some additional concepts were explained, which were not fully covered by the provided material for the guided self-studying activity and the lesson was concluded by performing the post-FC activity consisting of four open questions that the students needed to answer in about 40 minutes.

The results were assessed by means of the average marks obtained in the group for both the pre- and post-FC activities. For the initial on-line test an average mark of 8.0 ± 0.8 was obtained, while for the post-FC activity carried out in the classroom the average mark dropped down to 5.8 ± 1.7 . Contrary to what was expected, the results obtained indicated a much lower value for the second exercise and seemed to suggest a poor consolidation of knowledge after the implementation of the FC strategy. Nevertheless, a detailed comparative analysis of the two exercises shed some light into this issue and clarified some points: on the one hand, the results of the pre-FC on-line test showed a significant lower value of standard deviation, meaning a very narrow distribution of marks among the students, and indeed a close look at the specific answers given by the students revealed that the correct and incorrect answers were generally the same. This fact suggests that the test was generally answered in groups of students, which is a priori a positive point since the activity foments discussion and interaction between students, although this justifies the homogeneous results obtained and their low distribution. This could not happen in the post-FC activity since it was performed individually in the classroom and no discussion between students was allowed. Consequently, the standard deviation doubled, and the significantly lower average mark obtained might indicate that many students did not really consolidate knowledge during the first activity. On the other hand, while the pre-FC test was more focused on basic and/or more simple notions of the lesson, the post-FC activity was preferentially elaborated to understand if students assimilated those concepts of higher complexity. In order to minimize this discrepancy, the average mark of the pre-FC on-line test was recalculated considering only those sentences of the test related to the same advanced concepts included in the post-FC activity, obtaining a value of 6.5 ± 1.7 closer to that of the post activity and with the same deviation of the results. The unexpected still lower value obtained in the post-FC activity might be explained by the higher level of understanding and written expression required in the latter, which was not necessary at all to answer the on-line test. All in all, everything indicates that the post-FC activity showed a significantly higher level of difficulty in different senses and thus it might not be quantitatively comparable to the



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pre-FC test.

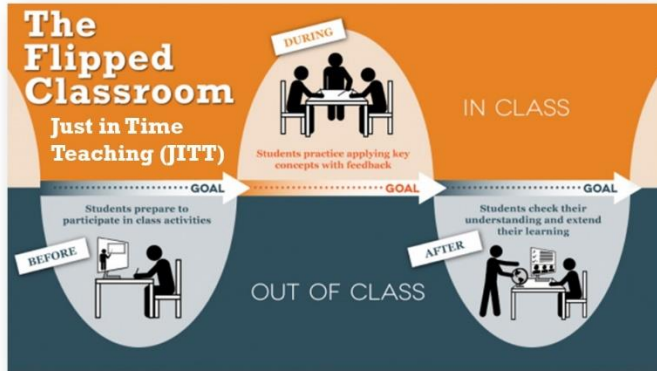
The FC methodology performed was also evaluated through the satisfaction survey filled by the students (Figure 5.2). Generally speaking, they found the prepared studying material and the resolution at the classroom of the on-line test very useful for the comprehensive understanding of the lesson. In general terms, the students believe that the FC strategy helped them to develop self-learning skills and to attend the lesson with a previous and useful knowledge on the topic, although it demands a larger amount of work and so they do not fully agree in extending the methodology to other lessons. As a professor, the most challenging part was the timescale organization and the preparation of the material for the face-to-face session, which was quite different from the traditional one. However, I would highlight that I received a significantly larger amount of questions from students who showed a strong motivation for the topic, most likely because they got involved into it already from the days before the FC face-to-face session.

Considering the results observed in this first experience, the next attempt should definitely address the issue of making both pre- and post-FC activities much more comparable. This can be done by first, answering both exercises individually in the classroom and second, focusing the questions of both activities on the same advanced concepts of the lesson. If the basic and fundamental concepts acquired by the students need to be assessed, this could be done in a separate questionnaire.

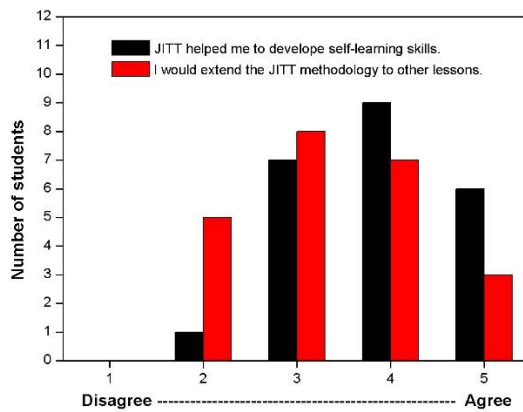


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3.1 GRAPHIC OR TABLE 1



3.2. GRAPHIC OR TABLE 2





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4. REFERENCES (ACCORDING APA REGULATIONS)

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