

Modelo de clase invertida en el aprendizaje de las series y ecuaciones diferenciales. Caso Cujae

Flipped classroom model in learning series and differential equations. Cujae case

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Resumen

El proceso docente educativo centrado en la enseñanza ha dado paso al centrado en el aprendizaje, donde el estudiante juega un rol más activo. Varias metodologías activas han demostrado su eficacia y efectividad en este nuevo contexto. La enseñanza de la matemática no puede estar ajena a estas transformaciones. Los estudiantes matriculados en carreras afines a la informática, por lo general, tienen a su disposición móviles, tabletas y/o computadoras y poseen determinadas habilidades para desempeñarse con ellas. En este trabajo se presenta la propuesta de aplicación de la clase invertida en el proceso de enseñanza aprendizaje de una asignatura que profundiza en las series y ecuaciones diferenciales que se imparte en la Universidad Tecnológica de La Habana José Antonio Echeverría, CUJAE. En particular, se muestra el modelo para el sistema de actividades con el rol que juega cada uno de los actores que participan, cómo se organizan las actividades y se ejemplifica con el tema de sucesiones y series numéricas. La propuesta presta especial atención a la incorporación de tecnologías digitales en los materiales que se proponen para dar soporte a este enfoque pedagógico.

Palabras clave: Clase invertida, Series, Ecuaciones diferenciales, Metodologías activas.

Abstract

The educational teaching process centered on teaching has given way to one centered on learning, where the student plays a more active role. Several active methodologies have demonstrated their efficiency and effectiveness in this new context. The teaching of mathematics cannot be alien to these transformations. Students enrolled in computer science-related courses usually have mobile phones, tablets and/or computers at their disposal and have certain skills to perform with them. This paper presents the proposal for applying the flipped classroom in the teaching-learning process of a subject that delves into series and differential equations taught at the Technological University of Havana José Antonio Echeverría, CUJAE. In particular, the model for the system of activities is shown with the role played by each of the participating actors, how the activities are organized and exemplified with the topic of numerical sequences and series. The proposal pays special attention to the incorporation of digital technologies in the materials proposed to support this pedagogical approach.

Keywords: Flipped classroom, Series, Differential equations, Active methodologies.

1. Introduction

The new framework of Higher Education proposes to transform the intervention paradigm, orienting it towards more active hybrid methodologies focused on the student's learning process, in which technological tools are incorporated that allow a better development of the teaching-learning processes [1].

The implementation of technology does not imply academic improvement or the acquisition of informational skills. It is necessary to analyze the pedagogical support of techno-educational approaches, among which is the flipped classroom model.

Active learning aims to actively involve students in class, making them protagonists, thinking about what they learn, ceasing to be listeners to the class [2]. This approach requires capturing the attention of students, generating confidence and increasing their self-esteem, offering more complex personal challenges, reinforcing knowledge and rewarding achievements, and combining with problem-based, collaborative and mobile learning [3].

The current student was born in the digital period, so they focus their learning on the spontaneous incorporation of information from digital resources. On the other hand, in the case of teachers, digital immigrants are mixed with digital natives [4]. In the research carried out by these authors, they reaffirm that the problem goes beyond the simple incorporation of technology, that the underlying debate lies in finding a true methodological renewal and an educational transformation that allows us to be up to the circumstances of today's society.

In the current context, given the need to promote developmental learning that turns the learner into an active subject, it is necessary to reformulate learning strategies, understood as sequences of actions aimed at achieving learning goals [5].

Among the teaching and learning methodologies that facilitate access to new technologies, the flipped classroom stands out [4]. The flipped classroom is an emerging methodology that has little development in scientific literature, despite this, interest is growing from different areas of knowledge, with science predominating [6].

Today, more than ever, the educational field continues to be immersed in the maelstrom of technological innovations, mobile devices and constantly changing information, which is why several publications address teaching methodologies that make use of digital technologies in higher education [7]. It remains essential that the teacher is not overwhelmed by the situation or tends to make inappropriate and unreflective use of the means at his disposal, so what means and how they should be used by students are crucial aspects in the design of the flipped classroom.

The introduction of technologies in the teaching-learning process of Mathematics can contribute to the knowledge, skills, modes of mental activity and attitudes that are desired to be formed. They are developed in such a way that students become accustomed to reflect, propose hypotheses and conjectures, validate and evaluate them [8].

The Computer Engineering degree at CUJAE is studied in the semi-presential modality under a flexible, structured, student-centered pedagogical model and with in-person and non-presential activities, since 2002 [5]. The Mathematics discipline has four subjects, with the content associated

with series and differential equations being the subject of the third of the subjects in chronological order.

This work proposes how to apply the inverted classroom pedagogical approach to this subject, based on the experience of more than 15 years with the semi-presential model.

2. Materials y Methods

B-learning or blended learning combines class work (in-person) and online work (non-in-person). Defined with some control parameter over the path, time and pace to follow; under the guidance of the teacher, making it an integrated learning experience of shared responsibility and proactive commitment.

The blended learning modality in the context of Higher Education in Cuba is considered a variant of mixed learning, which combines in-person and non-in-person activities [9]. This modality is characterized by a lower teaching load than in the in-person modality, which reduces the coincidence in time and space of teachers and students, and the latter work alone or together with other students in the execution of the indicated teaching tasks.

In the Regulations of the methodological teaching work of Higher Education [10], the meeting class is recognized as the fundamental activity in this modality, defining it as a type of class where doubts associated with the content previously studied are clarified, these new contents are debated and exercised, and the independent work to be carried out by the student for the next class is guided.

The essence of inverted learning, inverted classroom or flipped class, is that direct instruction is carried out outside the classroom and face-to-face time is used to develop meaningful and personalized learning activities [4, 11 and 11]. In this way, educational roles are reversed, in which the teacher acquires a secondary role as a learning guide, while the student learns the content outside the classroom [13].

Master classes do not disappear, they are complemented with active learning strategies that favor the meaningful learning of knowledge [4].

In the learning process following the blended learning modality, the flipped classroom methodology can be perfectly framed because the teacher changes his traditional role in the classroom and becomes a facilitator of knowledge that guides and directs the students during the acquisition of their skills. The student, for his part, becomes the central part of the teaching-learning process, acquiring an active role and taking responsibility for his learning.

The main characteristics of the flipped classroom are that it is a blended learning model in which part of the training action takes place online, the teacher goes from being a transmitter of knowledge to a facilitator of learning, the role of the teacher consists of becoming a facilitator and/or tutor, it involves the development of classroom activities that underpin group and collaborative work, in which the relevant thing for it to work is the classroom methodology proposed by the teacher, in which good digital materials and no face-to-face activity do not make the model effective and which mainly uses video, but other media can be used.

The benefits of the flipped classroom can be summarized as [14-17]:

- Promotes technology-enriched learning.
- Increases the relationship between the work that the student does in the classroom and the work that he or she does outside of it.
- It contributes to the fact that the teacher's work is not so individual or isolated since it can encourage collaborative work between teachers when implementing sessions, designing materials and exchanging activities, lessons and educational experiences.
- Allows teachers to dedicate more time to addressing the diversity present in the classroom and personalizing the educational response that they offer to each student, adapting them to their individual needs.
- Promotes the students' interest in their learning, by making use of technologies that capture their interest.
- The student can consult the materials whenever they require it.
- Generates collaborative work environments in class and makes use of ICTs in a more appropriate and interactive way.
- Increases the demand for educational feedback by the student.
- Students create resources, share them and use resources created by other students.
- Encourages the development of generic skills. The need to study the content beforehand fosters responsibility, autonomy, research capacity, learning and ongoing updating. Teamwork contributes to creativity, critical thinking, decision making, achieving common goals, time organization and planning, oral and written communication and the development of personal skills.

The proposal follows the historical-cultural approach since it assumes that learning is acquired through activity as a process that mediates the relationship between man and his objective reality (it considers the active nature of learning and the need to focus the teaching-learning process on the subject who learns), recognizes and emphasizes the role of the development of higher psychic functions in learning, and identifies mediation and generalization as the properties that distinguish them in their development.

3. Results y Discussion

The program of the subject in the degree course is divided into two topics: Sequences and numerical series (series of positive terms, series of arbitrary signs, series of functions, power series and Fourier series) and Ordinary differential equations (ordinary differential equations - ODE - integrable in quadratures, higher order ODE, non-homogeneous higher order ODE, diagonalization and systems of first order linear differential equations).

Based on the proposal described in [9], Figure 1 describes the proposed system of activities to implement the inverted class in this subject for the degree of Computer Engineering at CUJAE.

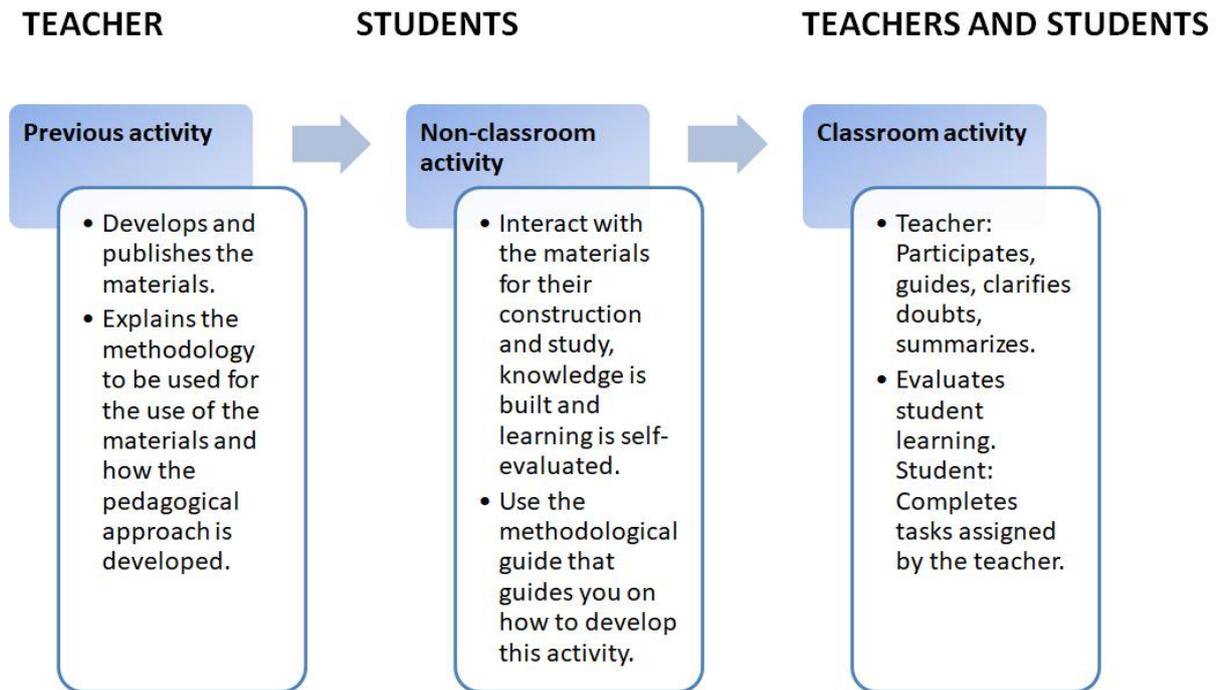


Fig. 1 Model for the system of activities in the implementation of the inverted class. Source: Own elaboration.

In the previous activity, it is suggested that an explanation be given of the essential aspects of the content that will be addressed in the next face-to-face activity and the orientation of the teaching tasks that the teacher must undertake as self-preparation for it. It can be a class dedicated exclusively to this or the last moment of the face-to-face activity.

In the face-to-face activity, students perform exercises of different levels of complexity, where the content is applied and the students are evaluated using co-assessment and hetero-assessment. It involves the teacher verifying that the students carried out the oriented teaching tasks and that they possess the expected knowledge; carrying out the actions required to ensure the latter.

The materials proposed to support this pedagogical approach are:

- Class presentations, which include the voice of a teacher with great expertise in the topics addressed.
- Teaching guide with exercises and problems that reinforce the learning.
- Written instructional material: books, articles and monographs.
- Short tutorial videos on the software tools that support the numerical methods studied.
- Sheet with questions on explicit aspects that come from the video and others that are inferred from the content of the video.

The combination of organizational forms (class typology and forms of independent work of the students) favor the use of deductive-inductive methods and the formation of logical thinking. Each topic has been organized following the structure exemplified in Fig. 2.

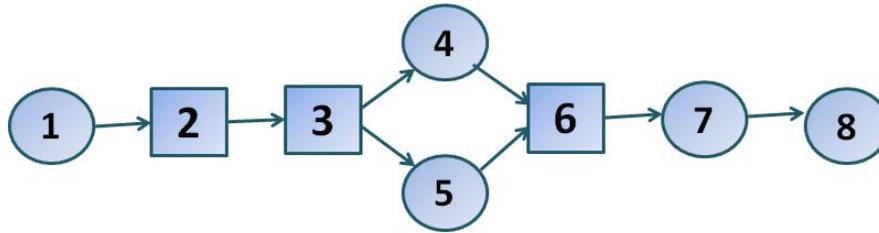


Fig. 2 Combination of organizational forms. Source: Own elaboration.

These elements represent:

- 1- Lecture.
- 2- Task that involves the study of the materials (reading documents, watching a video with an observation guide, reviewing a lecture given by an experienced professor and with the support of a ppt, ...)
- 3- Task where the problem-solving structure is applied to specific exercises.
- 4- Practical class where the problem-solving structure is applied to specific exercises of low or medium complexity.
- 5- Practical class where the problem-solving structure is applied to specific exercises of high complexity.
- 6- Task for the preparation of a seminar.
- 7- Seminar to systematize and classify results and carry out a theoretical synthesis of the topic.
- 8- Integrative workshop for the application of the problem-solving structure to unstructured problems.

Fig. 3 shows how topic 1 (Numerical sequences and series) would be organized, taking into account the previous proposal..

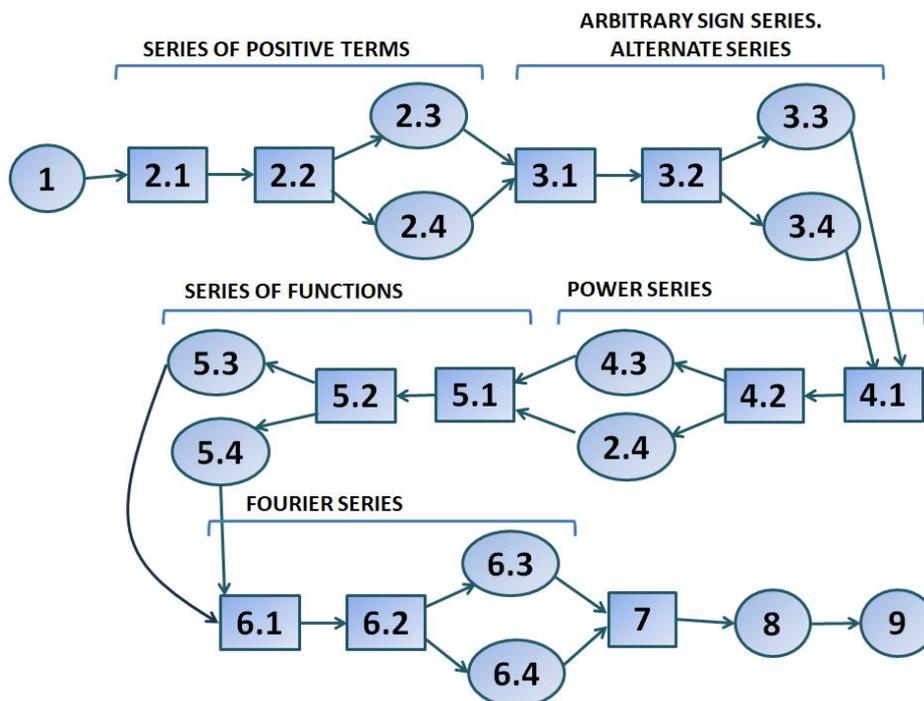


Fig.3 Organization of the topic Numerical sequences and series. Source: Own elaboration.

As can be seen, there are five subtopics within the topic that develop two types of non-classroom activities (one theoretical and one practical) and then two classroom activities in which problems of low or medium complexity are solved first and then problems of high complexity. The topic closes with a seminar and an integrative workshop.

4. Conclusions

Taking this pedagogical approach presupposes several challenges for teachers, including: the need to conceptualize the exercises by placing them in a context with a story or narrative that allows the student to feel immersed in a situation and the careful preparation of the materials so that it is truly effective in achieving the proposed goals; which requires feedback on each of the materials prepared. However, it is necessary to revolutionize the way in which the mathematics learning process takes place to make it more attractive to students and prepare them for a professional world in which they have to be active participants in their learning.

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Conflict of Interest

There are no conflicts of interest

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