World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Use of simulations to dynamize the implementation of adaptive Flipped classrooms in physics courses

Rayner Enriquez-Camps *, Niover Gonzales-Monzon and Raul Brito-Melgarejo

Department of Physics, Faculty of Computer Science and Exact Sciences, University of Camagüey Ignacio Agramonte Loynaz, Cuba.

World Journal of Advanced Research and Reviews, 2024, 23(02), 2426–2432

Publication history: Received on 10 June 2024; revised on 26 August 2024; accepted on 29 August 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.23.2.2207

Abstract

With the development of technology, with young people being the biggest consumers of it, the learning activity takes on different methods and approaches. Among these approaches, we can talk about virtual learning using learning management systems and the concept of flipped classroom. The Moodle platform represents one of these systems. In this paper, we analyze the teaching-learning process based on an adaptive flipped classroom applicable to both hybrid and virtual learning, which can be combined with the Moodle platform to provide students with content adapted to their level of knowledge and skills. Relates the experience with the use of Physics simulation software in the university environment, particularly applications of electromagnetism, optics and modern Physics. They are used as explanatory teaching material or for students to interact with the software at home. In addition, the implementation of the flipped classroom was carried out in the second year of the Industrial Engineering career of the regular daytime course following the methodological process that was presented.

Keywords: Computers in education; Laboratory computer; Education; General physics (physics education)

1. Introduction

It has been shown that the flipped classroom [1-4] creates the ideal context to encourage the continuous study of university students, increase their involvement in class and improve the achievement of learning results and therefore increase their academic performance in those subjects in which this teaching model is put into practice. Putting the flipped classroom into practice in the subjects and designing the way to do it in a specific unit is the fundamental objective of this work, as well as exposing the methodological foundations and recommendations for a successful implementation of this model in university subjects. It will be shown how to implement this model in blended and online teaching contexts through the use of the Moodle platform.

According to Peinado Rocamora [5], in the flipped classroom a high-speed learning effect appears, reflected in the resolution of exercises and the acquisition of new skills. For Cedeño Escobar & Vigueras Moreno [6], Flipped Classroom, inverted classroom, flipped classroom or inverted classroom, is a didactic strategy, a methodology that is characterized by a way of teaching, brings greater emphasis to practice. Its philosophy is that the student learns anywhere and practices in class, which is widely accepted in the company, business or education.

The importance of the flipped classroom lies in the fact that the contents are delivered in a timely manner to students through a virtual platform so that the theory and concepts can be studied, in order to dedicate more time to practice in classes. These materials are studied as many times as necessary, you can even consult the teacher and her classmates through virtual social networks [7].

* Corresponding author: Rayner Enriquez-Camps

The adaptive flipped classroom adds, to traditional teacher-student communication and the simple flipped classroom, a return route from the students to the teacher through online questionnaires that serve to collect information on the students' reactions to the materials sent. This two-way communication prior to class allows the teacher to adapt to the needs of his students by focusing the use of time in the classroom on overcoming the difficulties detected after the initial preparatory study. By analyzing the students' responses, the teacher receives feedback and can prepare examples that allow students a greater understanding of those issues that generate the most important doubts and difficulties. By not having to explain everything, but mainly the concepts that generate the most difficulty, the teacher has more class time to dedicate to solving and discussing exercises and exam questions. The combination of face-to-face teaching with online interactions produces a hybrid learning environment in which the information to be learned is initially conveyed along with work instructions that guide students in a sequenced and organized manner to facilitate understanding of essential ideas [8]. In the case of the adaptive flipped classroom, students interact with this information and answer questions in questionnaires that provide feedback to the teacher about the degree of understanding achieved through the preparatory study, the difficulties encountered and the doubts that have arisen. With the information received from the students, the teacher checks that his students have read and understood the materials and, if necessary, redesigns his class to focus on resolving the doubts that he has detected [9].

Today, simulation combines powerful mathematical and graphic engines that offer a sensation of reality, enhancing its use in the entertainment industry such as video games, planning surgical interventions or for pilot training. In this way, simulation not only allows studying the phenomenon, it also examines the performance of human beings when they intervene in these phenomena, with the assurance that in a virtual reality the human being will not be affected by adverse conditions. This fact becomes an unparalleled opportunity for the teaching of Sciences at any level, even more so when an advantageous relationship can be forged with the use of new information and communication technologies.

2. Material and methods

2.1. Adaptive flipped classroom

The flipped classroom has its origins in active learning methods. Research from recent decades demonstrates that incorporating active learning activities into classes improves the learning and academic performance of university students in science, engineering, mathematics, and technological disciplines.

The flipped classroom begins a path of improvement and methodological evolution that is accelerated by the new learning environment, since in this model communication with students is enriched, providing more feedback to the teacher, which is very useful for them to continue innovating their teaching methodology. . [10]

In this case, the use of an adaptive inverted classroom methodology based on Just in Time Teaching is proposed (Fig. 1) in which, based on the analysis of students' doubts, the difficulties to overcome and it is decided how to use class time so that it can contribute to a greater understanding of the contents by the students. It is indisputable that the proposed model is a very important alternative to take into account to leave once and for all the traditional ineffective, passive and boring model for the student, and comfortable for the student and the teacher of the expository class. It's a win win for everyone:

The methodology presented in Figure 1 consists of four steps that are described below:

- Transmission of the information to be learned and requests to carry out preparatory tasks and feedback on their difficulties. Take into account, as far as possible, adding complementary materials and links to web pages with content related to the topics to be discussed, since students prefer to have alternative sources of information that allow contrasting different points of view.
- Collection of responses from our students: online questionnaires.

They must serve to:

- Stimulate study, preparatory work and reflection.
- Check and evaluate the preparatory study with reflective questions.
- Detect the most prevalent reactions and needs in the students, after studying the materials

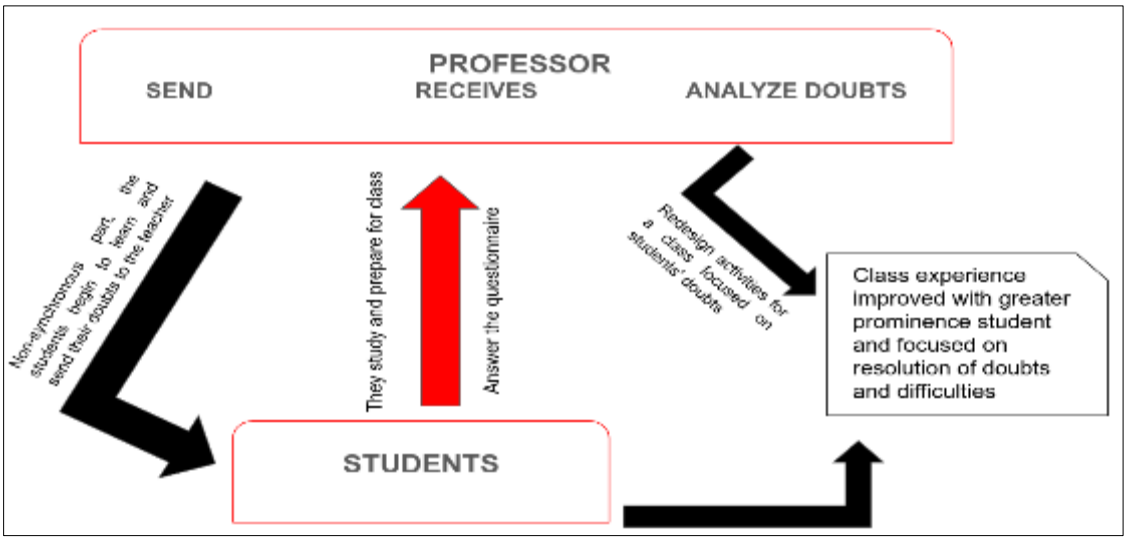

Figure 1 Adaptive inverted classroom methodology based on Just in Time Teaching

- Analysis of the students' responses and the teacher's reaction to focus the class on resolving what seems most important to us.
    - The answers are analyzed, preferably, with some technological tool in which we can have a global view of the answers to each question as well as know the number of students who do not understand each topic. In addition, it would be optimal to be able to label each type of doubt. (Alternatively, they can be analyzed in spreadsheets that show us each student's responses in a row.)
    - Each teacher must decide what seems most important to them after reading the doubts and needs of their students.
    - Enter: Free response and test questions, vignettes and cases for students to reason and discuss in pairs or teams. Activities for students to apply, analyze, and reflect on what they do and learn.
- Our adapted class proposal
    - Focus on resolving doubts and concepts that are more difficult for our students to understand. Incorporate example activities and complementary materials based on the doubts detected
    - Do formative evaluation, practice solving cases, problems and exercises. (In which students or groups of students respond using real-time response tools in the case of virtual teaching)

2.2. Moodle educational platform, as a tool for adaptive learning.

In order to do personalized learning, it is necessary to have adaptive technology. This means that the technology has to make decisions based on what a specific student does in the subject (activities, resources, learning results,...). Adaptability can be carried out based on the learning pace, the knowledge acquired or the profile of the students [11]. Although Moodle is not an advanced adaptive technology, it has adaptive characteristics that, if used intelligently by the teacher, allow infinite possibilities. There are numerous works that have been carried out on the application of Moodle as an adaptive tool. [12], [13], [14].

Moodle provides a software package designed to help instructors create and add quality content online. Allows you to provide and share documents, tasks, questionnaires, etc. with students, it is a free open source project, which means that users are free to download, use, modify and even distribute it under GNU terms. Provides the ability to create online courses and integrate some extensions.

2.3. Simulations, as a resource.

Physics simulations are a computational system that aims to approximate reality; instruments and phenomena are visualized. Numerical and graphic results are obtained, these being treated mathematically to obtain the objectives pursued in the teaching planning of the subjects. Below we highlight some important advantages.

- It brings together and facilitates a greater number of students to carry out experiences, even if the student and the laboratory do not coincide in space. The student accesses the laboratory equipment through a browser, being able to experiment without any risk.

- They reduce the cost of setting up and maintaining real practices and demonstrations, being an efficient alternative, where the student simulates the phenomena to be studied.
- It is a self-learning tool, where the student alters the input variables, configures new experiments, learns how to use instruments, personalizes the experiment, etc.
- Students learn through trial and error, without fear of suffering or causing an accident, without being ashamed of doing the same practice several times, since they can repeat them without limit; without fear of damaging any tool or equipment.

Simulation allows us to obtain a more intuitive vision of those phenomena that, when carried out manually, do not provide sufficient graphic clarity. Its use gives rise to fundamental changes in the usual teaching process, which usually begins with the mathematical model. The simulation in isolation has little didactic value; it must be immersed within a set of multimedia elements that guide the student effectively in the learning process.

In teaching, simulations can be used either at a demonstrative level in theoretical classes, or in problem classes or practical work. The teacher can also apply it to design exam problems. The planning of learning tasks for students is proposed, which are designed as open and qualitative problems. In this way, the expected responses can be varied, and the results obtained do not end in one or several numbers, but must contain comments and conclusions. This work modality, which can be implemented in groups and be complemented with individual activities, is aimed at promoting active learning, in which students make decisions, design simulated experiments and follow their own paths to reach certain objectives that they set. . These tasks are significantly facilitated by the flexibility of the Moodle educational platform.

3. Results and discussion

3.1. Implementation of the Proposal

The implementation of the flipped classroom was carried out in the second year of the Chemical Engineering degree in the regular daytime course from Physics II, following the methodological process that was presented.

The execution of the activities in the subject is in accordance with current trends in the teaching of Physics [15], in particular the sociocultural approach, the use of the experimental scientific method, the use of computational means, and in the specific engineering the interdisciplinary approach and the contextualization of the content.

The set of teaching aids includes the use of the computer system, with more than 200 simulations to develop in the different forms of teaching; simulations for mobile phones, tablets or laptops; demonstrative experiments; Power Point presentations; the videos, among other variants.

The bibliographic base includes the proposal in the study plan, as support, books and complementary materials have been prepared such as Optics Topics, Atomic Physics Topics, Nuclear Physics Topics and Physics II Brochure. All these texts are available on the Moodle Platform, which makes their use feasible; Students take advantage of the potential of WiFi technology networks that operate on the university campus, various public places and their own homes.

From their workplace in the classroom or at home, with the help of their cell phone, the student can follow the teacher's instructions; run the simulations corresponding to the class; consult texts, as is the case of the synthesis of contents that appear in the complementary material called Physics Brochure II, in which the models, concepts and laws that are being treated are found.

As an example, to guide learning in the Quantum Optics Topic, the student has the materials:

- Physics II Handout, which is a summary of the contents covered throughout the course, which includes models, concepts, laws and theories; questions, solved problems and proposed problems.
- Selection of questions and problems from Physics II, whose function is to guide students' learning through questions about models, concepts, laws and theories.

In the content corresponding to Nuclear Physics, the simulation was presented to the student (Fig.2, a)), Through this simulation the student can deduce the nature of the components of the radioactive emission, by their behavior in a magnetic field, experience carried out by Ernest Rutherford in his time.

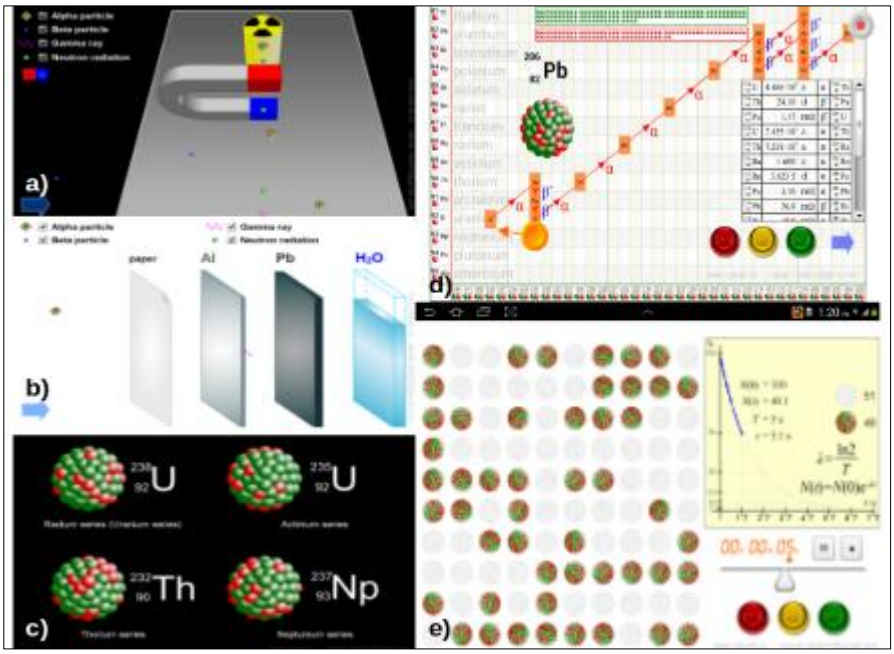

Figure 2 Examples of physics simulations

The simulation (Fig.2, b)) allows us to delve deeper into the properties of the radioactive emission, which is of great importance for protection against radiation.

The simulation (Fig.2, c)) allows you to choose one of the radioactive series, while (Fig.2, d)) shows the emergence of the uranium series, which allows you to appreciate the alternation of alpha and beta decays .

On the other hand, with the help of (Fig.2, d)) the student can verify the Law of radioactive decay and evaluate concepts such as half-life, radioactive activity, etc. With the help of these simulations, the Physics II Handout and the bibliography, the student must answer the questions that the teacher formulates in an autonomous and independent manner.

3.2. Record of experiences with the use of simulations in the teaching-learning process of Physics II.

Six teams of two students were formed who had access to the physics course implemented on the Moodle platform, which contained simulations implemented directly in the course; the Physics at School apk [16] and the reference bibliography.

To corroborate the students' performance, the following parameters were used:

Number of questions answered; Interpretation of concepts, laws and graphics; Use of the simulations; Interaction with other teams.

Table 1 Results of the experience

Teams	Question answered	Interpretation errors	Use of the simulations	Interaction with other teams
Team 1	12	Regular	Good	Bad
Team 2	16	Good	Good	Regular
Team 3	16	Regular	Good	Good
Team 4	11	Regular	Good	Good
Team 5	17	Good	Good	Good
Team 6	17	Good	Good	Regular

It was found that it is possible to develop teaching activities that have the student as the protagonist, the student shows a higher level of concentration, the speed of information processing depends on the individual characteristics of the team members, an increase in student motivation, as well as a better understanding of the content and greater development in solving problems, both theoretical and experimental.

The system allows simulations to be used to carry out virtual laboratories as training for real laboratories, to which the Theory of Uncertainties can be applied, for which software can be used for the processing of experimental data.

4. Conclusion

The most important tangible result was the proposal and analysis of the introduction of simulations in physics courses, taking into account the adaptive flipped classroom methodology based on Just-in-Time Teaching which allows students to detect difficulties and decide. How to use class time to achieve greater understanding of the content. A strategy for adaptive learning was presented, and the use of the educational platform Moodle is proposed, which reports progress in student learning and allows adaptive and personalized feedback.

Further research is needed to achieve an introduction of ICT that really meets the expectations of a more constructive and autonomous teaching-learning process that prepares students for ongoing training in this new era. The use of software in teaching requires that the teacher knows perfectly the model that is used, its possibilities and limitations, and has an opportunity to analyze and reflect on the methodological aspects of the application of these tools, in addition to mastering the management of the environment with agility. In other words, to obtain the greatest benefits from the introduction of computational methods to the teaching of Physics, a whole previous process of learning, elaboration and planning by the teacher is required. The method addressed encourages students to become more involved in their teaching-learning process.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Á. Fidalgo-Blanco, M. L. Sein-Echaluce, and F. García-Peñalvo, “CAN EDUCATIONAL INNOVATION TRENDS PREDICT THE CHANGES THAT WILL TRANSFORM THE EDUCATIONAL MODEL?,” May 2019.

[2] Á. Fidalgo-Blanco, M. L. Sein-Echaluce, and F. J. García Peñalvo, “Collective intelligence in the classroom. A cooperative paradigm - [Collective Intelligence in the classroom. A cooperative paradigm],” in Teaching innovation as a mission of teachers: International Congress on Learning, Innovation and Competitiveness, 2017, pp. 1–5.

[3] Á. Fidalgo-Blanco, M. L. Sein-Echaluce, and F. J. García-Peñalvo, “Micro Flip Teaching with Collective Intelligence,” in Learning and Collaboration Technologies. LCT 2018. Lecture Notes in Computer Science, I. A. Zaphiris P., Ed. Las Vegas: Springer, Cham, 2018, pp. 400–415

[4] Lage, M., Platt, G., & Treglia, M. (2000). “Inverting the Classroom: A gateway to Creating an Inclusive Learning Environment,” Journal of Economic Education.

[5] Peinado-Rocamora, D. P. (2018). The flipped class: an experience with students with learning difficulties. University of Murcia. International Doctoral School.

[6] Cedeño-Escobar, M. R., & Vigueras-Moreno, J. A. (2020). Flipped classroom a motivating teaching strategy for basic general education students. Scientific magazine. Mastery of sciences, pp. 878-897. doi:http://dx.doi.org/10.23857/dc.v6i3.1323

[7] Aguilera-Ruiz, C., Manzano-León, A., Martínez-Moreno, I., Lozano-Segura, M., & CasianoYanicelli, C. (2017). THE FLIPPED CLASSROOM MODEL. International Journal of Developmental and Educational Psychology, pp. 261-266. doi:https://doi.org/10.17060/ijodaep.2017.n1.v4.1055

[8] Talbert R. Flipped learning: a guide for higher education faculty. 12. Sterling, VA: Stylus; 2017.

[9] Prieto A, Díaz D, Lara I, Monserrat J, Sanvicén P, Santiago R, 20. et al. New combinations of flipped classroom with just in time teaching and analysis of student responses. RIED Ibero-American Journal of Distance Education 2018; 21: 175-94.

[10] Alfredo Prieto-Martín, José Barbarroja-Escudero, Isabel Lara-Aguilera, et al. Flipped classroom in health education: recommendations for its implementation. www.fundacioneducacionmedica.,org FEM 2019; 22 (6): 253-262

[11] Á. Fidalgo-Blanco, M. L. Sein-Echaluce, and F. J. García-Peñalvo, "APFT: Active peer-based Flip Teaching," in ACM International Conference Proceeding Series, 2017, vol. Part F1322.

[12] M. Á. Conde, F. J. García-Peñalvo, Á. Fidalgo-Blanco, and M. L. Sein-Echaluce, Can we apply learning analytics tools in challenge based learning contexts?, vol. 10296 LNCS. 2017.

[13] M. L. Sein-Echaluce Lacleta, Á. Fidalgo Blanco, and F. García Peñalvo, "Flip Teaching Methodology supported on b-learning and knowledge management," in Proceedings of the III International Congress on Learning, Innovation and Competitiveness. CINAIC, 2015, pp. 464–468.

[14] A. Fidalgo-Blanco, M. Martinez-Nuñez, O. Borrás-Gene, and J. J. Sanchez-Medina, "Micro flip teaching – An innovative model to promote the active involvement of students," Comput. Human Behav., vol. 72, pp. 713–723, 2017.

[15] D. Gil and M. Guzmán. Selected topics from physics teaching. Havana: Ed. People and Education (1993).

[16] V. Vascak. Physical Web at school. Simulations in web and apk formats [ISSN: 1874-088X], (2017, 2018, 2019) (www.vascak.cz). https://play.google.com/store/apps/details?id=air.cz.moravia.vascak.physicsatschool&hl=es.