

# MENDIVE

REVISTA DE EDUCACIÓN

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## Agility in active learning: proposal in the subject Models and Simulation

### Agilidad en el aprendizaje activo: propuesta en la asignatura Modelos y Simulación

### Agilidade na aprendizagem ativa: proposta na disciplina Modelos e Simulação

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#### ABSTRACT

Higher Education spaces apply a diversity of active methods, which are integrated to design innovations in order to achieve

significant learning. The article describes an active methodology experience focused on the inverted class and learning based on problems to reach significant learning. In the production of the educational material, Scrum, an agile project management methodology, was chosen. In order to validate this proposal, it was focused on the Dynamics Systems as a study topic, and mediation was achieved by adapting information and communication technologies available tools as resources on the Moodle platform. The proposal was done in the first semester of 2019, and positive results were obtained regarding the learning of disciplinary knowledge in a context of innovation, which are encouraging for its replication.

**Keywords:** agile educational project; inverted class; problem based learning; higher education.

#### RESUMEN

Los espacios de Educación Superior se valen de una diversidad de métodos activos, los que se integran en innovaciones que tienden a lograr aprendizajes significativos. En el artículo se describe una experiencia de metodología activa centrada en el Aula Invertida y el Aprendizaje Basado en Problemas para lograr aprendizajes significativos. En la producción del material educativo se optó por Scrum, metodología ágil de gestión de proyectos. Para validar la propuesta se particularizó abordando como tema de estudio la Dinámica de Sistemas y la mediación se logró por la adaptación de herramientas de las tecnologías de la información y comunicación disponibles como recursos en la plataforma Moodle. La propuesta se concretó en el primer semestre del año 2019 y se obtuvieron resultados positivos en torno al aprendizaje de conocimientos disciplinares en un contexto de innovación, los que son alentadores para su replicación.

**Palabras clave:** proyecto educativo ágil; Aula Invertida; Aprendizaje Basado en Problemas; educación superior.

#### RESUMO

Os espaços do Ensino Superior fazem uso de uma diversidade de métodos ativos, que são integrados em inovações que tendem a alcançar um aprendizado significativo. O artigo descreve uma experiência de metodologia ativa focada na Aula Invertida e no Aprendizado Baseado em Problemas para alcançar um aprendizado significativo. Scrum, uma metodologia ágil de gerenciamento de projetos, foi escolhida para a produção do material educacional. A fim de validar a proposta, a System Dynamics foi abordada como tema de estudo e mediação, adaptando as ferramentas de tecnologia da informação e comunicação disponíveis como recursos na plataforma Moodle. A proposta foi realizada no primeiro semestre de 2019 e foram obtidos resultados positivos em torno do aprendizado do conhecimento disciplinar em um contexto de inovação, que são encorajadores para a replicação.

**Palavras-chave:** projeto educacional ágil; Aula Invertida; Aprendizagem Baseada em Problemas; ensino superior.

## INTRODUCTION

Innovations in Higher Education imply the definition of interdisciplinary strategies with a view to improving the skills of future graduates. Models and Simulation is a fifth-year elective subject, taught in the first semester of the Bachelor's degree in Information Systems at the National University of the Northeast. In Mariño (2020) and Mariño and Alfonzo (2020) this subject was characterized.

For this reason, the proposal is characterized by its interdisciplinary approach oriented to administration, education and as a domain of application a subject of mathematics applied every treaty in a career in Computer Science. Regarding the scope, the solution is aimed at acquiring knowledge about System Dynamics, a specific subject of the subject; this approach is applied to other issues of similar nature.

Then a synthesis around active methods Reversed Classroom and Learning Based on problem is exposed.

### The Inverted Classroom

The Inverted Classroom (AI) is a model that modifies the traditional teaching method. It originates in pedagogical theories and models, among them active learning, which is why it guides students to develop responsibilities for learning responsibility, according to their space, time and rhythm (Hernández Silva and Tecpan Flores, 2017).

The AI is a process that involves students in an activity that requires them to reflect on the ideas and how they are using them.

Using various digital resources, they create presentations of their classes that they record using a computer, edit videos, or select classes from websites. Video is one of the main resources; audiovisual materials have a great impact on the learning process to explain concepts and demonstrate procedures. Depending on the topic to be carried out, you can choose the type of resources to use according to the learning style of the students.

The flipped learning network, according to Benites Yarleque (2018), considers as the fundamental pillars of the model:

- Flexible environment: this pillar refers to the fact that students can have different learning styles; it is important to provide content and activities so varied and flexible spaces for the student to choose when and where to study. In addition, the learning sessions can be readjusted as observed by the class leader.
- Learning culture: the student participates actively in the construction of their knowledge, evaluates their learning in a meaningful way. He assumes responsibilities, such as reviewing materials, interacting with the teacher and his classmates, contributing ideas in an environment of respect and collaboration.
- Intentional content: the teacher continually reflects on how to get students to learn the conceptual and procedural part, selects the information and materials according to the learning objectives. The teacher optimizes class time, employs student-centered methods and active learning strategies.
- Professional teacher: the role of the teacher is very important because he constantly monitors the student, gives him feedback and evaluates him. He also reflects on how to improve his work.
- Audiovisual resource: it is a tutorial video that must be planned by the teacher based on the objectives that the students are expected to achieve; it is recommended that the teacher create and edit the video. Before video made, you should make planning class, recording, editing and publishing. For the video to be attractive it must be short, with duration between 5 to 12 minutes.
- Digital presentations: the content of the class can be made by integrating various media such as text, links, images, audio and video.
- Work environment: it is a *hardware* and *software* platform that provides the Internet to put the video, where students can see how many times they require it and at the rate they want.

### Problem Based on Learning

The Problem Based Learning (ABP) can be approached as a learning - oriented education, inquiry and reflection to achieve a response to a problem posed (Hernández González, Muñoz Castillo and Perez Parra, 2020). Furthermore, it constitutes "a teaching-learning strategy in which both the acquisition of knowledge and the development of skills and attitudes are important" (Morales Bueno and Landa Fitzgerald, 2004).

On the other hand, PBL is defined as "a learning method based on the principle of using problems as a starting point for the acquisition and integration of new knowledge" (Barrows, 1986). In this methodology, the protagonists of learning are the students themselves, who assume the responsibility of being an active part in the process.

The pedagogical model based on the AI defines the roles of the teacher and the student. The first becomes a guide for the student in his learning process; Instead of being an exhibitor of the contents, he is in charge of preparing the resources and activities that will allow the students to understand the subject.

There is a diversity of resources that can be used, both in the virtual session and in the face-to-face session, considering the facilities of ICT:

A BP, as a teaching- learning method, has taken

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root in higher education institutions in recent years. While traditionally the information is first exposed and then its application is sought in solving a problem, in the case of PBL the problem is first presented, the learning needs are identified, the necessary information is sought and finally the problem is returned. In the course students live from the original planning problem up to its solution, work collaboratively in small groups, sharing the learning experience can practice and develop skills to observe and reflect on attitudes and values in the conventional expository method could hardly be put into action. The work experience in the small group aimed at solving the problem is one of the distinctive characteristics of the ABP (Rodríguez Ramírez, Delgadillo Salgado and Torres Trejo, 2018).

The ABP is a teaching and learning strategy in which, both the acquisition of knowledge and development of skills and attitudes are important. During the students' interaction process to understand and solve the problem, it is achieved, in addition to learning their own knowledge of the subject, that they can make a diagnosis of their own learning needs, that they understand the importance of working collaboratively, that they develop skills analysis and synthesis of information, in addition to committing to their learning process.

This method is based on different theoretical currents on human learning, where the constructivist theory has a particular presence; According to this position, three basic principles are followed (Morales Bueno and Landa Fitzgerald, 2004):

- Understanding regarding a situation of the reality arises from interactions with the Environment.
- The cognitive conflict when facing each new situation stimulates learning.

- Knowledge is developed through the recognition and acceptance of social processes and the evaluation of different individual interpretations of the same phenomenon.

It is intended that the student understands and properly delve into the answer to the problems that are used for learning, addressing aspects of philosophical, sociological, psychological, historical, etc. All this, with a comprehensive approach.

The structure and problem-solving process are always open, which encourages conscious learning and systematic group work in a collaborative learning experience. It is important to note that the objective is not focused on solving the problem but be used as a basis for identifying learning issues for study independently or in groups; that is, the problem serves as a trigger for students to meet the learning objectives of the course (Morales Bueno and Landa Fitzgerald, 2004).

In professional careers, applying PBL is essential, since it allows experimenting with the "rapidly changing demands of professional practice" (Pérez Lujan, 2016). Ferriere mentions that the ABP aims to develop student autonomy through the critical search for knowledge (Morales Bueno and Landa Fitzgerald, 2004).

The objective of this article is to present a proposal for significant active learning supported by the integration of the Reversed classroom or Reversed Class (AI) and Problem Based Learning (PBL) - mediated some tools of the Technologies of Information and the Communications (ICT). To manage the production of the educational material, it was decided to apply an adaptation of Scrum, an agile project management methodology.

In short, the contributions of the teamwork of Cousinet, The interdisciplinary in Decroly, the link between school and social life of Freinet, acting regulated by the thought of Dewey, the critical spirit of Ferriere, as well as responsibility and commitment in teaching, they are elements present in the current PBL (Morales Bueno and Landa Fitzgerald, 2004; Pérez Lujan, 2016; Calvopiña León and Bassante Jiménez, 2017).

PBL implies the interaction of teachers and students, they cannot separate, and both are important and tend towards cooperation (Rendón González, 2018). In particular, it argues that "applying a didactic strategy through the methodology of problem-based learning, (...) strengthens" competence in problem solving" (p.17), a central aspect in the subject Models and Simulation. In Morales Bueno and Landa Fitzgerald (2004) some objectives of the ABP are characterized and mentioned including: learning is centered on the student-; learning occurs in small groups of students; the teachers are facilitators or guides; The problems form the focus of organization and stimulus for learning; the problems are a vehicle for the development of skills of clinical problem solving; The new information is acquired through self - directed learning.

In Calvopiña Leon and Bassante Jimenez (2017) it states that the ABP is a real problem and therefore "conspires: The current form of organization of the Curriculum based on the transmission of knowledge" (p 341). These approaches, meanwhile, indicate the importance of the PBL approach in abstractions of real-world problems dealt with in the aforementioned subject.

## MATERIALS AND METHODS

The proposed research design is the case study. It was an investigation of a descriptive, exploratory and interpretive nature. It consisted of the following phases contemplated for the achievement of an agile educational proposal that integrates the AI and the PBL.

**Phase 1.** Selection of active methodologies to achieve meaningful learning. The AI model to promote responsibility in the educational process was selected. In addition, for the achievement of disciplinary learning in the subject object of Dynamics application of Systems, project-based learning was chosen

**Phase 2.** Selection of an agile method on which to base the educational project proposal.

The agile methodology is a process that allows the team to give quick and unpredictable responses to the feedback that their project receives. Scrum is an iterative and incremental framework for the development of projects, products and applications and it is structured in work cycles called Sprints (Gonçalves and Linders, 2014).

In Satpathy (2016) it is described Scrum as a framework adaptable work, iterative, fast, flexible and efficient, designed to deliver significant value quickly throughout the project. It guarantees transparency in communication and creates an environment of collective responsibility and continuous progress. One of the strength of Scrum lies in the use of self - organizing cross- functional teams and to divide their work in short cycles called Sprints and concentrates. Each Sprint begins with a planning meeting, during which it is decided which requirements with the highest priority will be

included. The Sprint Scrum is defined as the preset time interval during which an increase in product "Made or done" is created usable, potentially shippable. The following Sprints were considered in the development of the project:

1. Review and analysis of the state of the art of the most proposed topics: topics of PBL and the AI model were studied in depth to turn them into the subject Models and Simulation.

2. Inquiry, comparison and choice of tool for the implementation of Dynamics System: at this stage, every tool that can be used in the development of Dynamics System was sought and studied. Analyzing which is the most suitable for the study and it was selected one for its development.

3. Selection of resources for the development of I AI: after an analysis there were selected those considered most suitable for the development of the method of AI.

4. Construction of resources for the development of the methodology under study: in this stage, after analyzing and selecting the resources that are considered convenient for their use, the study material was carried out for the students, which fulfill a learning path.

5. Publication of resources: in this phase, once the previous stage has been completed, the learning path must be made public, in order to carry it forward.

6. Analysis of the results: in this stage, the results obtained in terms of obtaining knowledge of the subject by the students were carefully analyzed to find out if this new study methodology is advantageous.

7. Report writing: at this stage the report that describes the process of

preparing and implementing the proposed methodologies is written.

8. In agile environments as Scrum, user stories are a basic element to describe the requirements of a client. This process, the User Story Mapping Technique to obtain a series of essential features to ensure that the product meets its vital functions was used. The tables 1 and 2 detail the main user stories designed to carry out this project; the two main roles are established for the professor and the student, each have their respective features.

**Table 1 - History of user role teacher**

<b>AS</b>	Teacher
<b>I WANT</b>	The understanding of Dynamics System
<b>TO</b>	deepen the subject in the subject Models and Simulation.
<b>ACCEPTANCE</b>	<b>CRITERIA</b>
- Students of the subject with access to the Moodle platform.	
- That they carry out the proposed activities in the learning route.	
- That they meet the evaluation criteria.	

**Table 2- History of user role pupil**

<b>AS</b>	Students
<b>I WANT to</b>	<b>I WANT.</b> Understand the contents of the subject Models and Simulation.
<b>TO</b>	acquire new knowledge and be able to advance with the course of the degree.
<b>ACCEPTANCE</b>	<b>CRITERIA</b>
- Compliance with return of corrections.	
- Availability of information.	
- Answers to questions stated.	

**Phase 3. Selection of tools**

In the construction of the *software* solution that integrates the AI and ABP pedagogical model, the following tools were chosen:

## Tools for the development of resources for the AI

- POWTOON, online *software* that allows you to create videos and animated presentations and interpret what the user enters into its interface, reproducing itself in a kind of cartoon, of a person speaking or showing dialog boxes.
- Canva, tool design and create all kinds of web content: info graphics, posters, graphics. Just choose a template, which can be modified by adding our own images, adding text and changing the organization of the elements. It was applied for the elaboration of an info graphic for the learning path of the topic addressed "Dynamics of systems"; it was presented to the students to acquire prior knowledge of the subject.
- Camtasia Studio, a program to record what happens on the interface. It allows making the tutorial videos for different study topics.
- Moodle, platform to manage teaching- learning processes. It was used this system because the University provides a user name and password to each trainee student of the subject Model and Simulation. This tool of ICT available to a variety of resources, which are used to define this learning path and thus fulfill the objective of the method of AI.

## Tool to strengthen knowledge around System Dynamics

In the literature, a diversity of applications for modeling through System Dynamics is located (Vargas Sánchez and Parra Valencia, 2015). PLE Vensim 7.2 is a visual tool of

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modeling for conceptualizing, document, simulate, analyze and optimize models of Dynamic of Systems. The academic version of the Vensim PLE tool used in the proposal presents limits to simulate different problems. Commercial versions allow many cases to be solved, including the Monte Carlo sensitivity issue among others.

## Phase 4. Delivery phase or implementation of the proposal

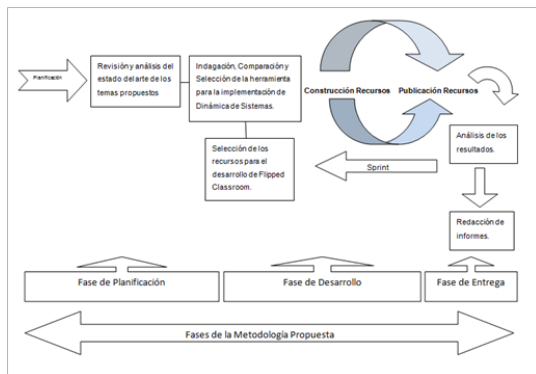
For purposes of validation, the described proposal, based on a method of project management such as Scrum and integrates the model of AI and the ABP, was implemented in the academic year 2019. It had a sample of 21 students.

## RESULTS

This section presents the educational proposal based on Scrum as an agile strategy to achieve significant learning supported by the integration of AI and PBL. The process decomposes up to the level of activities and tasks. The different resources provided by Moodle tool allows defining a set of activities and each form the process of AI and results in system dynamics.

## Adaptation of Scrum to the proposal

The figure 1 illustrates the implemented framework that integrates Scrum practices in building resources for the development of the educational proposal. As it is visualized, the Sprint iteration process is represented in the tasks that make up the elaboration of each version of the project. The table 3 shows the adaptation of Scrum to manage the educational process in the proposal designed and explained in this article in.



**Fig. 1-** Frame of agile work used to manage the process of the project

study the topic Dynamic Systems, in the which applied methodology AI. This material is available in the virtual classroom of the Models and Simulation subject, accessible from the Moodle platform of the University.

Referring to this resource of active learning, in the figure 2 the learning path available in the Dynamic Systems section is shown. Also, the different resources integrated to achieve the meaningful learning are appreciated.

**Table 3-** Phases of the proposed methodology

PHASES	Understood by Sprints	DURATION N
Planning	<b>Sprint 1:</b> review and analysis of the state of art of the topics proposed	1 month
	<b>Sprint 2 :</b> search, comparison and selection of the tool for the implementation of the Dynamics System	2 months
	<b>Sprint 3:</b> s choice of resources for the development of Flipped Classroom	3 months
Developing	<b>Sprint 4:</b> Construction of resources for the development of the methodology under study	2 months
	<b>Sprint 5 :</b> Resource Publishing	1 month
Delivery	<b>Sprint 6:</b> Analysis of the results	1 month
	<b>Sprint 7:</b> Report Writing	1 month



**Fig. 2 -** Path to Learning of the System Dynamics resource

Then, the resources provided by Moodle, which were adapted and integrated into the proposal AI are mentioned (see table 4):

- Questionnaire: It allows the teacher to design and pose with multiple choice, true / false, coincidence, short answer and numerical answer questions.
- Survey: It allows a teacher to create a custom survey to obtain feedback from participants, using a variety of question types, including multiple choices, yes / no or text.
- URL or External Tool: It allows students to interact with educational resources and activities hosted on other internet sites. For example, an external tool could provide access to a new

### Implementation of the methodology of the AI

The educational material was built around the ABP and involved as an object of



type of activity or educational materials from a publisher.

- File: It allows instructors to provide a file as a course resource. When possible, the file will be displayed within the course interface, if not, students will be asked if they want to download it.
- Folder: It allows the teacher to display a group of related files within a single folder. You can upload a compressed (zip) file that will later be unzipped to display its content, or you can create an empty folder and upload the files within it.

**Table 4-** Resources of the Moodle Tool integrated into the educational proposal

Recurso	Icono
Archivo	 Presentación Dinámica de Sistemas
Archivo	 Infografía
Carpeta	 Antecedentes
Encuesta	 Autoevaluativo
URL	 Aplicación de la Metodología en la herramienta Vensim PLE

The implementation evidenced the need to include the Task activity. The teacher evaluates the student learning by creating a task to perform auditing, value, qualify and which feeds back. Students have access to audio and video files from other resources of ICT. Alternatively or in addition, the task may require students to write the text directly into a field using the text editor. It can also be used to remind students of abstract "real world" activities that they need to analyze and that do not require the delivery of any digital content. For group work, the module has the ability to accept deliveries made by one of the members and links to the rest.

During the review process, teachers can leave comments and upload files such as graded papers, documents with written

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observations. Assignments can be graded using a numerical scale, a custom scale, or complex grading methods such as rubrics. Final scores are automatically updated in the model card.

### Implementation of the proposal in the subject Dynamics of Systems

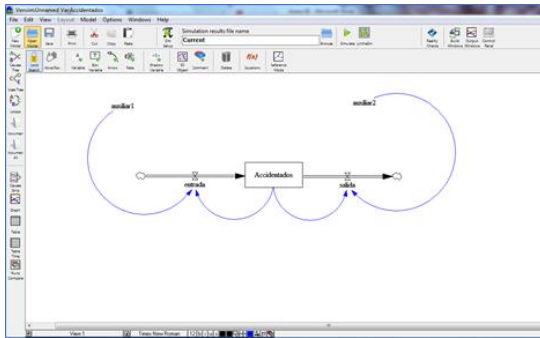
Analyzed the various active methodologies, the AI and PBL are selected as an object of integration.

In particular, it is explained how it was implemented the AB P in a context of AI to the present an object study problem and its resolution using technical system dynamics.

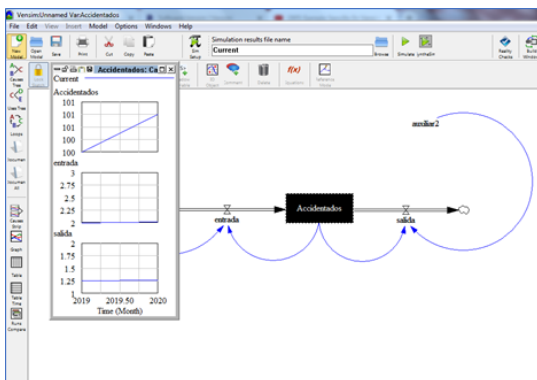
Then, the statement is exposed: the number of accidents in motorcycles must be simulated, the monthly application that follows a normal demand (250); 30 persons is established. We want to generate an artificial sample of the random variable that represents the monthly demand for injured persons during 6 years, 2,190 days.

In the figure 3 it is observed the graph of the simulation. It is set a level of rugged study, the state of the system is defined and the information on which actions are based and generates is generated and it allows decision making. The resolution has two assistants, both related to the flow variable of input and output respectively. In addition, the feedback loops are appreciated.

In figure 4 it is recognized a further analysis. The variation in each of the inflows and outflows is observed. On the left side the selection is shown according to detail of the Information.



**Fig. 3-** Simulation graph of the ABP statement



**Fig. 4-** Analysis of each of the components of the Simulation

### Assessment of the learning process

In a context of implementation of the AI, student-teacher and student-student interactions were evidenced. The teachers promoted group and individual work, the development of the students were observed, they evaluated and gave feedback on their contributions. The students acted as active participants in their learning process, attended the classes with prior knowledge, studied from the resources provided to understand the concepts, answer the questions, and carry out the proposed task. This is how it was achieved that the student arrived at the face-to-face instance with questions to consult the teacher; that is, it shares the knowledge acquired in advance.

The proposed activity completed 21 students, who downloaded the available resources and carried out the established practices. Student participation generated feedback information associated with the methodology.

The "self - evaluation" resource possible to analyze the interpretation and understanding of the subject under study Dynamic Systems, integrating a proposal for ABP in an AI context.

The issue discipline regarding whether the  $\xi$  is the System Dynamics a methodology for building models of *hardware*? It allowed to observe that 95.24 % of the students answered correctly. Regarding the study of the phases that make up System Dynamics, more than 80 % answered correctly.

In reference to the purpose of applying the methodology Dynamic Systems, it was reported that 23.81 % of the students recognized the parts of the system properly, and explain on their performance on 71.49 %. In addition, 95% understood one of the first phases of the methodology.

### DISCUSSION

Students of the 21st century need to develop general and specific competencies, that is, capacities, abilities and aptitudes that is useful and applicable in the social, academic and professional environment. In this context that new requirements emerge, innovation is aimed at the formation of autonomous learners, so the strategies should focus on the significance of learning.

In reference to the selected methodologies, the

integration of one from the administration and two from the domain of education stands out. The agile methodologies for project management are applied in various fields, one being the educational, as shown in Marino, Alfonzo and Arduino (2020).

Regarding the active educational methodologies, the ABP and the AI were chosen. Authors like Calvopiña León and Bassante Jimenez (2017) and Hernández González, Muñoz Castillo and Perez Parra (2020) presented case studies around the active methodology ABP, whereas in Benites Yarleque (2018) and Hernandez Silva and Tecpan Flores (2017), strategies based on the IA model are explained.

This article presented an educational proposal that, based on an agile practice as Scrum, integrates the model of AI and the ABP, reason possible to define a strategy motivating for the achievement of learning objectives and facilitates management of time of study to the students. This ICT-mediated proposal offers a constructivist model where, as mentioned by Rodríguez Ramírez, Delgadillo Salgado and Torres Trejo (2018, pp. 44), the role of the teacher transcends to a "facilitator of the learning process", the "experience and appreciation for multiple perspectives" and "learning in realistic and relevant contexts".

As for the results of the implementation in the school year 2019 to study System Dynamics, the experience provided a great opportunity to consolidate and reflect on the concepts and the important content selected in the case study, checking understanding and clarifying misconceptions, helping students to review content, evidence that is illustrated in the high percentages of positive responses recovered in the evaluation of the learning process.

The incorporation of a learning path that guides the appropriation of the specific contents with significance stands out.

It was shown that the conjunction of strategies and tools allowed the development of planning around the integration of these active methodologies with reliability. In addition, it is inferred to continue analyzing other resources to expand the proposal and continue its validation in future school cycles, with a view to carrying out comparative studies.

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Authors declare not to have any conflicts of interest.

**Authors' Contributions:**

*Sonia Itati Mariño:* Conception of the idea, general advice on the topic addressed, authorship coordinator, literature search and review, translation of terms or information obtained, preparation of instruments, application of instruments, drafting of the original (first version), revision and final version of the article, correction of the article, revision of the applied bibliographic norm.

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