Original article

The inverted classroom as a methodology for learning Organic Chemistry-Biochemistry in Agronomy Engineering

Gerardo Martínez Jimenez[1*] https://orcid.org/0000-0003-3888-4377

Rodolfo Luis Reyes Baños[1] https://orcid.org/0000-0002-8114-6874

Leyanis Rodríguez Betancourt[1] https://orcid.org/0000-0003-4824-2431

[1]Universidad de Ciego de Ávila Máximo Gómez Báez. Cuba

*****Author for the correspondence**:** gerardomj150869@gmail.com

ABSTRACT

The objective of this article is to evaluate the degree of satisfaction of first year students of Agricultural Engineering with the use of the inverted classroom methodology in the teaching-learning process of Organic Chemistry-Biochemistry. For this purpose, the students' perceptions questionnaire was used. The results obtained show that students prefer to participate in class through individual and group practical work rather than in a traditional class, stating that they make better use of the time in the classroom, the use of Information and Communication Technologies, enhancing self-learning.

Keywords: Agricultural Engineer; Inverted Classroom; Degree of satisfaction; Organic Chemistry-Biochemistry.

Introduction

The social task of the Cuban university is characterized by the need to deliver a competent professional committed to the homeland, understanding the former, who can solve the professional problems that arise in the working environment and the latter, unconditionality as an essential quality in terms of the defense of the principles of the Revolution (Vega, 2022).

The training of engineers capable of facing the challenges of this century is a challenge for universities. Currently, universities demand a comprehensive training of graduates, where the teaching-learning process should be aimed at promoting the comprehensive academic development of engineers that respond to the demands of contemporary society (Ruiz et al., 2021).

In recent years, our society has been characterized by scientific and technological advances linked to all organizational sectors and, above all, within the framework of education. The implementation of new teaching methods has generated profound transformations and an innovative style in which the teacher ceases to be a transmitter of finished knowledge and becomes aware that his role is to create the possibility for his students to produce their own knowledge, ceasing to be passive and becoming active entities (Jato et al., 2021).

Active learning and the determination to give students a leading role have been consolidated as the main premises of 21st century learning, to which we can add the use of technology. In this scenario, the flipped classroom methodology acquires a special emphasis, since it combines the main educational trends: active learning and the use of Information and Communication Technologies (ICT's) (Sola et al., 2019).

Several authors have systematized on the inverted classroom (IA) methodology (Bulege et al., 2022; Cedeño and Viguera, 2020; García, 2020; Jato et al., 2021; López, 2020; Peralta et al., 2020; Sablan and Prudente, 2022; among others). They agree that IL is a teaching methodology that surpasses the traditional one, which assumes that the student uses multimedia tools to consult autonomously, so that the classroom becomes a place to develop knowledge and skills through collaborative work, problem-based learning, project-based learning, stimulating the students' protagonism and favoring self-regulation of learning.

The subject Organic Chemistry-Biochemistry is basic for the formation of the Agricultural Engineer and is dedicated to the study of organic molecules, their structure, properties and applications, as well as their dynamics in the context of living organisms through the different pathways or sequences of metabolic reactions and the interrelation between each of them, allowing energy analysis and nutritional principles of the main biomolecules.

In order to make the most of the time available to the university professor when teaching the contents of the subject Organic Chemistry-Biochemistry, taking into account the learning pace of each student and the group in general, it is necessary to implement active methods such as the inverted classroom, which favors meaningful learning in students,

considering them as beings capable of regulating what they learn and at what pace they learn it.

In this line, the present study has the general objective of evaluating the degree of satisfaction of the first year students of Agronomic Engineering of the University of Ciego de Avila on the AI methodology in the teaching-learning process of Organic Chemistry-Biochemistry.

Development

The technological development achieved in the society of the new century accompanies modern educational trends. When talking about the inverted classroom as a teaching method for cognitive development, we refer to a new pedagogical model that contributes to students having meaningful learning, considering them as beings capable of regulating what they learn and at what pace they learn it (Jato et al., 2021).

According to Hu et al. (2019), IL is:

One of the blended learning methodologies that combines e-learning and face-to-face classroom. It aims to improve the effectiveness of classroom learning by allowing students to control the time and pace of their online learning and maximize their opportunity for active learning by engaging in class discussions and collaborative exercises with peers and teachers.(p. 2)

IA became a pedagogical method that changed the traditional learning model, since it brings more weight to individual practice generating meaningful and collaborative learning between students and teachers, managing the student's time and thus enhancing the effectiveness of the class session with a better understanding of the content presented and developed (Vidal et al., 2016).

In this new educational teaching method, students learn the basic content independently before class, such as previewing the chapters to be taught in class in advance and watching a learning video on the online platform or a multimedia presentation before class time (King et al., 2019).

Martinez (2019) mentions that AI is perceived as a powerful tool that allows students to be in control of their own learning, as they are responsible for watching the videos or presentations and asking appropriate questions around them. It is recommended that the

videos have duration of less than fifteen minutes; they are previously worked on at home and discussed in class, in addition to proposing research projects and activities aimed at problem solving, among other options.

Sablan and Prudente (2022) emphasize that the IA model has a positive effect on students' academic performance in Physics and Mathematics. With the traditional method, classroom time is used to explain new content to students - while taking notes on what is being presented - and to guide the tasks that the student must perform, alone or in teams, at home or in libraries.

Currently, a set of active learning strategies have emerged, which, using ICTs, help to improve the teaching-learning process, among which is the inverted classroom or Flipped Classroom (Bergmann and Sams, 2014), which consists of a new pedagogical approach, in which students outside class time, observe certain content provided by the teacher (Martinez et al., 2014), allocating class time to promote other enriching processes, such as discussion and implementation of the knowledge acquired for problem solving and clarification of doubts, debates, among other activities, which stimulate the exchange of ideas and feedback from the teacher in the classroom (García et al., 2019).

This methodology includes, turning to traditional pedagogy, and leaving aside the exposure of the contents taught in the classroom, for the analysis and activities based on collaborative learning among classmates for problem solving, while the teacher guides the development of activities (Cedeño and Vigueras, 2020).

The structure on which the IA strategy is based is a reflection of the levels of Bloom's Taxonomy (Domínguez and Palomares, 2020), where the first three levels: remember, understand and apply, are approached asynchronously, it is there where the concepts are explored and their meaning is generated, these activities are not subject to classroom time. On the other hand, the last levels on Bloom's scale: analyze, evaluate and create, are carried out through synchronous activities or in the classroom, with the guidance of the teacher, where the acquired knowledge is experimented, demonstrated and applied.

In each of the activities the teacher must organize the strategies and choose the appropriate materials in order to meet the objectives set, the techniques must be varied and dynamic, useful in terms of what is planned, must be flexible and adjust to the needs of students, thereby maintaining a high commitment and ensuring the quality of learning (Cedeño and Vigueras, 2020).

Among the advantages of inverting the classroom into the classroom is the differentiated attention given to the student by the teacher, especially when clarifying doubts and when facing difficulties in solving problems. This method contributes to create a productive climate in the classroom, so that students learn to learn by themselves, identify the way they learn best, collaborate and help each other, become more motivated and involved in their own learning, improve their reflective and critical capacity, creativity and academic performance (Torres, 2019). It also contributes to develop responsibility, self-regulation and skills in the use of information and communication technologies. The success of this methodology depends on the quality of the material available for the student's previous independent work and the dynamics of the face-to-face class. The results are also influenced by the acceptance of the application of the method and the motivation of the students (Peralta et al., 2020).

Among the limitations pointed out to the method are that it is very demanding for the student due to the degree of independence he/she must achieve and his/her reluctance to change the role of receiver of information that he/she occupies in the teaching-learning process with the use of traditional methods. For the teacher, it represents making greater efforts in the elaboration of the materials to be made available to the students (Espinosa et al., 2016).

It is not always achieved that students adequately interpret the objectives to be achieved and conveniently delimit the contents to be studied to fulfill them, which influences in that they do not manage to appropriate the contents with the depth required by the program or that, on the contrary, they study aspects that will not be evaluated, which is not detrimental, except for the additional time invested (Peralta et al., 2020). In addition, the use of the inverted classroom method can be affected by the lack of adequate equipment and facilities; weaknesses in communication skills and ICT management by the teacher; it can create a feeling of frustration if the student is not guided in a timely manner (Cedeño and Vigueras, 2020).

In order to fulfill the objectives of the present work, a quantitative, descriptive and exploratory study was proposed, where the population were the 56 first year students of the Agronomy Engineering Career of the University of Ciego de Avila. The study sample consisted of 20 students enrolled in group 103 (35.7%), which was selected intentionally and non-probabilistically by the researchers. Of this sample of students, 12 were male (60%) and eight were female (40%).

This work is an intervention proposal for a first year classroom of Agronomy Engineering at the University of Ciego de Avila Máximo Gómez Báez, Cuba. It is based on the standard inverted class model, which is characterized in that the students work previously at home the contents through videos and didactic activities of learning in digital format via WhatsApp, Telegram, MODDLE Platform of the University, and then, in the classroom, they perform complementary tasks with the guidance of the teacher. This proposal focuses on the Biomolecules didactic unit, which is part of the content of topic II of the subject Organic Chemistry-Biochemistry.

Data collection was carried out after 12 weeks of the implementation of this methodology. A questionnaire was distributed online. The questionnaire used in this study to evaluate the degree of satisfaction of first year students of Agronomic Engineering at the University of Ciego de Avila Máximo Gómez Báez on the Inverted Classroom methodology was adapted from Domínguez and Palomares (2020). The questionnaire consists of a Likert scale, an instrument with anonymous responses and each with five items with the following options: strongly agree, agree, neutral, disagree or strongly disagree.

After the implementation of the activities in topics I (Organic functions: structure, properties, applications and biological functions) and II (Biomolecules), a survey was applied to the 20 students selected for the study to evaluate the experience, to obtain the assessments and the degree of satisfaction of the first year students of Agronomy Engineering of the University of Ciego de Avila on the AI methodology.

Regarding item 1 "I liked the possibility of watching a video instead of having a traditional class on chemistry topics". The result of the survey indicates that most of the students liked the possibility of watching videos of the contents related to the topic of Biomolecules before class, 55% (11) agreed and 25% (five) strongly agreed, 15% (three) affirmed themselves in a neutral position in this case; and finally only a small part equivalent to 5% (one) disagreed with this possibility.

According to item 2 "I prefer to have the traditional lecture of the teacher instead of doing practical and research work on the platform, both individual and group work in classes such as those carried out with the IA method", it is evident that a large part of the students prefer to do practical and group work in classes such as those carried out with the inverted classroom methodology rather than having the traditional class (lecture) of the teacher, since 50% (10) are inclined to strongly disagree, 25% (five)

disagree, another 15% (three) are neutral in this regard, while a minority is in very strong agreement and agree with the traditional methodology, 5% (one).

For its part, item 3 "The use of videos allows me to learn the study material more effectively than doing the readings alone". It shows that students prefer the videos given by the teacher, since 35% (seven) strongly agree and another 50% (10) agree, only a small minority 10% (two) are neutral and 5% (one) prefer the readings alone.

According to item 4 "I learned more when I used the AI learning method (videos, short readings and active learning activities in class) compared to the traditional method through lecture by the teacher". 45% (9) of the students strongly agree that with the use of the AI method they learned more, 35% (seven) said that they agree that the use of the AI method influenced their learning, while 10% (two) were neutral towards their learning in relation to the implementation of the AI method, and 10% (two) considered to disagree, in general terms it can be said that the use of the AI method according to the students' answers influenced their learning since the AI method favors cooperative and collaborative learning; stimulating group work in both virtual and face-to-face learning environments, encouraging the student to take an active and autonomous role in their learning, where the student is the one who builds, enriches, modifies, diversifies and coordinates their schemes, is the true protagonist of the learning process, coupled with the interaction between the teacher, the student and the student - student interaction.

Regarding item 5 "I felt disconnected without a teacher present during the videos or virtual activities". The minority of the sample surveyed agreed 10% (two) that they did feel disconnected, while 25% (five) were neutral, 30% (six) disagreed and together with 35% (seven) said that they did not have any problem when working autonomously on the platform. This reveals that in the application of the AI methodology mediated by ICT's, students can acquire knowledge in a self-managed way at their own pace; when the activities represented a higher level of complexity students resorted to the communication channel such as the group in WhatsApp giving importance to the teacher's feedback both in the virtual environment, as well as in the face-to-face class.

In relation to item 6 "I had problems accessing the resources due to lack of internet, or another tool to perform the activities". It shows that in general, 15% (three) of the students had problems to access the resources due to lack of internet, or other tool to perform the activities, also 10% (two) had some difficulties to perform the activities due to lack of internet, on the other hand, 10% (two) are neutral, and 65% (13) did not have any problem since they have a computer or mobile devices. Although some of the

students had difficulties of this type, it did not represent a barrier to carry out the activities, since the students were organized in small work teams to access the networks, which facilitated access to resources, as well as cooperative work when solving exercises and problems.

According to item 7 "I learned to use other computer tools that I did not know and that will be very useful in my academic life", 40% (eight) strongly agreed, 50% (10) agreed, giving a total of 90% (17) students who recognize that they learned to use other computer tools in the learning process, showing them that there are countless resources on the web that they can access for free.

In general, the satisfaction survey shows that most of the first year students of Agronomy Engineering accept and approve the possibility of watching a video instead of a traditional class in the subject of Organic Chemistry-Biochemistry, which allows them to have the information, access it and learn at their own pace from collaborative and cooperative learning, encouraged in the discussions on the platform, and active participation in face-to-face classes, turning the educator into a guide and promoter of learning environments.

The criteria exposed by the students who participated in the research coincide with what was exposed by Peralta et al. (2020) about the advantages of the application of the inverted classroom method. These are: it adapts to the learning pace of each student and avoids feelings of frustration for not having fully grasped the class dictated in the traditional model; students advance in learning at their own pace and develop personalized learning styles; the teacher ceases to be the center of attention of the classes and of the teaching-learning process; students become responsible for their learning, and consequently are motivated to organize their time to dedicate it to reviewing the material at home (otherwise, when attending classes they will not be able to develop the activities proposed); and the evaluation will not only be of the results, but above all of the entire process.

These results agree with those obtained by Salazar (2019), who exposes that, in general terms, the implementation of the inverted classroom methodology in the PEA of Chemistry was widely beneficial, since the students considered, that they felt more motivated at the time of the face-to-face class, compared to the previous topics that were developed in a traditional way, this motivation allowed the student to develop skills, which contributed to the learning being significant, and that the students would like the following topics to be developed in the same way.

According to a study conducted by Lopez (2020), students agreed that they felt more comfortable in learning by employing the IA method because they could watch the audiovisual material as many times as they needed to answer the questions and the cooperative work in the classroom gave them more confidence to correct the mistakes they made as well as to solve the exercises of greater complexity presented to them in the practical class, in which they had more time to go deeper and clarify doubts than in the class in which most of the time the teacher uses it to explain the essential knowledge.

Conclusions

During the years 2021-2022 we have been able to introduce, for the first time, the inverted classroom method in the PEA of the subject Organic Chemistry-Biochemistry in the first year of the Agricultural Engineering course. Taking into account the high degree of satisfaction shown by the students (up to 80% considered that they liked the possibility of watching a video instead of having a traditional class (lecture) of the topics of the subject; and 85% found it very useful to have the videos and teaching materials in advance for their self-preparation for the face-to-face classes), we consider that the inverted classroom is a very appropriate methodology in this subject.

The inverted classroom method constitutes a valuable tool to strengthen autonomous learning, critical thinking and collaborative work in university students, since it focuses on student learning and its modality makes the student's role to be inverted in terms of the traditional class so that he becomes an active subject, who has to take control of his learning; and be able to self-manage his process, elements that are important to reach the construction of knowledge.