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Artículos científicos

El juego, estrategia pedagógica en la enseñanza de la programación y elaboración de algoritmos

Games as a Pedagogical Strategy in the Teaching of Programming and the Elaboration of Algorithms

O jogo, estratégia pedagógica no ensino de programação e elaboração de algoritmos

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Resumen

El objetivo de este trabajo fue evaluar la viabilidad de la implementación de diversos juegos con el propósito de disminuir el índice de reprobación y deserción escolar de estudiantes de ingeniería en Alimentos del Instituto Politécnico Nacional (IPN). La aplicación de la investigación se efectuó en el periodo 2019 a 160 estudiantes que cursaban la materia de Programación. Se evaluaron diferentes actividades en tres momentos a lo largo del semestre, los cuales se enfocaron en la construcción de algoritmos empleando estructuras de control, la aplicación de un lenguaje de programación de alto nivel y la aplicación de los temas revisados a un problema real. En el análisis de resultados se encontró que los juegos sí contribuyen a la disminución del índice de reprobación; permitieron el aprendizaje significativo, derivado de las formas de aprender, y el cómo enfrentar diversas emociones. Estos materiales fueron desarrollados por los propios alumnos, lo que a su vez fortaleció la relación entre pares, el deseo de competencia y la curiosidad de encontrar diversas soluciones a problemas de ingeniería.

Palabras clave: agrupamiento educacional, aprendizaje activo, autoaprendizaje, enseñanza superior, método heurístico.

Abstract

The objective of this work was to evaluate the feasibility of the implementation of various games with the purpose of reducing the rate of failure and school dropout of Food Engineering students of the Instituto Politécnico Nacional (IPN). The application of the research was carried out in the period 2019 to 160 students who were studying the subject of Programming. Different activities were evaluated at three moments throughout the semester, which focused on the construction of algorithms using control structures, the application of a high-level programming language, and the application of the reviewed topics to a real problem. In the analysis of results, it was found that the games do contribute to the reduction of the failure rate; the games allowed significant learning, derived from the ways of learning, and how to face various emotions. These materials were developed by the students themselves, which in turn strengthened the peer relationship, the desire for competition, and the curiosity to find various solutions to engineering problems.

Keywords: educational grouping, active learning, self-learning, higher education, heuristic method.

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Resumo

O objetivo deste trabalho foi avaliar a viabilidade da implementação de diversos jogos com a finalidade de reduzir a taxa de reprovação e evasão escolar dos alunos de Engenharia de Alimentos do Instituto Politécnico Nacional (IPN). A aplicação da pesquisa foi realizada no período de 2019 a 160 alunos que cursavam a disciplina de Programação. Diferentes atividades foram avaliadas em três momentos ao longo do semestre, que se concentraram na construção de algoritmos usando estruturas de controle, na aplicação de uma linguagem de programação de alto nível e na aplicação dos tópicos revisados a um problema real. Na análise dos resultados, verificou-se que os jogos contribuem para a redução do índice de insucesso; Permitiram uma aprendizagem significativa, derivada das formas de aprender, e de como enfrentar diversas emoções. Esses materiais foram desenvolvidos pelos próprios alunos, o que fortaleceu o relacionamento com os colegas, o desejo de competição e a curiosidade de encontrar várias soluções para problemas de engenharia.

Palavras-chave: agrupamento educacional, aprendizagem ativa, autoaprendizagem, ensino superior, método heurístico.

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Introduction

To speak of games is to evoke the stage of childhood. At this stage, games produce joy, yes, but they also invite reflection and arouse interest and the desire to learn. Educational games take up this facet and develop different skills, aptitudes and greater resilience and tolerance to frustration. The design of these can be taken from already tested games, with certain changes to be applied in various learning units, at all educational levels, and thus serve as an educational contextual framework. It is not, however, about applying these teaching resources without any intention; it is necessary to take into account their principles: the rules that govern them, immediate feedback, recognition of achievements, maturity and freedom to make mistakes and mainly enrich learning. Games have created opportunities in the educational field, according to Minerva (2002).

For Chou (2015, cited in Reyes and Quiñones, 2020), if fun and attractive elements are used, an innovative way of teaching can be opened. Torres, Romero, Pérez, and Björk (2018) acknowledge that games are easily adapted to distance learning. Focused on students, your app can boost unconventional skills. Undoubtedly, there are enough elements to affirm

that the strategy of the game is a model that can be used in the different engineering careers and that it can be used in the different university training courses.

The rain of information to which students are exposed today has been creating a lack of concentration and distraction when interacting with the concepts of the learning unit to work on. Nearly 2000 years ago, Quintilian formulated the wish that "study be a game for children" (United Nations Educational, Scientific and Cultural Organization [Unesco], 1980, p. 19).

The problem with the Food Engineering Programming learning unit of the National Polytechnic Institute (IPN) is the high level of student dropout and failure. There is a lack of interest on the part of the students due to the lack of new didactic strategies and spaces that invite the construction and reconstruction of knowledge. Classroom classes are monotonous and even boring; the students only limit themselves to copying the encodings that show the solution of the problem posed.

Currently, the students' environment is influenced by multiple factors, as we mentioned above, that do not allow them to have an ideal concentration in the classroom and, by extension, have a better performance.

For Chacón (2010), the game is a strategy that can be used at any level or modality of the educational process. Although, in general, the teacher uses it very little because he is unaware of its many advantages. The game that has an educational objective includes moments of pre-reflective and abstract-logical action for the achievement of curricular teaching objectives. The ultimate goal, of course, is appropriation by the player of the content and encourage the development of creativity and learning. The use of this strategy pursues a large number of objectives that are directed towards the exercise of skills in a certain area.

In this regard, the Didactics of Libraries site (September 25, 2017) highlights the following:

> The game is used as a privileged tool to facilitate and stimulate individual and group teaching and learning processes. From teaching, different aspects are combined: participation, dynamism, training, interpretation of roles, community, modeling, feedback, problematic character, obtaining complete results, initiative, systemic character and competence. (párr. 2).

In addition, innovative strategies must be implemented that allow the student to be recognized as a participatory and sociable being; that encourages them to play as a principle

that is part of their total development, facilitates the development of their ability to discriminate and carry out activities that give them pleasure and enjoyment.

The educational games were designed with the aim that students build metacognitive learning, and not as a mere entertainment activity. By creating a degree of awareness, the student, guided by rules, is immersed in an environment of challenges that lead him to reach an established goal, where losing does not exist, since effort and dedication are encouraged, this tests their knowledge and skills, which generates various sensations and emotions in the participants.

Dicheva, Dichev, Agre and Angelova (2015) conclude that, for learners, the desire to continue playing with their peers is attractive and motivating. Likewise, critical thinking is created in the ways of solving a problem. It provides a state of joy, which generates pleasant, active and meaningful learning. And they promote social ties. Thus, learning and feedback, being inverse one within the other, transform environments and make them more exciting (p. 88).

For his part, Frederic Fröebel (1782) mentions: "The game stimulates the player's senses, creating feelings of well-being by having time against him to give an answer."

And Huizinga (1995) define the game as:

> A free action or occupation, which takes place within certain time and space limits, according to absolutely mandatory rules, although freely accepted, an action that has ¿in itself is it accompanied by a feeling of tension and joy and the awareness of being of other way than in ordinary life (p. 45).

While Motta (cited in Posada, 2004) expresses that "the game is an external manifestation of the ludic impulse" (p. 23). Feelings are emotions, a component that is expressed during the game. "The emotions that are oriented towards entertainment, fun, recreation, which leads to enjoying, laughing, screaming and even crying is a true source of emotions" (Parada and Segura, 2011, p. 29). In this same line, Sánchez (2000) expresses:

> Through the experiences of the game, a personal meaning of the values, attitudes and norms is created (...) becoming a practice that gradually introduces the individual to the world of values and attitudes, such as respect for the norm, team spirit, cooperation, self-improvement, among others (p. 46)

Unesco (2000) determines that the use of the game in teaching transmits practical knowledge, and not only that, but also gives rise to new ways of building it, starting from the understanding and association of the environment.

For Hertz (August 14, 2013), games teach how to fail and how to learn from those failures. “The games challenge our students. They offer them immediate feedback, a safe space in which they can fail and learn, and don't forget the social connections they create” (para. 6).

Taking into account all of the above, when a situation of failure and desertion occurred in the Food Engineering Programming learning unit, belonging to the Interdisciplinary Professional Unit of Biotechnology of the IPN, it was proposed to implement the game as a support tool with in order to provide a playful opportunity to reinforce different topics of the course. Currently, this strategy is not used in higher or university education, because it is not considered a didactic strategy for students of a higher educational level, rather for those who are in basic preschool and primary education, since it usually attracts the attention of students. students of that level. However, this contravenes what is stated in various learning theories which indicate that people learn according to different experiences. Among these theories, Piaget's (1966) points to the conception of being as a constructor of its own knowledge. In fact, Piaget (1966) affirms that the game precedes the processes of ideas and abilities. Likewise, Bandura (1977) expresses that the game, in addition to stimulating our senses, leads us to meaningful learning.

Therefore, using games as a teaching-learning strategy at a higher level could provide opportunities to redesign educational processes and create a challenge for both teachers and students, involving students in their own development, designing games with various materials and present different challenges, as well as the possibility of developing multiple solutions to problems that involve decision making or identifying repetition tasks and recognizing which path to take in the construction of the different numerical algorithms.

Having to demonstrate their knowledge before a group of classmates provokes a desire for competition, which motivates the learning processes, and generates in the student a behavior of respect, cooperation and commitment in the activity in which they are participating, a positive attitude to achieve the set goal.

Now, the questions that opened the door to this research were: in what way do games develop metacognitive learning in Food Engineering students and contribute to reducing the failure rate? Are games attractive to generate meaningful learning? To do this, the following hypothesis is proposed: by performing various activities through games, knowledge is increased; test your skills in various challenges that are presented in each game, allows you to address different topics presented during the course and improve learning.

The general objective of this work is to evaluate the feasibility of the implementation of various games in order to reduce the rate of failure and dropout rates and to encourage students to build their own learning and acquire the necessary knowledge to solve engineering problems. in food.

Methodology

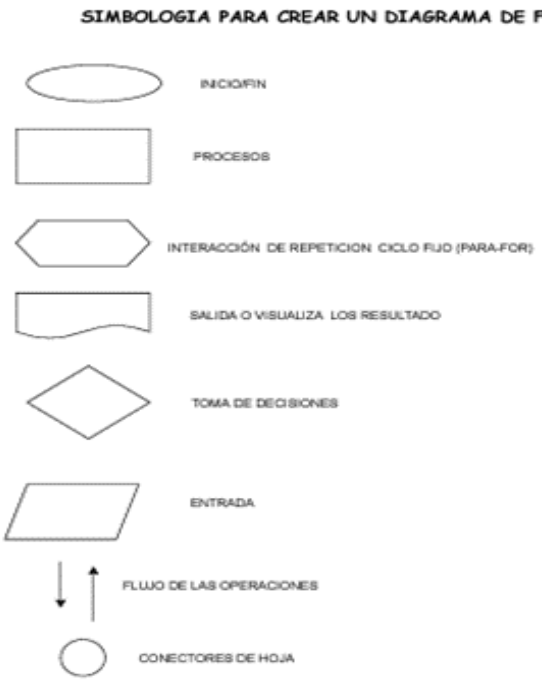
It seeks to evaluate the viability in the implementation of various games in order to reduce the rate of failure and dropout rates by encouraging students to build their own learning and acquire the necessary knowledge to solve food engineering problems. The application of the research was carried out in 2019 in the Interdisciplinary Professional Unit of Biotechnology. The sample consisted of 160 students who were studying the Programming learning unit. Different activities were evaluated at three times throughout the semester. In the first stage, the construction of algorithms was reinforced using control structures. In the second stage, the application of a high-level programming language was reinforced. For the execution of the third stage, a problem was formulated that tested their knowledge in solving engineering problems using numerical algorithms. Finally, throughout all of them, the rules of coexistence were dictated, always seeking an atmosphere of cordiality and respect.

Analysis of results

First stage

A game was implemented to complement algorithms (graphic and textual [pseudocode]) and reinforce the theoretical concepts that contribute to the solution of various problems. The game consists of a board with empty areas made from flipchart sheets. The empty areas are complemented with figures from the structured programming symbology, as shown in figure 1.

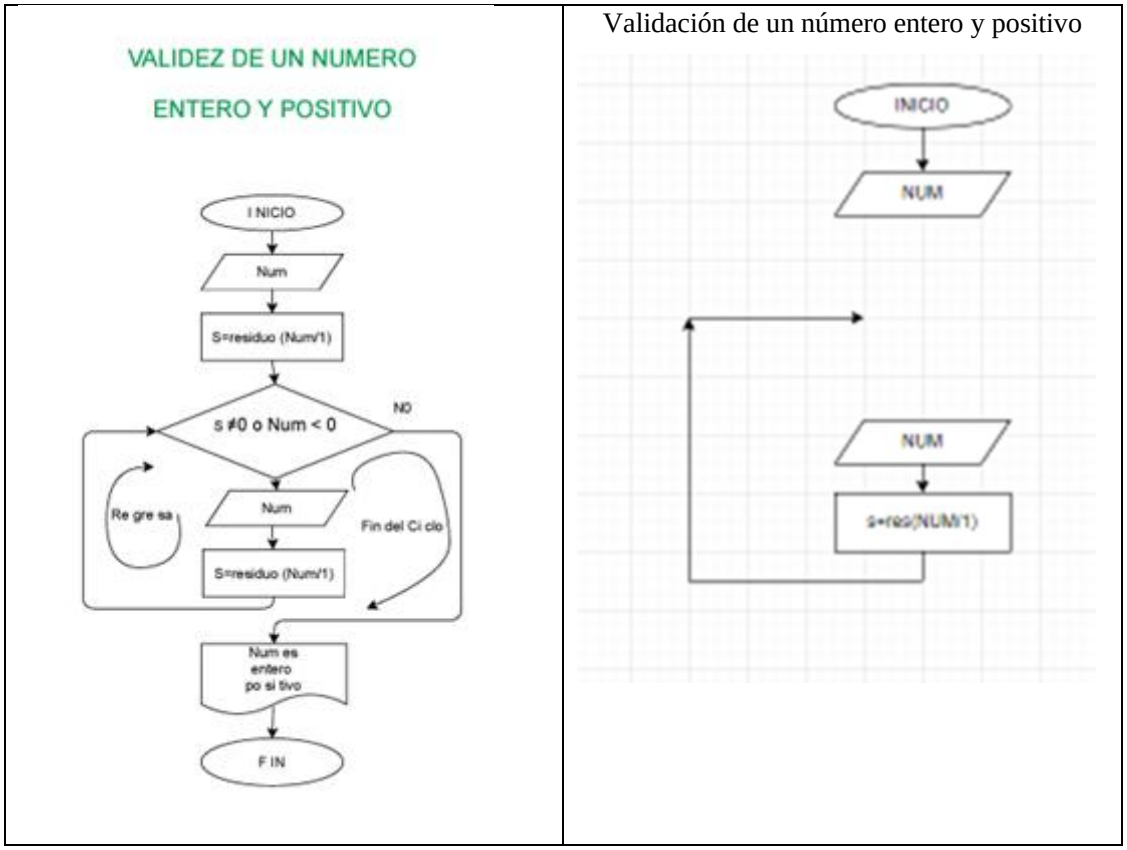
Figure 1. The symbols used to solve the algorithms are shown



Source: self made

Cards with the symbols and instructions were made, which served to complete the graphic algorithms based on the approach, as shown in Figure 2.

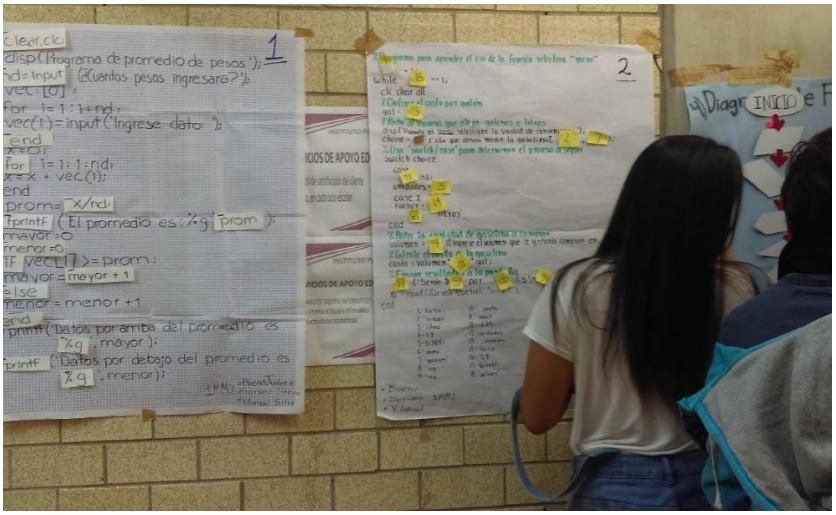
Figure 2. It shows two windows: the first, a complete example and the second window shows the incomplete algorithm



Source: self made

Work teams were formed. They were provided with materials and the rules of execution were dictated. Among the evaluation criteria were considered the time in the construction of the algorithm and the adequate use of symbology. This determined which team was the winner (see figures 3 and 4).

Figure 3. Group of students interacting to obtain the solution to the problem posed



Source: self made

Figure 4. Group of students interacting to obtain the solution to the problem posed

Source: self made

A record of the students' performance was kept, in which the evaluations obtained by the students during the game were recorded. This record consisted of a table for evaluating the results in the algorithm game made up of three response items (Bad, Fair and Good), whose results for each team are shown in Table 1.

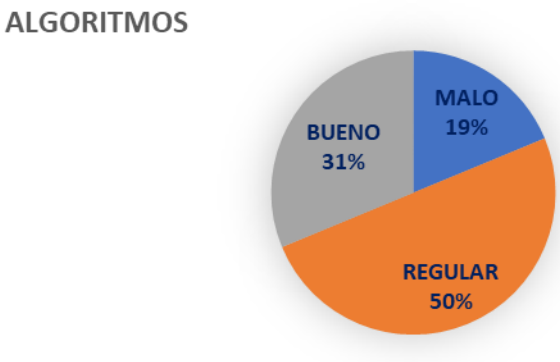
Table 1. Evaluation of results in the game of algorithms

Evaluación del juego			
Nombre del juego		Algoritmos	
Evaluación	Malo	Regular	Bueno
Estudiantes	30	80	50

Source: self made

In the image association game for the construction of graphic algorithms, programming symbols were used that contribute to the creation of the necessary steps to achieve the solution of various problems, in this task a regular evaluation was presented, with a score of 80, which represents 50% of the opinion of the students. The challenge posed was qualified as motivating, according to the opinion of the students, who agreed that this represented a challenge for them, trying to obtain the result quickly. It should be noted that the coordination of the team was taken into account, given that the previously assigned activity was written on cards, which indicated the time for its solution and the type of algorithm to be solved. Figure 5 shows the evaluations obtained.

Figure 5. Percentage of students who evaluated the game



Source: self made

Second stage

In this second stage, the Guess What game was implemented. This game is made using two boards where the figures or words to guess by means of certain questions were found. Some of these questions are shown below:

a) It is a command.

b) Graph, a new window.

c) Displays 2D and 3D graphics.

d) It is a command that requests data.

e) It is an output command.

The different boards are shown in figure 6 and 7.

Figure 6. Group of students participating in the game of Guess what

Source: self made

Figure 7. Group of students participating in the game of Guess what

Source: self made

To keep a record of the students' performance, a table of evaluation of the students in the game of Guess what was elaborated, where the evaluations obtained by the players were noted, if the established learning was fulfilled. This is shown in table 2.

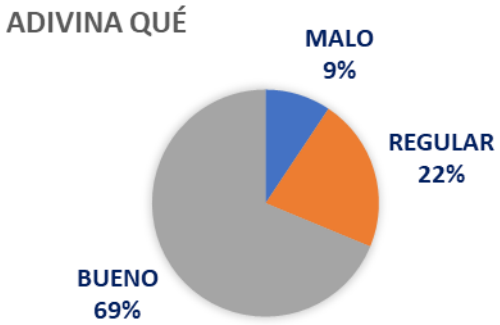
Table 2. Evaluation of the students in the game Guess what

Evaluación del juego			
Nombre del juego		Adivina qué	
Evaluación	Malo	Regular	Bueno
Estudiantes	15	35	110

Source: self made

According to the above, 110 of the students considered the game Guess what as good, since it allowed them to identify the commands and ask a question whose answer was found on the board, as shown in figure 8.

Figure 8. Percentage of acceptance by the students who evaluated the corrector game



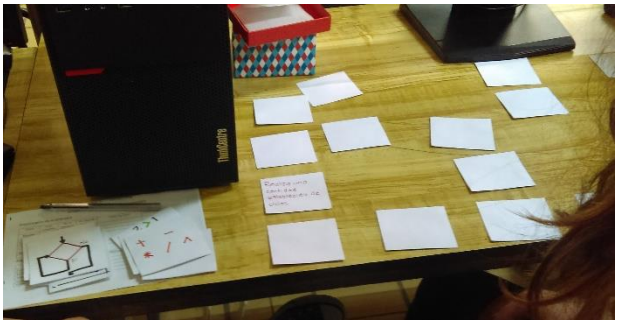
Source: self made

According to the results obtained, an acceptance of 69% by the students is observed; an evaluation of good, motivating and exciting.

Third stage

This third stage was characterized by the use of a memorama. The objective is to associate commands, figures and instructions using cards. This is shown in figure 9.

Figure 9. Students posing the memorama



Source: self made

To keep track of student performance, a report evaluation table was created, in which the evaluations were recorded. The format was made up of three response items (Bad, Fair and Good). This activity promotes the application of students' knowledge and skills during the course, as shown in Table 3.

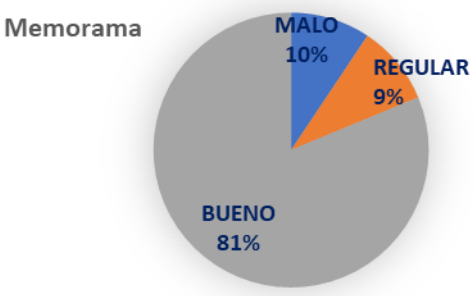
Table 3. Evaluation of the Memorandum

Evaluación del juego			
Nombre del juego		Memorama	
Evaluación	Malo	Regular	Bueno
Estudiantes	15	15	130

Source: self made

According to what was mentioned by the students, they considered the memorama to be a fairly good resource. In fact, it obtained a score of 130 from the students, who highlighted that this game puts skills, abilities and knowledge into practice (see figure 10).

Figure 10. Percentage of students who evaluated the game



Source: self made

In this last stage, a greater interest of the students was observed when putting into action their skills and knowledge that they acquired throughout the course. In addition, teamwork strengthens cooperation and communication in a pleasant environment.

Discussion

According to the analysis, we find that the games are enriching elements because they favor the metacognitive learning of the Food Engineering students in the construction of algorithms and lead them to solve practical problems. Students become more involved in creating their learning and make it meaningful. In the different games, the teacher only had the function of coordinating. Creating activities for educational purposes provides the opportunity for students to measure their knowledge and reinforce it together with their peers.

The game implemented in the course is an option to promote a way of learning under pressure in delivering results. The game has been used for teamwork reinforcement purposes before. The need to implement modifications to the games and adapt them so that they could include several solution strategies in each problem was also observed, which gave the player freedom to give various solution answers.

Students influence each other in the ways of solving challenges, in the ability to accept help from their peers, coordinate times and forms of organization. Therefore, the game is a strategy that generates knowledge, improves communication between team members and facilitates understanding of the issues; in short, they lead to lasting learning.

Conclusion

Implementing various games during the programming course allowed students to test their skills and knowledge. In addition, it motivated the sense of competition and teamwork. These strategies elicit immediate feedback that leads to learning and promotes metacognition.

Having clear instructions and times for each game is vital to reduce some difficulties. In the analysis, it was found that the students were able to apply their knowledge in the different evaluations: in the creation of commitment to help their game team, strengthening teamwork, in the face of the frustration of not managing enough knowledge to create the solutions of the problem, using different algorithms.

Throughout each one of the developed activities, the students were able to test their abilities before their peers, they achieved significant learning and reinforced the concepts of

programming in the management of control structures in the solution of engineering problems. We have a high compression when our senses are in an emotional state of joy, which motivates the imagination and drives the freedom to arrive at the best way to solve a problem. In short, the construction of knowledge was carried out in an enjoyable way.

Thus, it is concluded that metacognitive learning is achieved after reflecting on the solution of each challenge with the correct answer in a creative way; An atmosphere of competition and excitement is also created to know who will win by testing their knowledge and skills in various challenges that are presented in each game with the different topics addressed during the course, using different games built and proposed by them and achieve learning. That is: a response was given to the hypothesis that it is possible to learn in that context.

Future lines of research

This work provides the opportunity to explore new teaching strategies at a higher level. Implementing playful activities can improve not only the academic performance of the students, it also provides the opportunity to delve into areas aimed at emotional analysis and focus studies related to activities to improve the communicative relationships of the students.

As IPN teachers, we consider it necessary to address the areas of opportunity that arise in each of the various learning units, so that the application of these strategies can scale other areas of knowledge.

Another line of research that emerges is the qualitative analysis of the various teaching-learning strategies aimed at reaching an appropriate level of professional development to provide students with the relevant knowledge and skills with a high level of thinking that facilitates the analysis, interpret, solve and innovate in present and future situations in relation to their personal, family, work and social life.

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