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## Kahoot in formative evaluation: teaching experience in Higher Basic General Education

### *Kahoot en la evaluación formativa: experiencia docente en la Educación General Básica Superior*

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(Received on: 01/12/2023; Accepted on: 03/01/2024; Final version received on: 25/04/2024)

Suggested citation: Cárdenas-Rogel, J. C., Quezada-Lozano, G. y Guerrero-Chirino, R. (2024). Kahoot in formative evaluation: teaching experience in Higher Basic General Education. *Revista Cátedra*, 7(2), 117-138.



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## Abstract

The use of information and communication technologies (ICTs) has become widespread in today's society, covering various fields such as industry and communication. In the field of education, ICTs also play a fundamental role, since various multimedia tools and applications are used, such as videos, audio files, educational programs and didactic applications for pedagogical purposes. In this context, the use of Kahoot stands out as a teaching experience in Higher General Basic Education (EGB), specifically in formative assessment. The main objective of this research was to determine the impact of the application of Kahoot as a didactic strategy to assess knowledge in Natural Sciences. The research question was: Does the application of Kahoot have an impact on the learning of Natural Sciences? The methodology used in this study was quantitative, quasi-experimental, cross-sectional and descriptive. Two learning scenarios were considered: a traditional classroom (control group) and another in which the Kahoot evaluation tool was used (experimental group). The technique used to collect data was a survey applied to students through Google Forms. Among the main findings of this study, it is highlighted that the application of Kahoot as a didactic strategy for assessment significantly influences the levels of student participation in the learning of Natural Sciences.

## Key words

Natural sciences, school environment, teaching experience, educational innovation, learning platform.

## Resumen

El uso de las tecnologías de la información y comunicación (TIC) se ha extendido ampliamente en la sociedad actual, abarcando diversos campos como la industria y la comunicación. En el ámbito educativo, las TIC también desempeñan un papel fundamental, ya que se utilizan diversas herramientas y aplicaciones multimedia, como videos, archivos de audio, programas educativos y aplicaciones didácticas con fines pedagógicos. En este contexto, se destaca el uso de Kahoot como una experiencia docente en la Educación General Básica Superior (EGB), específicamente en la evaluación formativa. El objetivo principal de esta investigación fue determinar el impacto de la aplicación de Kahoot como estrategia didáctica para evaluar los conocimientos en Ciencias Naturales. La pregunta de investigación planteada fue ¿la aplicación de Kahoot tiene incidencia en el aprendizaje de las Ciencias Naturales? La metodología utilizada en este estudio fue de enfoque cuantitativo, quasi experimental, transversal y descriptiva. Se consideraron dos escenarios de aprendizaje: una clase tradicional (grupo control) y otra en la que se empleó la herramienta de evaluación de Kahoot (grupo experimental). La técnica utilizada para recolectar los datos fue una encuesta aplicada a los estudiantes a través de los formularios de Google Forms. Entre los principales hallazgos de este estudio, se destaca que la aplicación de Kahoot como estrategia didáctica para la evaluación influye de manera significativa en los niveles de participación de los estudiantes en el aprendizaje de las Ciencias Naturales

## Palabras clave

Ciencias Naturales, entorno escolar, experiencia docente, innovación educativa, plataforma de aprendizaje.



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## 1. Introduction

In the current landscape of national education, Information and Communication Technologies (ICT) have acquired significant relevance. The constant technological growth and the need for connectivity in the social sphere have generated a demand to develop a variety of personal and professional activities. In this context, education stands out as a field that does not remain on the margin of this requirement, especially during extraordinary situations such as the pandemic, where ICT have allowed to advance in academic studies and to maintain the teaching task in force. This research focuses on exploring the use of the Kahoot tool in the summative evaluation of a natural science course. This approach arises from the recognition of the need to innovate in the educational field in order to face pedagogical, didactic and curricular challenges.

Based on the study conducted by Islas 2017 and Martínez 2017, it is evident that Kahoot, from its playful approach to learning and evaluation, is presented as a motivating and attractive factor to obtain objective information about students' knowledge, reducing the tension, stress and anxiety associated with traditional evaluation methods. In this context, the present research becomes relevant by offering teachers and the educational community in general the possibility of innovating the school environment through the pedagogical use of ICT, specifically through gamification with Kahoot, which leads to meaningful and lasting learning.

Regarding the structure of the article, section 2 presents the concepts related to the research. Section 3 details the methodology used to develop this research process. Section 4 shows the analysis and discussion of the results. In section 5, conclusions are drawn according to the results obtained.

## 2. Theoretical Reference

### 2.1 Changes in education

Educational institutions are undergoing change due to the needs and shortcomings present in the classroom. This drive to improve teaching leads to addressing current pedagogical and technological challenges, recognizing both teachers and students as central actors whose teaching and learning process deserves further exploration. Reinoso-Gonzales and Hechenleiter-Carvalho (2020) argue that, "a change in the role of the teacher in the teaching process minimizes direct instruction and content exposition, replacing them with classroom experiences that promote student protagonism" (p. 1).

In view of the above, new technologies have brought about many social and business developments, but they have also led to processes of profound change. The education sector is no stranger to this and is changing rapidly to try to adapt to the challenge presented by this new scenario. Traditional teaching methods give way to new ways of learning as new technologies transform the learning process, the role of the student and the teacher becomes more active and dynamic, so, technological limitations in schools must be covered and provide the necessary resources to observe if indeed the new cognitive experience points to effective transformations; only when this happens, it can be said that there is a pedagogical innovation.

Based on UNESCO's reading in 2017, at personal criteria, it can be pointed out that the adaptation of education to current changes implies the creation of new learning environments that incorporate innovative didactic materials, as well as new ideas, strategies and practices. This includes teaching-learning experiences that challenge



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teachers to improve their skills and understand new approaches, which contributes to a transformative change in the educational process. The idea of integrating technology in the teaching exercise, if it is truly an improvement in the educational process, should also consider other elements that allow for greater knowledge regarding its operation and impact on the development of cognitive skills, that is, what happens in the brain of the learner to consolidate his new learning; the articulation of these factors leads to a true transformation of the teaching and learning process, the actions planned within education, with or without technology, must be consciously codified, with a goal set to be achieved. "The role of information technologies should be a means in the actions of teaching and learning, not an end" (Reinoso-Gonzales and Hechenleiter-Carvalho, 2020, p. 3). Thus, several studies point to

an alternative teaching method based on active student learning and supported by the use of new technologies that allow redirecting learning through interactive interfaces that contributes to the development of students' intellectual and emotional skills and abilities (Martinez, 2017, p. 254).

It is worth mentioning that the use of information technologies in learning is a process that must be developed gradually, it offers the possibility of correcting errors, as well as obtaining experiences that will allow determining the main tools. The benefits of these tools must be applied for learning, in such a way that the achievement of educational objectives is guaranteed.

## 2.2 Importance of technological tools

According to Gallardo (2018) "from the organizational point of view it is necessary to complement the implementation of ICT with a global and integrative strategy that provides coherence between purely technological aspects and educational models, in order to achieve superior results" (p. 1) as can be observed current technological innovations evidence remarkable advances over time; ICT have transformed habits and lifestyle worldwide, including the educational field. They have revolutionized the way in which information is shared, which has generated a more interactive and dynamic environment for students. In this context, teachers face the challenge of adapting to the so-called new generation of digital natives within the educational system. ICTs are perceived in the school environment as tools that can improve the internal functioning, the services offered and the teaching provided to students.

ICT contribute to "a new understanding and vision of the contemporary school, which without forgetting the traditional pedagogical foundations incorporates these technologies into new ways of conceiving teaching and learning" (Granda et al., 2019, p. 2). In different contexts of society, the combination of ICT has transformed pedagogical activities in the educational process, including in terms of skills development both inside and outside the learning environment. In general, ICTs revolve around three basic media: computing, microelectronics and telecommunications; but they revolve, not only in isolation, but what is more significant in an interactive and inter-connected way, which makes it possible to achieve new communicative realities (Santana, 2019). According to Granda et al. ICT contribute to a new understanding and vision of the contemporary school, which without forgetting the traditional pedagogical foundations incorporates these technologies to the new ways of conceiving teaching and learning, are causing various attitudes and opinions regarding the use and exploitation to achieve optimal academic performance. In various social contexts, the combination of ICT has transformed pedagogical practices in the



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educational environment, including in terms of skills development both inside and outside the learning environment (Granda et al., 2019).

Molina and Molina (2021) point out that "the phenomenon of globalization, scientific and technological transformation and communicational networks, have gradually eliminated geographical as well as cultural boundaries, thus promoting substantial changes in interaction and communication in academic contexts" (p. 3). Communication technologies have become fundamental tools in various sectors of society, where information and communication are stored, processed and transmitted freely and without restrictions. The importance of these technologies in education is evident; in recent years their need has become more evident, transforming and improving the field of teaching and learning. They have generated a wide range of capabilities that have eliminated the barriers in the transmission of communications and information, providing numerous advantages in several fields.

On the other hand, González and Martínez (2019) mention that "information and communication technologies in education represent the new learning environments and, because of their impact on education, they are developers of competencies necessary for learning and generators of life skills" (p. 4). In other words, it is necessary to identify the scientific and technological competencies that shape the citizens of the 21st century, so that people must acquire scientific and technological knowledge that will allow them to perform better in everyday life, and thus acquire broader knowledge according to the requirements of society and their environment. In the same way, Cañedo (2021) states that, "today science and technology are a powerful basis for the cultural, social, economic and public development of life in modern society" (p. 1). Their influence has reached such a point that life today requires their presence in all its aspects with the diffusion of products from one field to another, and their systematic use has become a growing condition in this historical period.

### 2.3 Gamification in education

Ortiz-Colón et al. (2018) point out that "the knowledge society and technology have brought with them a new map in which young people feel concerns that education has not always been able to satisfy" (p. 1). These changes generate a shift in students' interests, which requires teachers to seek new strategies and resources to increase their students' motivation and engagement. Liberio (2019) suggests that "play as knowledge construction requires committed teachers with different attitude, demands that they abandon traditional approaches, which worked at the time" (p. 1). Nowadays, it is crucial to impact the integral development of students. Play is one of the main ways in which children acquire knowledge and skills. Therefore, opportunities for fun and environments that encourage hands-on play, discovery, and learning are essential in effective early childhood education programs. Heinze et al. (2017) argue that "teacher quality and ongoing professional development is critical to achieving quality education" (p. 2). Through gamification in education, education, updating and training processes can be mediated. Prieto (2020) proposes:

Gamification within learning consists of the use of game mechanics developed in non-game environments, a methodology that allows working on aspects such as motivation, effort and cooperation within the school environment, stimulating students in such a way that it leads to an expansion of their knowledge (p. 2).



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These methodologies offer an effective approach to student-centered learning, promoting the development of skills and the acquisition of knowledge through situations created specifically for educational purposes. Prieto and Gómez (2022) argue that, "games that address the integral development of personality, cognitive, motor and socio-affective can have a positive impact on student motivation and participation" (p. 3).

Based on Islas' reading in 2017, at personal discretion, it can be considered that games involve engaging in pleasurable physical or mental activities to satisfy emotions, it is crucial to evaluate three essential characteristics: mechanics, dynamics, and emotions. This means that, in order to create a dynamic environment, it is necessary to plan activities that incorporate these elements, which will facilitate learning to be more relevant and effective in the acquisition of knowledge.

### 2.3.1 Games in the educational process

García et al. (2021) point out that, "the new educational framework requires an effort on the part of teachers to innovate and improve their teaching methodologies and tools, in order to guarantee student learning by competencies from the perspective of didactic innovation and effectiveness" (p. 1). In addition, Rojas et al., (2021) highlight that, "the strategy of implementing elements of games is used in different areas of knowledge that aim to motivate people to use a certain product, to participate in a campaign or as in this case to learn" (p. 5). Games, with basic components such as rules, objectives, players, playing field and rewards, offer dynamic learning that arouses students' interest.

On the other hand, Rojas et al. (2021) argue that, "the educational sector is one of the most affected and by not keeping pace with new advances in information and communication technologies, it is affected in the teaching-learning process" (p. 2). These technologies seek to provide answers from different didactic, communicative and social perspectives in the development of education, taking into account the different contexts in which they are applied. Jaramillo and Tene (2022) argue that, "technological didactic resources have become indispensable in today's life; however, their importance in the teaching-learning process lies in the pedagogical sense that teachers must incorporate" (p. 1).

According to Islas (2017) "ICTs represent for education a major element, from the infrastructure, the theories from which they are investigated, the competencies they have implied in the development of students and teachers or the learning environments they make possible" (p. 3). One specific area of interest is gamification in the classroom, which seeks to reconfigure educational methods to adapt to new needs. Gamification aims to influence behavior through game-generated experiences and feelings, fostering motivation and engagement to achieve specific objectives. It can be added then that gamification seeks to motivate behavior within the educational environment, stimulating the construction of learning through student participation, contributing to the creation of knowledge and making traditional education obsolete.

## 2.4 Innovation in education

González and Martínez (2019) point out that "the transformations and advances in science, technology and information we are living are originating a new social context in which citizens every day must assume the changes and challenges imposed by the information and knowledge society" (p. 5). On the other hand, Reinoso-Gonzales and Hechenleiter-Carvalho (2020) point out that, "the positive perception of students regarding methodological and evaluative innovation shows that flipped classroom is an adequate method to work with and that Kahoot constitutes an evaluation tool to evidence the achievement of learning" (p.



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5). As can be seen, innovation in education and the concern for improving the skills and motivation of students in the classroom have been topics of continuous interest, in this sense, the education industry is dynamic and students express diverse needs and concerns over time. With new technologies, teachers have access to innovative and sophisticated tools that, when used for pedagogical purposes, can transform traditional learning systems.

Finally, Tapia et al., (2020) argue that "the exercise of pedagogy in university classrooms has made it necessary to implement new teaching-learning strategies; the current scenario of education must be aligned with technological trends" (p. 8). Thus, it can be seen that the trend of innovative educational models is to focus on solving games with a high ludic component, integrating devices such as tablets or smartphones in the classroom in a way that enhances motivation, interest and participation of students. These models can also develop basic cognitive skills and improve specific skills through game-facilitated interactions and interpersonal relationships. Consequently, pedagogical strategies linked to technology should ensure optimal development of students' academic competencies.

Ortiz-Colon et al. (2018) currently and as a result of the impact that technology has taken as a fundamental point during the academic process of students shows how it has highlighted the influential factor in the teaching-learning process, within the tools it can be mentioned that Kahoot is a free online educational platform that reinforces certain concepts through evaluation as part of the learning process, in a different way to the use of technical devices, especially cell phones. According to Garcia et al. (2021) the interactive platform

kahoot allows educators to create relevant quizzes with clear and understandable questions on any topic they consider to reinforce it, students become active participants or actors and the way the tool impacts on the traditional method thus causes motivation in the teaching and learning process, where students have to attentively answer the questions from their technological devices, whether they are cell phones, tablets, laptops or computers (p. 4).

The use depends on the availability of resources such as a computer or a laboratory, as well as accessibility to the Internet, this at the time the activity is performed with the student, so that the student can interact quickly and earn points must consider all the elements of connectivity. The activities in the classroom are shown in a more attractive way, highlighting its interactive, dynamic and fun interface, that is, it has the form of a game. In this sense, Kahoot allows playing quizzes through questions in which the student is the most active protagonist in giving answers while the teacher becomes the coach or mediator of the process allowing him to connect with the student; it is a complete tool to be used in the teaching-learning process due to its multiple benefits. In the last five years, one of the most popular game-based digital learning resources in Spain is called Kahoot. It is free and easy to use, due to these aspects it has become a popular material for both teachers and students, it is valued as an element that enables the dynamization of classroom activities and contributes to the improvement of student participation, because it fosters positive group relations.

Thanks to new technologies and games, learning becomes easier, which helps to develop students' creativity, improve information management and collaboration with peers, improve problem-solving skills and critical thinking. These learning systems help reduce the fear of error, which is often one of the barriers to student participation in the classroom.



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New technologies are then considered a trial-and-error process that allows rectifying mistakes. According to Rojas et al. (2021)

if this concept is proposed for the use of Kahoot in the classroom, it means that the questions provided by this tool should be relevant to the student's level of knowledge, thus presenting achievable testing challenges, thus creating knowledge, skills and abilities (p. 3).

The tool is a digital educational resource that can be used for various purposes, for example, to diagnose knowledge on a topic, to find out highlights of a unit or test what has been learned, as well as to assess the level of understanding of a paragraph of reading or discussion on a particular topic. It is important to highlight that Kahoot was created by Professor Alf Inge Wang, who thought of a comfortable and fun educational environment. This game-based tool is more than a simple online test and has certain features that invite students to participate using any mobile device, in an accessible and easy-to-use way, both for teachers and students.

## 2.5 Teaching of Natural Sciences

Jaramillo (2019) argues that "teachers will know how to incorporate in the teaching of students knowledge that is related to updated science in order to rescue proven knowledge that enhances knowledge that helps to validate scientific truth and also to perform constructivist criticism" (p. 4). In this order of ideas, in relation to Jaramillo's reading in 2019 at the authors' criteria it can be stated that, teachers should integrate knowledge of modern sciences in teaching so that students acquire verified knowledge that enhance and validate scientific truth, in addition to facilitating a process of reflection to perform constructive criticism. According to the author, Natural Sciences are classified as real sciences due to their foundation in facts, empiricism and materialism, which leads them to work in the search for reality. Lozada (2017) argues that "games act as mediators in the teaching-learning processes, achieving in students a better understanding of theoretical concepts, thus, optimizing their competencies in academics" (p. 8). Thus, science education in the new millennium requires a profound transition from basic education to primary education, but not in an adaptive way, but in an innovative way so that it is the beginning of a process that guarantees the learning elements for the baccalaureate level of study. According to the author, the teacher should not limit himself to transmitting information, but should allow students to produce and construct knowledge, to feel happy and satisfied when they find it, and to use methods similar to the world in their daily work.

On the other hand, Arancibia et al. (2020) point out "the importance of creating a useful learning environment that promotes the generation of knowledge from a constructivist approach (p. 9). This is based on dialogue, collaborative learning and the application of knowledge to real problems with the help of technology. Méndez and Arteaga (2021) suggest that "the levels of experience of teachers in the natural sciences are closely related to the social management of the classroom" (p. 1). These levels represent the foundations on which the teacher bases his or her approach to teaching and learning in the natural sciences and specialized knowledge, adapting them to the characteristics of the professional environment in which the teacher has developed in practice.

Finally, Peña-Nivicela et al. (2019) emphasize that "science teaching should not only focus on learning concepts, but should also contribute to the development of competencies related to how to do and think about science" (p. 3). It is essential that the evaluation of topics such as river water pollution allows determining the acquisition of the knowledge



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worked on during the class, providing the opportunity to correct or reinforce certain knowledge.

### 2.6 Articulating Natural Science learning with *kahoot*

Lozada (2017) states that "games act as mediators in the teaching-learning processes, achieving in students a better understanding of theoretical concepts, thus optimizing their skills in the academic field" (p. 8). In such a way that gamification becomes an activator of attention and an alternative to complement traditional educational programs with the integration of elements that enable sustainable learning over time. On the other hand, Mallitasig and Freire (2020) argue that "the study of natural sciences seeks to train students with a scientific attitude that allows understanding science as a systematic and logical investigation of reality" (p. 2). For this, the use of innovative, alternative, investigative, constructivist and resolute didactic strategies is required, where the student is the main component, which implies changing the traditional paradigm of learning in the natural sciences. Riquelme (2021) emphasizes "the fundamental role of the teacher as an articulating agent of learning and highlights the importance of the methodological strategies used to achieve this change" (p. 4). Guayara et al. (2018) point out that "learning needs the participation of students in the construction of their knowledge, not being sufficient the simple personal reconstruction of knowledge previously elaborated by others" (p. 27). According to them, it is crucial that students create their own knowledge.

On the other hand, Lozada (2017) defines collaborative learning as methods that foster collaboration among individuals to understand, share, and expand information about a topic. This approach involves sharing data through real or virtual discussion rooms, where group members assume related and complementary roles to achieve a common goal. Lozada highlights the use of tools such as Kahoot to foster collaborative learning, facilitating immediate feedback from the teacher and promoting a more active attitude among students. Garcia et al. (2021) point out that research shows that the more a student is exposed to the information they are learning, the easier it is for them to remember the topic and the less they have to resort to memorization highlighting that Kahoot not only facilitates learning, but also allows students to learn in a variety of ways, turning them into creators of their own knowledge (Garcia et al., 2021).

Finally, Guevara et al. argue that education cannot be based solely on the transmission of knowledge from the figure of the teacher, especially considering the new scenarios and lifestyles faced by the various educational actors (Guevara et al., 2022). They highlight that online education, mediated with tools such as Kahoot, plays an important role in this transition, educational institutions have had to adopt changes to support the teaching and learning process. In addition, Vergara (2021) and Salazar (2020) point out that "the pedagogical intervention mediated with Kahoot contributes to improving students' academic performance in science learning" (p. 7).

## 3. Methods and instruments

In attention to the object of study, the quantitative approach was used, quasi-experimental type of research, cross-sectional and descriptive design where its purpose is to collect data at a single moment, to describe variables and the incidence of one variable on the other at a given moment. The study population was selected by means of a non-probabilistic sample by convenience, it was formed by 96 students; a parallel of 32 students intervened as the control group with the application of a traditional methodology and two parallels with a total of 64 students became the experimental group with whom the technological tool was



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used; the research process had the consent approved by the legal representatives for the collection of the information, analysis and sharing of the results with the community of the Educational Institution.

The technique used for data collection consisted in the application of a survey to students. This methodology was selected due to its wide use in research, which guarantees its relevance. The data collection instrument included closed questions evaluated on a Likert scale, which ensures its validity and reliability; it was administered through Google Forms, which allowed the creation of a digitized questionnaire to facilitate the collection of responses and provide the research with an interactive, novel and innovative instrument. For the processing and analysis of the information collected, a statistical process will be used, supported by graphs that will facilitate the presentation and interpretation of the results obtained.

#### 4. Discussion and results

The answer to the research question "Does the application of Kahoot have an impact on the learning of Natural Sciences? The evaluation of learning is an important indicator to determine the effectiveness of the Kahoot tool as a mediator of this process, where it is possible to verify if its use contributes to a better acquisition of knowledge, in such a way that the evaluation shows the following results.

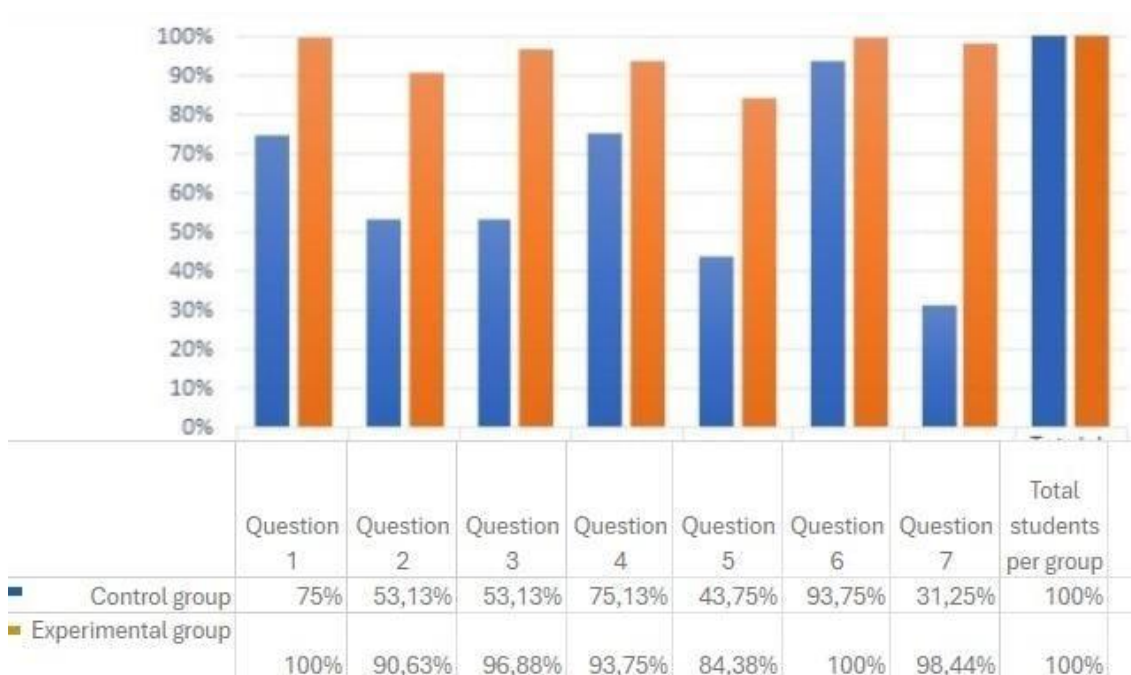


Figure 1. Learning assessment results of the control and experimental groups

For the evaluation of learning, seven knowledge questions were used as a reference, among which are: question 1, water pollution occurs when substances are added or physical changes are applied that alter its characteristics and quality; the students in the control group (CG) answered 75% correctly, while the students in the experimental group (EG) with whom the intervention was carried out answered correctly with 100%. Question 2, the



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water does not have cleaning systems, so they are not carried out through the self-purification cycle; the control group answered this question with 53.13% and the experimental group with 90.63%. Question 3, water has a natural capacity to eliminate contaminants, but many times contamination exceeds the self-purification capacity of water, the response obtained by the CG was 53.13% and for the SG 96.88%. Question 4, the cleaning capacity of water is not limited, since only biodegradable substances can be removed and in not excessive quantities, 75.13% of the CG students answered correctly, and with 93.75% the GE. Question 5, wastewater from industries and mines contain toxic substances and solid materials that are difficult to decompose, 43.75% of the CG students give an appropriate answer, while 84.38% belonging to the GE answer in a timely manner. Question 6, What are the main water pollutant groups, the answers obtained for the CG are 93.75% and for the SG 100%. Finally, question 7, what are the main water pollutants according to their origin? To this question, the CG responded with 31.25%, while the SG responded with 98.44%.

After administering the natural science knowledge assessment instrument through Google Forms to both the control and experimental groups, and observing the results presented in Figure 1, a significant difference is evident. In the control group, composed of a total of 32 students, the average correct answers to the seven questions established on the contribution to learning oscillate around 60%. In contrast, in the experimental group, these correct answers reached approximately 95%. This result highlights that the implementation of the tool has a significant impact on learning. It should be noted that the experimental group received a lesson plan based on the use of Kahoot as a means of knowledge assessment. The results obtained are in agreement with Malvasi and Recio (2022) who point out that:

When planning playful didactic experiences in the school context it should be considered that such an approach does not have to be unique, but that the proposal can be enriched by adding other elements, such as the observation of the starting situation or the problem that contextualizes the experience, the story serves as a thread and scenario, an approach to various challenges that encourages action, collaboration and participation in problem solving can lead to great results with the intervention of digital platforms (p. 63).

In this sense, it can be pointed out that the use of the tool is beneficial for the teaching-learning process; students are more enthusiastic about the activities, getting involved in their learning and acquiring significant knowledge.



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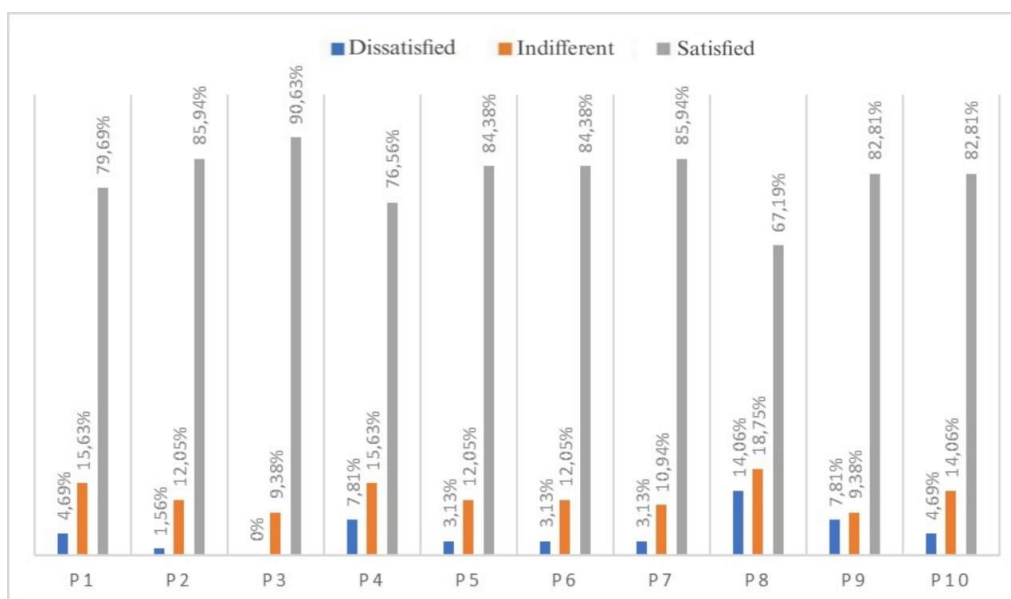


Figure 2. Learning assessment results of the control and experimental groups

Once the satisfaction evaluation instrument was applied using Google Forms to the experimental group, and according to the results presented in Figure 2, it can be observed that in the area of learning using the Kahoot tool, all the questions presented with the letter P reflect percentages higher than 50%. This indicates that students are satisfied with the usefulness of this tool to evaluate their academic progress through this medium.

These findings confirm that gamification emerges as an extremely popular educational methodology, as it increases the attractiveness of learning processes by fostering innovation, enjoyment, efficiency, concept retention and skill acquisition. In this way, the *Kahoot tool* contributes to the teaching-learning process by generating satisfaction among students, increasing their motivation to acquire new knowledge, and their dynamic and interactive participation goes hand in hand with interaction with the teacher.

Once the satisfaction evaluation instrument was applied through the *Google forms* to the experimental group, and according to the results presented in Figure 2, it can be seen that in the area of learning using the *Kahoot tool*, all the questions show percentages above 50%. This means that students claim to be satisfied with the usefulness of the tool to evaluate their learning through this medium.

With the above, it is ratified that gamification is positioned as a widely accepted educational methodology, since it enhances the attractiveness of learning processes, stimulates innovation, enjoyment, effectiveness, knowledge retention and skills acquisition. Consequently, the *Kahoot tool* contributes significantly to the teaching-learning process by reflecting student satisfaction, increasing their motivation to expand their knowledge, and their participation and interactivity in tune with the teacher.



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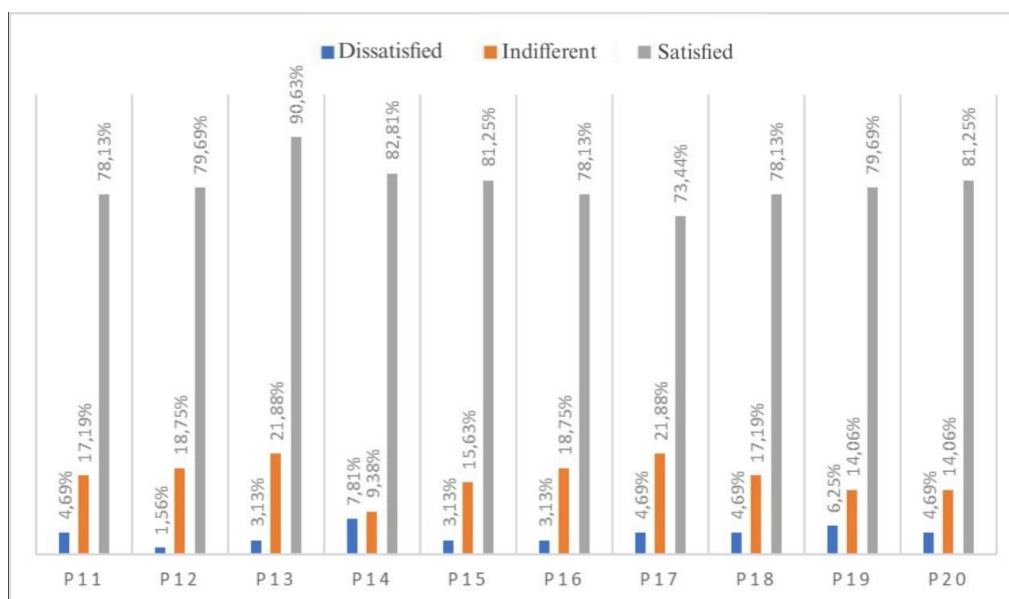


Figure 3. Results of satisfaction with the conceptual design dimension

Figure 3 presents the analysis of questions from eleven to twenty, the same are represented by the letter P, it is also observed that about 80% of students are satisfied with the conceptual design presented by the tool in their learning process in the area of conceptual design. According to Valero (2018) "these applications allow such everyday activities such as a written test or the completion of a classroom activity to become more dynamic and offer positive reinforcement to the students by the teacher" (p. 18). One of the most important keys to achieving this satisfaction is to give students full control over the dynamics of the game being used; it is critical that all activities are designed in a way that engages the learner in the game and allows them to move toward their goals. Depending on the specific dynamics, the teacher can employ various resources to achieve the established objectives.

The results obtained show that the conceptual design generated with the Kahoot tool has contributed to the achievement of the educational objectives established for the learning process. This confirms that the established standards have been met and that the achievements and rewards proposed by the program have been achieved.



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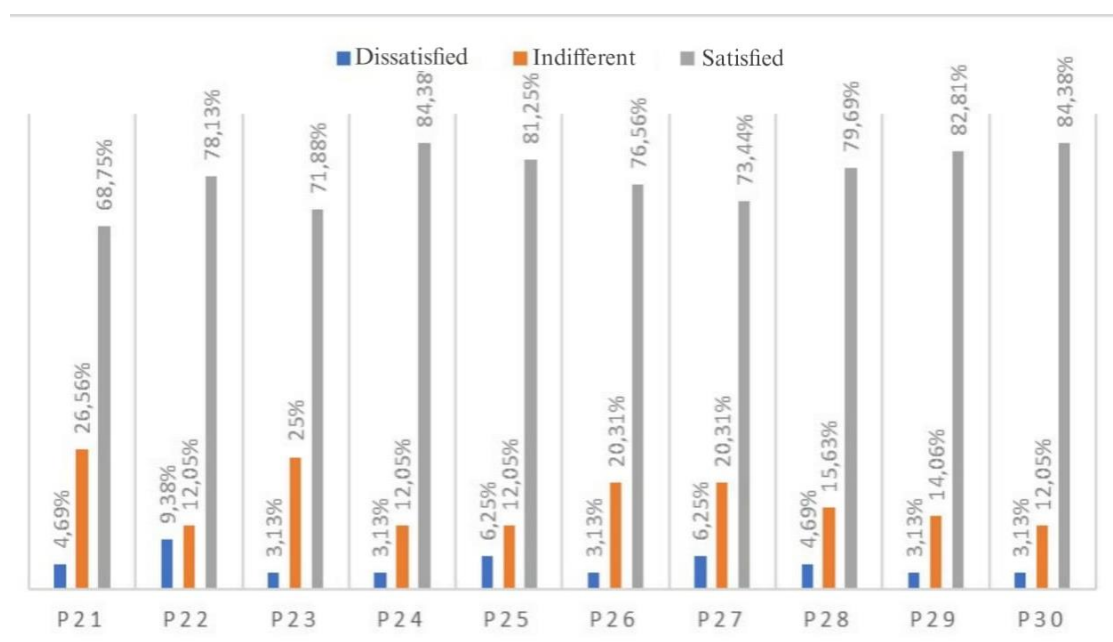


Figure 4. Satisfaction results procedural design

The figure shows the analysis of some questions, which are represented by the letter P. According to the results obtained, Figure 4 shows that, in the area of procedural design, using the *Kahoot* tool, more than 50% of the students are satisfied with the procedural design presented in their learning process. According to Zepeda et al. (2016) point out that "the factor to take into account from gamification is the reward scheme used by video games, which is depending on the level reached certain privileges or additional rewards are offered" (p. 6). As can be seen, the teacher's objective is to awaken the student's interest through the game, and to achieve this, he can use the reward dynamics; if the teacher's objective is to generate interest in the activity, he can apply a competitive dynamic, which, although not perceived as positive, can be useful in the educational environment.

From the results obtained, it can be concluded that the procedural design generated with the *Kahoot* tool has made it possible to verify that students understand the steps executed during the activities, following the established planning. In addition, attractive and challenging activities have been promoted, which guide the student's experience in the learning process. It is important to highlight that the data obtained in the study are presented in the corresponding figures, providing additional and complementary information to the analysis.

Model	R	R square	R tight square	Standard error of estimation
1	.997 <sup>a</sup>	.993	.993	.620

a. Predictors: (Constant), Kahoot Score



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Table 1. Summary of the model. Linear Regression Analysis

In the linear regression analysis presented in Table 1, the multiple correlation coefficient (R) was selected because of its importance in determining the strength and direction of the relationship between the variables studied. In this case, the multiple correlation coefficient was found to be 0.997, indicating a very high correlation between the level of participation and the score obtained in *Kahoot*. This statistic was chosen because it provides crucial information on the strength of the linear relationship between these two variables. A high correlation suggests that changes in the level of participation are closely related to changes in the *Kahoot* score in a consistent and predictable manner, which reinforces the validity of the linear regression model used to analyze the relationship between these variables. Thus:

- R-squared: The coefficient of determination (*R*-squared) is 0.993. This means that approximately 99.3% of the variability in the *Kahoot* score can be explained by the level of participation using this linear regression model. Such a high *R*-squared value indicates that the model is highly predictive.
- Adjusted *R*-squared: The adjusted coefficient of determination (adjusted *R*-squared) is 0.993. This measure adjusts the *R*-squared to account for the number of variables and samples used in the model.
- Standard error of the estimate: The standard error of the estimate is 0.620. This value indicates the average variability between the observed values of the *Kahoot* score and the values predicted by the regression model. A lower standard error indicates better accuracy of the model.
- Predictors: The predictors included in the model are the constant (intercept) and the *Kahoot* score. This means that the model uses the *Kahoot* score to predict the level of participation.

In summary, the linear regression model shows a strong and highly predictive linear relationship between the level of participation and the *Kahoot* score. The *Kahoot* score is a significant predictor of participation level.

Model		Sum of squares	<i>gl</i>	Root mean square	<i>F</i>	Sig.
1	Regression	1542.616	1	1542.616	4017.715	.000 <sup>b</sup>
	Residue	10.751	28	.384		
	Total	1553.367	29			

a. Dependent variable: Level of Participation  
b. Predictores: (Constante), Puntaje Kahoot

Table 2. ANOVA analysis

In this case, ANOVA analysis was used to determine the significance of the linear regression model applied in the study. ANOVA provides information on the total variability of the data (total sum of squares) as well as the variability explained by the regression model (regression sum of squares). By comparing these two measures of variability, we can determine whether the regression model explains a significant amount of the variability observed in the data.



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In the specific case of Table 2, we observe that the regression sum of squares is considerably high compared to the total sum of squares, suggesting that the regression model explains a significant portion of the total variability in the data. This supports the usefulness of the linear regression model in explaining the relationship between the variables studied and justifies its statistical significance using the ANOVA test

- Root mean square: The root mean square is the sum of squares divided by the corresponding degrees of freedom. In this case, the root mean square of the regression is 1542.616 and the root mean square of the residual is 0.384.
- *F* and *p*-value: The *F*-value is a measure of the overall significance of the regression model. A high *F* value indicates that the model is significant. In this case, the *F*-value is 4017.715 and the *p*-value is less than 0.001 (indicated by 0.000). This indicates that the regression model is highly significant.

After performing an ANOVA analysis to determine the impact of the application of Kahoot as a didactic strategy in the evaluation of knowledge in natural sciences, significant results were found. The statistical test revealed a sum of squares of 1542.616 for the regression model, with an *F*-value of 4017.715 and a *p*-value (Sig.) of 0.000. This indicated that the regression model was highly significant.

Therefore, the alternative hypothesis (*H<sub>a</sub>*), which stated that the application of Kahoot as a didactic strategy had a significant impact on the assessment of knowledge in natural science, was accepted. This finding suggests that the use of Kahoot as an educational tool could have significantly influenced students' level of participation and performance in the subject of natural science.

These results support the conclusion that the linear regression model is statistically significant in predicting the level of participation using the *Kahoot* score as a predictor. The very low *p*-value indicates that the relationship between the variables is very unlikely to be the result of chance.

Model		Non-standardized coefficients		Standardized	<i>T</i>	Sig.
		B	Desv. Error	Coefficients		
1	(Constant)	-5.129	1.247		-4.114	.000
	Kahoot Score	.948	.015	.997	63.385	.000

a. Dependent variable: Level of Participationc

Table 3. Analysis of the coefficients in the linear regression model. Linear regression line.  $y = -5.129 + 0.948x$ , i.e.: Level of Participation =  $-5.129 + 0.948$  (Kahoot score), i.e.: Level of Participation =  $-5.129 + 0.948$  (Kahoot score)

Table 3 indicates the analysis of the coefficients in the linear regression model provides information on the magnitude and significance of each predictor. Unstandardized coefficients (B): the coefficient for the constant (intercept) is -5.129. This indicates the expected value of participation level when the *Kahoot* score is equal to zero. The coefficient for the *Kahoot* score is 0.948, which means that for each unit increase in the *Kahoot* score an increase of 0.948 in the level of participation is expected.

Standardized coefficients (Beta): the standardized coefficients represent the relative contribution of each predictor in the prediction of the dependent variable. In this case, the



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standardized coefficient for the *Kahoot* score is 0.997, indicating that the *Kahoot* score has a very strong and positive influence on the level of participation.

The *t*-value is a measure of the individual significance of each coefficient. A high *t*-value indicates that the coefficient is significant. In this case, both the coefficient for the constant and the coefficient for the *Kahoot* score have high *t*-values. The *t*-value for the *Kahoot* score is 63.385, indicating high statistical significance. The *p*-value indicates the probability of obtaining a coefficient value equal to or more extreme if the true relationship between the variables is zero. In this case, the *p*-value for both coefficients is less than 0.001 (indicated by 0.000). This means that the coefficients are highly significant, and it is unlikely that the relationship between the variables is the result of chance.

In summary, the coefficients indicate that both the constant and the *Kahoot* score are significant predictors of the level of participation. The *Kahoot* score has a very strong positive influence on the level of participation, meaning that as the *Kahoot* score increases, an increase in the level of participation is expected.

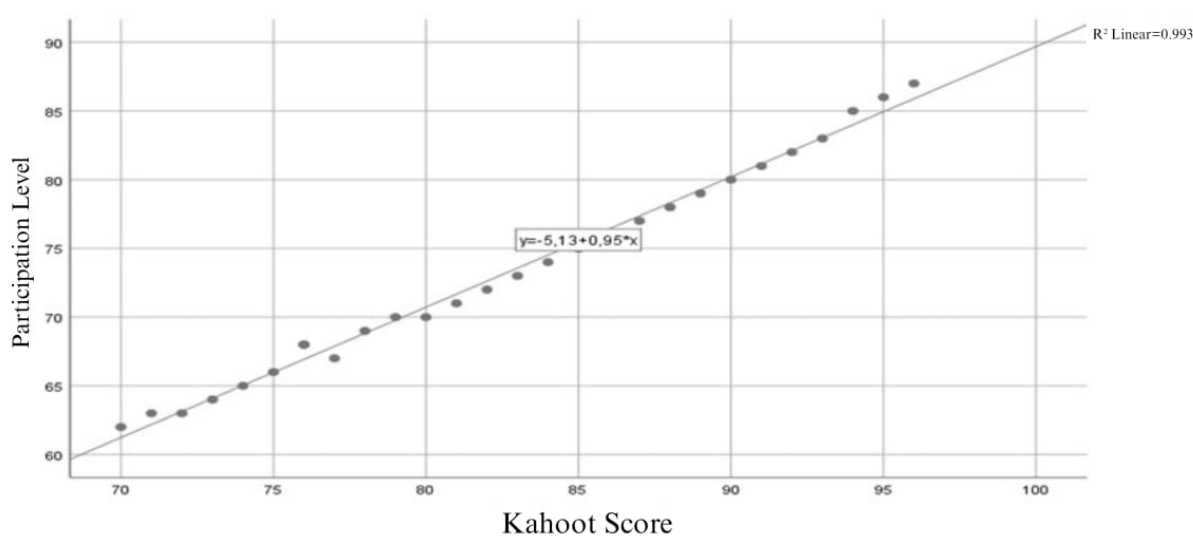


Figure 5. Kahoot as a function of participation

Since the sample size is 96, it is assumed that the visual analysis of the linear regression graph is representative of the data. Looking at the linear regression figure 5 with the data provided, the positive linear trend between *Kahoot* score and level of participation is confirmed. The scattered points are clustered around an ascending straight line, indicating a strong positive correlation between the variables. The fitted regression line shows a positive slope, implying that, on average, as the *Kahoot* score increases the level of participation also tends to increase.

Given the sample size and the consistency of the linear relationship evidenced in the graph, it can be affirmed that there is a significant difference between the mean scores of the groups. In summary, the linear regression figure, based on a sample of 30 observations, supports the existence of a significant difference between the score obtained in *Kahoot* and the level of student participation.



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## 5. Conclusions

After analyzing the methodology and the data collected, the following main conclusions can be highlighted:

According to García et al. (2021) "the implementation of Kahoot as a didactic tool in the subject of natural sciences has shown a significant improvement in the students' mastery of knowledge" (p. 3). This platform has been shown to be a motivating element in the teaching-learning process, offering various functions and strategies that facilitate learning through play. The use of *Kahoot* in the learning of natural sciences has shown to have a positive impact on the development of social and cognitive skills. The games based on scientific content, combined with a playful environment, encouraged student participation, generating an increase in their self-esteem and promoting interaction within the group.

The results show a significant increase in student learning in the experimental group that used *Kahoot* compared to the control group that did not use the tool. This suggests that the intervention of *Kahoot* in the teaching process contributes to increased student engagement and academic performance.

These findings highlight the practical and positive impact of the application of *Kahoot* as a didactic tool in the teaching of natural sciences. However, future research is recommended to explore in greater detail the long-term effect of the use of *Kahoot*, as well as its application in other areas of knowledge and its combination with different educational strategies.

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### Statement of Authorship-CRediT

**JUAN CARLOS CÁRDENAS-ROGEL:** state of the art, related concepts, methodology, validation, data analysis, writing-first draft.

**GRETHY QUEZADA-LOZANO:** state of the art, related concepts, data analysis, organization and integration of collected data, project management.

**REINALDO GUERRERO-CHIRINOS:** related concepts, organization and integration of collected data, conclusions, final draft and editing.



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