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GAMIFICATION IN THE NATURAL SCIENCE CURRICULUM IN BASIC EDUCATION: EMPIRICAL EVIDENCE OF EFFECTIVENESS IN LEARNING

GAMIFICACIÓN EN EL CURRÍCULO DE CIENCIAS NATURALES EN EDUCACIÓN BÁSICA: EVIDENCIA EMPÍRICA DE EFECTIVIDAD EN EL APRENDIZAJE

Martha Cecilia Betancur Taborda[1]
International Iberoamerican University, Mexico
(macebeta@gmail.com) (https://orcid.org/0000-0002-4177-1827)
Antonio Rafael Fernández Paradas
University of Granada, Spain
(antonioparadas@ugr.es) (https://orcid.org/0000-0003-3751-7479)

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ABSTRACT

This research offers the educational community a design proposal for action within the natural sciences curriculum, involving the learning of the concept of energy through gamification. The intervention took place José Martí School in Bogotá, with a sample of 32 fifth grade elementary students. The intention is to address the scientific problem posed: what elements should a proposal for action contain in the José Martí school curriculum that involves the construction of the concept of energy through gamification? The proposed questions lead to the formulation of several hypotheses, among them, whether learning strategies that use gamification as an educational resource enrich the natural sciences curriculum and facilitate the meaningful construction of the concept of energy by students. This research adopts a mixed approach, combining descriptive, explanatory and interpretive methods; For the quantitative analysis, statistical algorithms such as the Shapiro-Wilk test and the student t test were used, while the qualitative part was used maxqda software. This study provides the educational community with an innovative learning strategy to teach the concept of energy through gamification, generating significant changes in the curriculum. In addition to verifying that the use of technological and gamified tools, specifically the game "an energy journey: the magic of energy" promoted significant learning of the concept in fifth grade primary school students at the José Martí school.

Palabras clave:
currículo, gamificación, energía, aprendizaje, didáctica.

RESUMEN

Esta investigación ofrece a la comunidad educativa un diseño de propuesta de actuación en el currículo de ciencias naturales, que implicó el aprendizaje del concepto de la energía mediante la gamificación. La intervención se desarrolló en el Colegio José Martí

[1] Autor de correspondencia.

en Bogotá, con una muestra de 32 estudiantes de quinto grado de educación básica primaria. La intención es abordar el problema científico planteado: ¿qué elementos debe contener una propuesta de actuación en el currículo del colegio José Martí que involucre la construcción del concepto de energía a través de la gamificación? Los interrogantes propuestos conducen a la formulación de varias hipótesis, entre ellas, si las estrategias de aprendizaje que utilizan la gamificación como un recurso educativo enriquecen el currículo en ciencias naturales y facilitan la construcción significativa del concepto de energía por parte los estudiantes. Esta investigación adopta un enfoque mixto, que combina métodos descriptivos, explicativos e interpretativos. Para el análisis cuantitativo, se emplearon algoritmos estadísticos como la prueba de Shapiro-Wilk y la prueba t de student, mientras que la parte cualitativa se usó el software maxqda. Este estudio aporta a la comunidad educativa una estrategia de aprendizaje innovadora para enseñar el concepto de la energía a través de la gamificación, generando cambios significativos en el currículo. Además de verificar que la utilización de herramientas tecnológicas y gamificadas, específicamente el juego "un recorrido energético: la magia de la energía" promovió un aprendizaje significativo del concepto en los estudiantes de quinto grado de básica primaria del colegio José Martí.

Introduction

This research focused on the analysis of the regulations of the natural sciences and environmental education curriculum for elementary school in Colombia. Based on the analysis, an innovative learning strategy was designed using gamification to integrate the natural science curriculum and teach the concept of energy, considering its scientific and social dimensions. The selected population was fifth grade students of the José Martí school in Bogotá, Colombia, and the relevance of the study was to provide the academic community with a proposal for action in the curriculum.

Gamification in education emerges as a powerful tool to improve the understanding of multidisciplinary concepts. Along these lines, the game "An energy journey: the magic of energy" was designed and implemented as part of the educational strategy that uses gamification to facilitate the learning of the concept of energy in a playful and participatory way. This resource was an integral part of the process and was successfully implemented with students in 2023. The game used characteristic elements of games, such as designs and dynamics, in an educational context, available at: https://aprendejugando.com.co/.

The game was based on a didactic unit on energy, organized from the constructivist perspective of Sanmartí (2002) and the problematic didactic approach of Bravo (2002). This methodology offered a didactic and playful route, which considered what and how to learn, as well as the self-regulation of learning, fundamental elements of curricular planning.

The nature of this research is mixed, that is, located in the quantitative and qualitative paradigm, the study questions respond to a descriptive, explanatory and interpretative inquiry aimed at collecting information on the curriculum in Colombia, the analysis and limitations of the study plan, the curriculum structure of natural sciences and environmental education of the José Martí school with respect to energy.

Instruments such as surveys, interviews, field diaries and analysis of documents related to the issue of curriculum in Colombia, Latin America and globally were used, highlighting its relevance in the educational and institutional sphere. The concept of energy was prioritized, and the potentialities and deficiencies of the curriculum in the Colombian and institutional context were identified.

The scientific field was approached from an educational perspective, highlighting the importance of building the concept of energy with children, which is fundamental to understand and explain a wide variety of phenomena in different social, economic, political, scientific and technological aspects. He also emphasized the need to raise awareness among new generations of the global energy crisis, due to the depletion of natural resources and climate change, which represent major contemporary challenges both locally and internationally.

In the social context, it provided the educational community with a learning strategy to implement in the classroom focused on curriculum, gamification and energy. The latter is a complex and challenging concept to build with students, since it is essential to understand it from multiple perspectives: physical, biological, anthropic and technological, it was approached through daily activities, exploring its scientific aspect and its social implication.

The scientific problem was: what elements should be included in an action proposal in the curriculum of the José Martí school that involves the construction of the concept of energy through gamification?

The objectives were: 1. To design a proposal for action in the natural sciences curriculum of the José Martí school that involves learning the concept of energy through gamification, 2. Analyze the regulations and curriculum of natural sciences in Colombia and the institution, 3. Apply a learning strategy for energy concept building using gamification, and 3. To provide the educational community with a proposal for the transformation of the natural sciences curriculum involving the learning of the concept of energy through gamification.

The research was based on authors such as Caillois (1986), Díez (2017), Huamaní Quispe and Vega (2023), Huizinga (2007), Soto et al. (2024) and Teixes (2015) who consider it innovative to use playful strategies, gamification, educational software, and hobbies that favor motivation and learning. "Gamification, by influencing the behavior and motivation of participants, makes learning a more engaging and effective experience" (Teixes, 2015, p. 18).

As for the curriculum, epistemological, pedagogical, didactic and methodological aspects converge in it, enriching the curricular design and the way of approaching the contents that integrate it. Currently, various curricular theories strengthen and re-signify this process in the school, and its implementation is a crucial aspect, which is adapted in a unique and pertinent way to the needs of each context. The involvement of the curriculum in institutions is relevant, given that current generations are marked by complex technological, environmental, scientific, economic, political and social dynamics.

Díaz (2003), highlights the curriculum as a multidisciplinary knowledge, emphasizes the importance of considering "the perspectives of curriculum as a lived process or as the hidden", which opens the possibility of diverse conceptual developments and allows for a deeper understanding of school culture" (p. 9).

Stenhouse (1991), the curriculum reflects a conception of knowledge and the process of education, implies an "educational vision and a psycho-pedagogical translation of the contents coherent with the epistemological position of the curriculum (p.14).

"The curriculum represents a problem of relationship between theory and practice, between education and society, its configuration and development encompass political, social, economic, administrative practices, production of didactic means, control of the educational system" (Kemmis, 1986, p. 22 cited in Gimeno, 2010, p.12).

Bourdieu and Gros propose guidelines for the elaboration and application of educational content. The first is to "prioritize modes of thinking with general validity and applicability, such as deductive, critical and reflective thinking" and to consider programs as flexible frameworks for action, interpreted by experts and teachers; the second is to "favor interdisciplinarity to avoid repetitions and disconnections in knowledge" and finally to carry out "periodic reviews of programs to incorporate scientific advances and social needs" (Bourdieu and Gros 1990 cited in Gimeno 2010, p. 284).

In relation to critical pedagogy, it is conceived as "a curriculum based on social transformation". This "sociocultural and political outlook allows developing in the student a critical understanding of social reality and commitment to its transformation, the structure of the curriculum is very open and flexible" (Apple, 1979; Giroux, 1988; McLaren, 1989 cited in Ortiz, 2014, p. 33).

The perspective of the critical curriculum at the Latin American level has an important place in the history of education in Colombia, which seeks the formation of critical and reflective subjects, in the words of Giroux (2007), forming critical individuals is necessary for teachers to be" transforming intellectuals" (Giroux 2007 cited in Flórez, et al 2018). Similarly, Giroux (2003), "argues that the teacher must reflect on the concept of emancipatory and transformative authority in terms of the ability to think and act critically with social transformation" (p.155).

Pinto (2008) proposes a sociocultural approach that involves the school, teachers and popular education, seeking to democratize social, economic and cultural relations. He identifies two approaches in Latin America: the comprehensive curriculum, influenced by Anglo-Saxon theory, and the critical comprehensive curriculum, which promotes a school cultural transformation based on popular education and consensus.

De Zubiría emphasizes the importance of the curriculum as a vehicle for bringing pedagogical principles and purposes to the classroom environment. For him, this process involves a continuous dialogue between theory and practice, reflection and action, pedagogy and didactic strategies. "The curriculum is the characterization of the various educational contexts in coherence with the educational intentions and purposes, it covers aspects such as planning, content sequencing, methodological strategies, didactic resources and evaluation" (De Zubiría ,2013, p. 77).

UNESCO defines curriculum as "a political and social agreement that reflects society and considers local, national and global needs, curriculum design is a topic of discussion from diverse perspectives such as policy, experts, practitioners and society at large" (Stabback, 2016, p.6).

Opting for a paradigm based on learning requires significant changes in the curricula of the institutions, the methodologies and didactics of the teachers and consequently in the teaching-learning processes, which imply innovating in relevant educational strategies that motivate reflection, autonomy, the development of critical thinking, teamwork, creativity, the search for peace and harmony with oneself, living beings and nature.

The integration of gamification in the curriculum of the José Martí school represents an educational innovation that addresses identified shortcomings in its pedagogical, didactic and epistemological approach. Gamification, by linking simulation, games, concepts, activities and projects, offers a different way of building knowledge. It is a growing tool in the educational field that seeks to transform the learning environment into a meaningful and fun space, where students are active agents of their educational process, allowing teamwork, self-evaluation and skills for the integral development of the student.

Method

The methodological design follows the principles of Hernández et al. (2014), focused on a plan to obtain information and solve a problem. This design is structured in five parts, which are detailed below:

Methodological Perspective

A mixed approach is adopted, i.e. quantitative and qualitative, integrating descriptive, explanatory and interpretative methods. In the qualitative aspect, document analysis is used to explore the curriculum of natural sciences and environmental education in Colombia, as well as the José Martí school. Individual and group interviews allowed to deepen the students' understanding of the concept of energy, the analysis used MAXQDA software.

On the quantitative side, surveys (pretest and posttest) were designed and applied to collect information about students' perceptions of gamification and energy, before and after the implementation of the learning strategy.

Inquiry methods include descriptive procedures based on observational data, interviews and surveys. The explanatory and interpretive method verifies the children's

construction of the concept of energy after the implementation of the learning strategy using gamification as an educational resource. The interpretative process focuses on the analysis of the curriculum in Colombia and in the José Martí school. As a result, a curriculum performance design is proposed that employs gamification as a learning strategy to build the concept of energy.

Context

This research corresponds to the research line called educational technology, educational innovation with ICT. Carried out at the José Martí school, located in the city of Bogotá in the locality of Rafael Uribe, neighborhood of Las Lomas. It is a formal educational entity, of an official, mixed nature, under the District's Secretary of Education that serves a population between the ages of 4 and 21 years old.

Study population and sample

Fifth grade elementary school students who attended school in the morning, together with a control group made up of students from the same grade who attended school in the afternoon. As for the population, a total of 47 students, 32 belonging to the morning session and 15 to the afternoon session, formed the control group. The study sample consisted of 32 morning students, of which 17 belonged to grade 501 and 15 to grade 502. The selection of the sample was by means of non-probabilistic sampling, which implies an "informal and casual selection process, characterized by using easily accessible individuals, depending on various fortuitous circumstances" (Bisquerra ,2012, p. 148).

Methodology

It was structured in two phases, with their respective stages.

Phase 1: Analysis of the curriculum issue in Colombia

It corresponds to a qualitative methodology with an exploratory inquiry of the documents, it analyzed the strengths and deficiencies present in the natural sciences curriculum of the José Martí school, in the documentary framework on the issue of the curriculum in Colombia.

Phase 2: Proposed action in the curriculum

After analyzing the results of phase I, we proposed the design, application and testing of the learning strategy using the gamified resource for learning the concept of energy. The methodology is mixed with techniques such as survey, observation, and in-depth focused and group interviews.

The above phases contain the following stages

Stage 1: Theoretical and methodological background

It corresponds to the issue of the curriculum in Colombia, the analysis of the institution's curriculum, the relevance of the concept of energy within the curriculum, gamification and learning strategies.

Stage 2: design and application of instruments.

Validated and ad hoc designed instruments were used to collect information. Among them are the survey directed to students, the focused and group in-depth interview, the field diary and the gamified resource based on a didactic unit to approach the concept of energy with children through gamification.

Stage 3: Data organization and analysis

It consists of the tabulation, verification, organization, representation and interpretation of the information obtained in each of the phases and stages of the research in order to establish the respective reflections and conclusions.

Stage 4: Assessment of the learning strategy and recommendations

The learning strategy is evaluated, corroborating the hypotheses and the research question, and recommendations for future research are established.

Techniques and Instruments

The techniques were: content analysis of documents, survey, interview and ethnographic observation. To ensure the validity of the data, the collection instruments were validated by experts, a control group and other previously validated instruments.

The questionnaire-type survey with a quantitative approach was used to assess the children's knowledge of the concept of energy and gamification. The design of the energy instrument was based on previous works such as those of Bañas (2001 and 2003) and the CLIS Project instrument (Brook and Driver, 1984) and research by Doménech et al (2001) on the teaching of energy in secondary education.

The qualitative methodology employed in-depth, focused, group interviews designed specifically for this research, as well as a field diary completed by the children in focus groups.

Variables

Independent*:* gamification as a learning strategy for the concept of energy enriches the curriculum in natural sciences
Dependent: children's learning of the concept of energy
Strange: the learning strategy that does not use gamification as an educational resource for the construction of the concept of energy*.*

Information Analysis

It refers to the analysis of the issue of the curriculum in Colombia and the educational institution, the learning generated in the students from the development and application of the learning strategy, using the gamified resource for the construction of the concept of energy, which allowed the performance proposal in the curriculum*.*

Ethical implications and limitations in working with students were considered. Informed consent was obtained from parents, ensuring that students understood the research objectives and procedures. Confidentiality and anonymity of personal data were prioritized. The research was conducted during the school year, ensuring an ethical and professional approach.

Results

The results of the documentary analysis, surveys, interviews and field diaries of the research are presented.

Documentary Analysis

After reviewing the state of the art of the curriculum and analyzing the educational regulations in Colombia in the area of natural sciences, it is observed that the concept of energy is present at all levels of formal education. This presence is confirmed in the curricular guidelines, the basic standards of competence, the curricular grids, the basic learning rights and the curriculum of the José Martí School. These documents offer an explanation of the theoretical, epistemological, pedagogical, sociological, didactic and psychological foundations for curriculum development in natural sciences and environmental education.

The potential of the institution's curriculum includes compliance with legislation and regulations, the structure by cycles, the organization in training fields, a focus on scientific competencies and the view of professors at all levels. However, significant shortcomings were identified, such as the lack of a clear epistemological position in natural sciences, the absence of strategies to teach the concept of energy, a more defined methodological orientation, the inclusion of technological tools and ludic strategies for learning, concrete evaluation criteria, detailing students' abilities, learning skills and motivation towards science.

Pre-Test and Post-Test Survey Results to Inquire About the Use of Gamification

The instruments were given to three fifth grade classes: two in the morning and one in the afternoon, the latter serving as a control group. The validation of the instrument was carried out with the 501st grade in the afternoon day in 2022, reliability was established by means of Cronbach's alpha coefficient ($\alpha = 0.73$) in a pilot sample of 15 students.

Regarding the results of the experimental groups of grades 501 and 502 in the morning day, grade 501 started with 17 students, with a majority of girls (53%) and boys (47%), the age distribution was between 9 and 12 years old. At the end of the year, enrollment was reduced to 15 students, with a slight change in distribution (60% girls and 40% boys) and the age range was from 10 to 13 years old.

Grade 502 started with 15 students, with a higher proportion of boys (66%) and girls (34%) and a similar age distribution; at the end of the year, the group was reduced to 14 students. These data provide an overview of the groups studied, which made it possible to analyze how these factors could influence the results of the research.

Overall there was a significant increase in teachers' use of gamification and an improvement in students' perception and understanding of learning through online games and gamification. Table 1

The results of the 501st grade experimental group showed a substantial increase in the use of gamification, with 100% of the students participating in gamified activities after the intervention, indicating the effectiveness of this strategy in teaching the concept of energy. In addition, students expressed a greater preference for the inclusion of challenges and rewards in the classes, demonstrating their liking for this methodology.

In the case of grade 502, similar results were observed, with a favorable response from students and an improvement in the perception and teaching practice related to gamification. These findings support the feasibility of incorporating gamification into the natural sciences curriculum at José Martí School.

Table 1

Implementation of gamification (experimental group responses)

Items	501		502	
	Pretest	Post test	Pretest	Post test
1.Your teachers use gamification in their classes.	12%	100%	34%	100%
2.Your teachers use games related to the subject they teach.	53 %	100%	46%	100%
3.Your teachers use online games to conduct their classes.	30%	100%	13%	100%
4.You consider that you learn through online games.	70%	100%	47%	100%
5. Did you know what gamification is?	6%	100%	34%	100%
6. Would you like your teacher to use challenges, rewards, competitions, challenges, etc. to explain a subject in a class?	71%	100 %	80%	93%

Note. Percentage of affirmative answers

The results of students' responses in both experimental groups regarding gamification in the classroom show remarkable changes between pretest and posttest; students experienced a significant improvement in perception and experience with gamification as an educational strategy, although initially girls showed less knowledge about gamification, both expressed liking for online games as a teaching tool and showed interest in gamified strategies in class, such as challenges and rewards. In summary, an increase in students' perception and attitude towards gamification was observed, indicating a greater acceptance and understanding of this learning strategy.

The perception of students in the control group on the use of gamification decreased from 84% to 44% between pretest and posttest, the preference for games related to the topic and the perception of students in affirming that they learn through online games remains high (73%). However, understanding of the concept of gamification decreased significantly, possibly to traditional teaching by teachers. Despite this, the preference for challenges and competitions in the classroom remains high, supporting the significant impact of the gamification-based learning strategy.

Results of the Pretest and Posttest Survey to Inquire About the Concept of Energy

In question one of the instrument, most of the students in grades 501 and 502 associated energy with household appliances, reflecting their presence in everyday life; for them, the word "explosives" has nothing to do with the idea of energy. However, after the application of the gamified learning strategy, a significant change in associations was observed during the post-test, indicating a transformation in the students' conceptualization of energy.

After selecting the words the students had to form two sentences justifying their choice, the analysis of these sentences was based on the categories proposed by Varela et al (1995) in their research on the construction of the concept of energy, a gap was observed between the students' expressions and the scientific concept of energy,

especially in the associations with force, work and movement, the written sentences were related more to everyday aspects than to precise notions of physics, example: *"My mom has a lot of strength."*

In the post-test, students elaborated sentences closer to scientific principles (Table 2), this change suggests a conceptual understanding of energy, also supports the effectiveness of the didactic strategy, which supports the need for a revision of the natural sciences curriculum of the institution.

Table 2

Phrases related to the concept of energy (post test)

Categories	Representative phrases
1.Identification with the concept of work	- Energy is the capacity of bodies to produce changes, works and transformations.
2.Exclusive association of energy with motion	-The windmill needs kinetic energy. - The energy of motion is kinetic energy.
3.Energy as an ingredient or reservoir	-The battery has chemical energy - Chemical energy is found in food.
4.Functional idea of energy	- Electrical appliances are powered by electricity.

Note. The categories proposed by Varela et al. (1995)

The quantitative analysis used statistical algorithms, except for question thirteen, which was analyzed independently due to its open-ended nature and the mixed nature of the research (Figure 1). It was confirmed that the data follow a normal distribution using the Shapiro-Wilk test and the contrast coefficients. Hypothesis testing based on Student's t-statistic was used because of the sample size and the normal distribution of the data, which made it possible to compare means of two groups and determine significant differences between them.

The results showed a difference between pretest and posttest scores with a mean of 25.57 and 64.27 respectively, indicating a significant improvement, which focused on evaluating the children's performance with respect to the construction of the concept of energy through gamification. Hypothesis testing rejected the idea of equal mean performance before and after gamification implementation, supporting the alternative hypothesis suggesting that gamification improves performance in understanding the concept of energy (Figure 2).

Strong statistical evidence is shown to reject the null hypothesis, indicating a significant difference between the sample means. The extremely small value of p (statistical measure indicating the probability of obtaining a result equal to or more extreme than the observed one) strongly supports this decision at a significance level of 5%, there is a low probability of making a type I error.

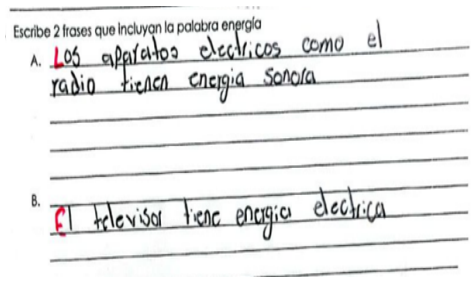
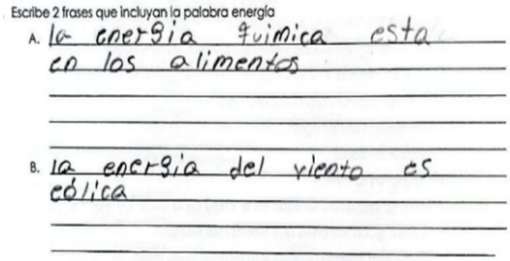
The critical region for a two-tailed test is found at values -2.048 and 2.048, with a sample of 29 students and a t-value of 12.73, the null hypothesis is rejected when finding an absolute value of t greater than 2.048. In conclusion, the results support the hypothesis of the study, indicating that learning strategies that incorporate gamification as an

educational resource enrich the natural science curriculum and lead to the meaningful construction of the concept of energy by students.

No significant changes were observed in the identification of energy-consuming artifacts between pretest and posttest in both experimental groups. The most frequently mentioned appliances were the television, telephone and computer, indicating that students are aware of the importance of energy for their operation. This question is related to the understanding of the energy crisis, a topic addressed in the interviews and the gamified resource.

Figure 1

Evidence question 13

Danna	Alejandro
	

Note. Phrases written by students

Figure 2

Student's t-test

i	Puntos Pretest	Puntos Post test	di
1	42	75	33
2	42	67	25
3	42	67	25
4	50	42	-8
5	33	67	33
6	25	67	42
7	17	83	67
8	25	67	42
9	25	83	58
10	25	58	33
11	17	50	33
12	17	67	50
13	33	75	42
14	25	33	8
15	17	58	42
16	17	50	33
17	25	67	42
18	42	92	50
19	50	67	17
20	17	67	50
21	8	42	33
22	17	67	50
23	33	75	42
24	25	92	67
25	0	67	67
26	8	67	58
27	25	83	58
28	33	83	50
29	8	75	67
MEDIA=	μ_1 =25,57	μ_2 =67,24	$\bar{d}$ = 41,67
SD(σ) =	σ_1 = 12,73	σ_2 =14,50	S_d =17,63
VARIANZA=	163,35	203,03	310,88

Note. Pretest and posttest scores

The study compared the performance of the control group with the experimental groups, all subjected to the same statistical analysis, calculations with Student's t-test showed no significant differences in the average performance of the control group between pretest and posttest, without the implementation of the gamified strategy, the performance of the control group remained constant without significant changes in the construction of the concept of energy by the students during the period evaluated.

Results Focused In-Depth and Group Interviews

Students from both grades distributed in focus groups were interviewed and analyzed using the content analysis method, where words and phrases about learning the concept of energy and the application of gamification as an educational strategy were highlighted. Bardín (1996) was used as a reference for coding and categorization guidelines.

The category system resulting from the content analysis identified five main categories: learning the concept of energy, hands-on activities and experiments related to energy, sources of energy, importance of energy in everyday life, energy crisis and conservation measures, experience, opinions and participation in the gamified resource.

The results of the interviews highlighted the effectiveness of the gamified resource in facilitating the learning of complex concepts such as energy in a fun and participatory way. The children acquired significant knowledge about the importance and types of energy, as well as practical measures to conserve and save it in daily life, also to mitigate the energy crisis. They expressed a positive evaluation of the activities and games, highlighting their usefulness for learning in an effective and entertaining way.

Results Field Diary

They were essential in the process, allowing students to reflect on their experience and learning with the gamified resource, provided feedback on their concerns, expectations, self-evaluations and understanding of the situations presented. The students expressed in their journals the knowledge acquired and the difficulties in understanding certain concepts, such as nuclear energy and photosynthesis. Regarding assessment, they reflected on its contribution to learning and highlighted the usefulness of gamification in the educational process.

Discussion and Conclusions

This research delved into the conceptions of curriculum, gamification and energy at local, national and international levels, adopting an integral perspective of the educational process, focused on the interpretation of knowledge and its pedagogical adaptation, in line with epistemological positions such as that of Stenhouse (1991).

It was nourished by the ideas of authors such as Giroux, Kemmis and De Zubiría, who propose a curriculum that integrates culture, society, academia and history. It coincides with the position of UNESCO (2016), which considers it a political and social agreement reflecting a transformation of the teaching and learning of natural sciences.

He assumed the De Zubiría position, which emphasizes the "coherence between the curriculum and the contexts, proposing the sequencing of contents, selection of methodological strategies and alignment with general pedagogical principles and specific didactic strategies of the classroom" (De Zubiría, 2013, p.19).

Ortiz et al. (2018), state that gamification-focused curriculum design aims to maintain students' interest during the teaching process, thus encouraging participation and avoiding boredom. Along the same lines, Rodríguez and Mas Rubí (2024), Soto et al. (2024), and Zumba et al. (2024), support the benefits of gamification in the classroom, highlighting its impact on learning processes, creativity and curriculum. In addition, they point out that these activities can be effective teaching strategies for learning a variety of concepts.

Some critics of gamification "link it to behaviorism, arguing that it allows conditioning students' behavior through reinforcement or punishment" (García, et al. 2022, p.82). However, this research showed significant differences in overcoming this pedagogical model, the proposed game was based on a didactic unit based on the constructivist perspective of Sanmartí (2002), in line with the problematic didactics of Bravo (2002), which was considered fundamental in curricular planning and learning by students about the concept of energy.

The successful implementation of the proposal at the institutional level is a model for other educational institutions, the use of gamification in the teaching of scientific concepts, such as energy, is an innovative practice with the potential to transcend geographical and cultural boundaries. Research offers new opportunities to improve the educational process and curriculum in diverse global academic communities.

The objectives were met by designing a proposal for action in the natural sciences curriculum of the José Martí school, focused on gamification and learning the concept of energy. This proposal facilitated the understanding of a complex topic and its implementation provided a dynamic and fun learning experience for students, supported by the results and aligned with previous research, in addition, the hypothesis raised was confirmed, evidencing that the integration of gamification in the teaching of natural sciences enriches the curriculum and promotes a meaningful understanding of the concept of energy.

It addressed a deficiency in the curriculum of the José Martí School related to the absence of a clear epistemological position on the teaching of natural sciences, which was overcome by enriching the curriculum with a didactic strategy based on gamification and the learning of the concept of energy. The strategy focused on the design, implementation and evaluation of a gamified resource, integrating constructivist and socio-constructivist epistemological postures that recognize the learning process of students and their social and cultural context.

For Soto (2019), energy is an essential and complex concept in science curricula, necessary to promote scientific thinking. This research had the potential to develop scientific skills in students, fostering a scientific and technological culture in the institution, the educational strategy not only addressed curricular deficiencies, but also promoted participatory, contextualized and meaningful teaching, fundamental aspects for curricular planning.

It evidenced the construction of the concept of energy among students, highlighting the evolution from vague concepts to a more solid understanding of scientific principles, student testimonials reveal significant learning, indicating that classes became more interesting and fun. They incorporated natural science terms into their vocabulary, supporting the effectiveness of this proposal and the idea of transforming the natural science curriculum through gamification.

The results of the two-tailed t-test showed significant statistical evidence to affirm that the population mean differs from the hypothesized value, this supports the hypothesis put forward in the research project and suggests that learning strategies that incorporate gamification enrich the natural science curriculum and lead to a meaningful construction of the concept of energy.

It is concluded that gamification as a learning strategy had a positive impact on the transformation of the natural science curriculum, highlighting the participation of children in activities such as completing the field diary, conducting experiments and participating in games of the gamified resource.

Students expressed sensitivity to the conservation of energy sources, understanding of the energy crisis, results that highlight the potential of gamification to enrich education and foster learning of complex scientific concepts.

Students enjoyed learning through the game, highlighting the autonomy, joy, and valued the achievement of achievements, points, medals and rewards, expressing that the gamified resource facilitated the understanding of theoretical and practical aspects of energy, some opinions are shown below:

Linda: "*In that way, I learn and understand about energy, its types, transformations. The class becomes fun."*

Helen: "*There are cool things like alphabet soup, workshops, experiments, hangman game, which give us points and badges.*

The remarkable performance of students in the use of gamification as an energy learning strategy, supported by statistical evidence, demonstrates the effectiveness of interactive and playful learning strategies in the classroom, provides teachers with didactics to improve their educational practice. The data show a significant change in the perception and adoption of gamification in the educational environment, which contributes to the transformation of the natural sciences curriculum and the understanding of the concept of energy, findings that serve as a basis for pedagogical and curricular adjustments in educational institutions and future research.

Among the limitations identified, it is worth noting that the learning strategy was only implemented during one school year; it is necessary to carry out a follow-up over several periods and with different populations to verify whether learning strategies involving gamification in the teaching of natural science concepts maintain the impact achieved in this research.

Finally, as a prospective, the results suggest that gamification is a promising strategy to enhance learning, especially in teaching the concept of energy. These results open up opportunities for educators to integrate gamification into the curriculum, which could facilitate the understanding of complex scientific concepts and enrich the educational process.

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