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Development of natural science through the Gamification and ICT in Primary Education

Desarrollo de la competencia científica a través de la Gamificación y las TIC en Educación Primaria

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Abstract

Innovative methodologies and new emerging technologies have significant potential for education. Therefore, their use is becoming more and more common in the educational society. This research analyses the integration of gamification through ICT in natural sciences in primary education to improve environmental education. Two didactic units of renewable energies are implemented through a control group which uses a traditional learning method and an experimental group which uses the gamification method and ICT as an educational resource. By means of a mixed methodology, data from 36 students of 6th grade of primary school are analysed, applying the Mann Whitney U-test, a questionnaire and systematic observation. It is highlighted that the work and integration of the gamification methodology, through ICT, does not significantly improve academic performance. However, statistically significant improvements are stressed in satisfaction and motivation in learning processes. The results underline the need for teachers to receive technological and pedagogical training to improve the use of technology in their classrooms.

Keywords: educational innovation, gamification, ICT, natural science, environmental education

Resumen

Las metodologías innovadoras y las nuevas tecnologías emergentes tienen un potencial significativo para la educación. Por ello, su uso es cada vez más común en la sociedad educativa. Esta investigación analiza la integración de la gamificación, a través de las TIC en las ciencias naturales de educación primaria para mejorar la educación ambiental. Se implementan dos unidades didácticas de energías renovables a través de un grupo de control que utiliza un método de aprendizaje tradicional y un grupo experimental que utiliza el método de gamificación y las TIC como recurso educativo. Mediante una metodología mixta se analizan datos de 36 alumnos de 6º de primaria, aplicando la prueba U de Mann Whitney, un cuestionario y observación sistemática. Se destaca que el trabajo e integración de la metodología de gamificación, a través de las TIC, no mejora significativamente el rendimiento académico. Sin embargo, se subrayan mejoras estadísticamente significativas en la satisfacción y motivación en los procesos de aprendizaje. Los resultados subrayan la necesidad de que los profesores reciban formación tecnológica y pedagógica para mejorar el uso de la tecnología en sus aulas.

Palabras clave: *innovación pedagógica, gamificación, TIC, ciencias naturales, educación ambiental*

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1. INTRODUCTION

The Information and Communication Technologies (ICT) have brought about a revolution in all areas and sectors of society, which is now considered the Information and Knowledge Society. Some authors indicate that the information and communication society mark the end of the industrial era and the beginning of the digital era (Barroso et al., 2007). Furthermore, today's society is heading towards a fourth industrial revolution where citizens will need digital competences (Williamson et al., 2019; Cedefop, 2019). Furthermore, Johnson et al. (2015) explain the importance of technological applications and future and emerging technologies (FET), as they are the background for new social and scientific challenges. Area & González (2015) indicates that the school must transform teaching materials as well as learning methodologies to respond to new teaching and learning needs.

As a result of the importance of digital competences, several organisations and institutions give a new approach to the education system, in which they list the basic competences and digital competences are included in all of them (European Commission, 2022; INTEF, 2017; OCDE, 2005; UNESCO, 2011).

In just a few months, COVID-19 has boosted the digital transformation to which the educational community was committed. This situation has given rise to network learning through different technological tools and has broken some of the characteristics of traditional education: unity of time, space, and action, among others. Therefore, teachers have had to act and make use of synchronous and asynchronous tools (Arruti et al., 2020; Council of the European Union, 2020; Ramírez-Montoya, 2020).

Consequently, ICT is a revolution for the concept of traditional education, as it allows the implementation of innovative actions in any educational environment and at any educational level (Salinas, 2008). Similarly, Yang & Kwok (2017) highlight the use of ICT to facilitate teaching and learning for both teachers and students. Salinas (2008) supports that teacher have a significant change in their role as they become facilitators and guides of the learning process. However, it is not only the teacher who experiences a role change, students take on a more active role in their teaching process, increasing their autonomy (Salinas, 2008).

Barroso et al. (2007) indicate that the use of ICT in education have some advantages, such as, wide range of information, creation of flexible learning environments, elimination of spatial and temporal barriers between teacher and students, increase of communicative competence, improve of interactive scenarios and environments, independent learning, self-learning and collaborative learning, new possibilities for student guidance and tutoring, lifelong learning and breaks with classical training scenarios, limited to school institutions.

On the other hand, gamification is understood as an innovative didactic strategy that incorporates game dynamics and structures, such as medals, missions, points… in non-game contexts (Alsawaier, 2018). Through the gamification method, the students become participants in a learning community, experimenting, exploring freely, and learning from mistakes in a pleasant environment (Brull & Finlayson, 2016). Contreras (2016) indicates that games contribute to experimenting with diverse identities, considering different options, drawing conclusions, and exploring the limits of the learner.

Games promote various competences, such as: motivation, communication, collaboration, attention, concentration, complex thinking, strategic planning, logical thinking, critical thinking, cognitive competences, and the internalisation of multidisciplinary knowledge (Kenny & McDaniel, 2011; Perrotta et al., 2013). Gamification also creates a relationship between learners and content from an innovative and different perspective (Hanus & Fox, 2015).

The teacher can use the gamification to enhance primary education knowledge through the educational contents of the game, thus using prior knowledge to consciously develop learning strategies of students (Paris et al., 1983). Therefore, play is self-generating and self-motivating and is the combination of several actions. Play is an activity shared between people, where participants play with a predisposition and follow established rules in the same way as in education (Contreras, 2016).

Cornellà (2019) points out that gamification is a methodology that improves the attitudes of people who participate in the experience, increasing their motivation and enjoyment. It also stresses that gamification is based on the use of game-related elements in non-game environments.

Likewise, Silva et al. (2020) highlight that gamification supported using ICT is currently being implemented and is obtaining positive results in teaching-learning process.

Therefore, the present study is implemented in the teaching of natural sciences in primary school, specifically in renewable, non-renewable resources and care for the environment since it is a subject and a compulsory topic in the science curriculum.

It also addresses the problem that this topic is most of the time taught through a traditional methodology, not encouraging its use in everyday life.

The following section describes the methodological aspects of the research carried out, and the third section shows the analysis of the findings. The paper ends with the discussion and conclusions section.

2. METHOD

2.1. Relevance of the study and research questions

The effect of gamification using ICT on the performance of primary school students is unclear. Therefore, this case study is conducted using a mixed quasi-experimental methodology that analyses the pedagogical aspects of classrooms that promote or inhibit learning in primary school students' education.

The general objective of this research is to analyse the impact of the pedagogical use of gamification and ICT in the teaching of natural sciences in the primary education classroom. Two other specific objectives emerge from this general objective:

a) To analyse whether there are significant differences in academic performance after the incorporation and use of gamification and ICT.

b) To find out pupils' satisfaction and motivation with the teaching-learning process.

2.2. Research design

This study consists of a mixed methodology research design in which traditional instruction is applied in the control group and the experimental group applies instruction designed according to gamification using ICT. In addition, a descriptive analysis of a questionnaire and systematic observation is carried out in both groups.

2.3. Educational context

The research is carried out in a charter school in Bizkaia, which is in the Basque Country, Spain. The school offers 3 levels of education: early childhood education, primary education, and compulsory secondary education. It has 40 teachers and 3 administrative staff. It educates 700 students and participates in the Bologna process, as it aims to achieve better standards in all areas of education. The primary school consists of 6 levels and each level has two classes (A-B). At school, students are trained to obtain the necessary scientific knowledge and competences. Therefore, all courses are carried out in accordance with the framework programme established by the Spanish Government. The duration of the academic year is determined in 3 sections of 3 months.

2.4. Course information

The research is carried out in two classrooms of 6th grade of primary education within the subject of Natural Sciences, which is taught for three hours a week. In the traditional classroom, learning is done through textbooks and direct instruction, while in the experimental classroom, is used the gamification method through ICT. With traditional teaching, students are expected to practice what they have learned in their everyday life without having put it into practice during teaching-learning. Through the experiential perspective, therefore, students put into practice the contents learned during the teaching-learning. Furthermore, the objectives of the course for both groups are to take awareness of the social responsibilities we must assume as citizens.

2.5. Participants

Two primary school classrooms are involved in the study, one class is chosen as the control group and the other as the experimental group. In neither case the students are informed about the method of instruction that they use. The sample consists of 36 students in total, 19 girls (52.78%) and 17 boys (47.22%), all between 11 and 12 years old. On the one hand, the control group has 18 students, of whom 10 are girls and 8 are boys. On the other hand, the experimental group consists of 18 students, of which 9 are girls and 9 are boys. It should be noted that all students own and use laptops during the lessons in the classroom and have access to various ICT tools (Gmail, Google Meet, Google Drive...). Random selection of students is not possible, as the school chooses two groups in the same year according to the equality of the groups: age, gender, motivation, previous experience in the subject, reading competences,

reading comprehension, communicative competences.... Therefore, the study sample is non-probabilistic and purposive.

As far as educational support needs are concerned, it should be underlined that no students need such support.

2.6. Instruments

On the one hand, the research uses a questionnaire created for this study that analyses three dimensions: academic performance, student satisfaction and student motivation. For academic performance, 7 closed-ended items with multiple-choice alternatives are used. These are nominal scale questions where the participant must choose one of the response alternatives. This type of questions facilitates the generation of quantitative data and the increase of the precision with participants report, reducing compression and singularity errors and controlling dispersion. In the satisfaction and motivation dimensions, 1 closed-ended item with an ordinal response alternative is used for each dimension, using a Likert scale (1 to 5) with 1 being strongly disagree and 5 being strongly agree. There are two questions based on a fixed scale, where each dimension is ordered in a sequence of arbitrary points from lower to higher intensity. Using this scale, the results are easily transformed into percentages and the tool provides descriptive data, based on a scale and using a quantitative approach. Creswell (2003) indicates that this type of research aims to describe individual experience in particular settings. As for the reliability calculated through the Cronbach's alpha coefficient in the questionnaire, it offers a 0.909, which is considered acceptable (Hair et al., 1998).

On the other hand, a qualitative approach is developed through the technique of systematic observation. With this research methodology it is possible to have direct access to what the students have experienced while carrying out the activities (Fuertes, 2011). According to Sáez-López & Cózar (2017) systematic observation is defined as a structured and intentional technique of looking at and examining data, objects, or phenomena without modifying them. This methodology is essential for fieldwork, as it is a way of extracting valuable data in the socio-educational context.

As for the reliability of this classification process, it is constituted by several questions to two teachers, thus, an independent certification of the classification with the same set of objects is ascertained. Therefore, an inter-rater reliability is involved by comparing their degree of agreement. The means used for this test is the measurement of Cohen's kappa, with the teacher (in each class) and the researcher as evaluator, considering the level of agreement. This kappa correlation value can vary from -1 to 1, so taking it into account, the ratters agree only to accept items above 0.60 in this research, so that all items below this value are eliminated. Cohen (1960) accepts values from 0.60 as acceptable and substantial.

2.7. Project implementation

In Spain, the curriculum framework is based on content, assessment criteria and learning standards in primary school (Ministry of Education, Culture & Sport, MECD, 2014) and key competences throughout life (European Commission, 2018). The project has considered the regulatory framework and curricular elements.

This study is considered to use an innovative methodology, as it uses a mixed methodology to analyse the development of scientific competence through gamification and ICT in primary education. In addition, the study involves prior work on the analysis of specific student needs and change processes aimed at improving teaching and learning.

The research is carried out in two classrooms of 6th grade of primary education, during the 2018-2019 academic year. In each classroom, 5 sessions of 50 minutes are carried out in the natural science curriculum area. The two interventions are carried out in Basque. Several authors indicate that it is advisable to use a student-centred teaching methodology (Ausubel et al., 1983) based on collaborative learning (Johnson, 2003), assuming roles and encouraging active and dynamic work in the classroom.

The contents taught in the two groups are the same: renewable and non-renewable energies and care for the environment. On the one hand, in the control group, learning is carried out using traditional methodology, through reading the contents of the programme on their laptops and direct instruction. The students read and listen to the material and complete the appropriate worksheets in the 5 sessions.

On the other hand, in the experimental group, learning is carried out through an innovative methodology using gamification and ICT. This methodology makes it possible to share content through ICT and introduces the ability to work with multimedia elements and games, thus facilitating the work of the contents. The following link shows the implementation of the didactic unit of the experimental group with the gamification methodology: https://itzi-miranda.wixsite.com/lurra/portafolio (Miranda-Urqujo, 2018). Finally, with the multimedia platform, the interactive possibilities are more enriching, as students always play and work with their peers.

Table 1 below present the sessions and contents of the control and experimental groups:

Table 1
Sessions and contents of the control and experimental groups

Session (50 min) Control group	Contents
1st session (Traditional method)	Presentation of the project
	Reading the introduction contents
2nd session (Traditional method)	Energy resources:
	Reading the contents on the laptops
	Exercises in the notebook
3rd session (Traditional method)	Environmental issues and their solutions:
	Listening of a content to the teacher
	Reading the contents on the laptops
	Exercises in the notebook
4th session (Traditional method)	Solutions to environmental issues:
	Listening of the problem to the teacher
	Reading the description of the causes of the problem on the laptops
	Proposing solutions in the notebook
5th session	Completion of the questionnaire

Session (50 min) Experimental group	Contents
1st session (Gamification method)	Presentation of the project and the website
	Reading the story and rules
	Creation of characters
	Familiarisation with the website
2nd session (Gamification method)	Energy resources (website):
	Initial comic reading
	Carrying out the activity of mission 1 (individual)
	Watching the video
	Carrying out the activity of mission 2 (group)
3rd session (Gamification method)	Environmental issues and their solutions (website):
	Carrying out the activity of mission 1 (watching the video and answering the questions)
	Carrying out the Kahoot
	Carrying out the activity of mission 2 (group)
4th session (Gamification method)	Solutions to environmental issues (website):
	Description of the problem
	Description of the causes of the problem
	Proposing solutions
5th session	Completion of the questionnaire

3. RESULTS

This chapter shows the results obtained in the three dimensions and the systematic observation mentioned in the methodology, bearing the control group and the experimental group. The SPSS (Statistical Package for Social Sciences) and Excel tools were used for data typing, analysis, and presentation.

3.1. Academic performance dimension 1

As for statistical inference in the dimension of academic performance, a non-parametric test is applied to analyse independent samples. The data obtained from a comparison of means in terms of correct items of the control group and the experimental group are also evaluated (table 2). It should be noted that this dimension has 7 items, which means that the maximum score is 7 correct items, equivalent to a 10. It can be seen from this table that the control group obtains an average of (4.889) and the experimental group obtains a higher average of (5.333). This table also shows the standard deviation of each group:

Table 2

Means of the correct items of both groups

Group statistics					
	Group	N	Mean	Std. Deviation	Std. Error
Correct items	Control Group	18	4.889	1.491	.351
	Experimental Group	18	5.333	1.283	.303

Likewise, through this instrument, Cohen's d is obtained for the academic performance dimension, which is (0.320) (Table 3). Thus, the effect size of the independent samples in this dimension is large (Cohen,1998).

Table 3

Effect size

Effect size					
				95% confidence interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Correct items	Cohen´s d	1.391	-.320	-.975	.340
	Hedges´correction	1.423	-.312	-.953	.333
	Glass´s delta	1.283	-.346	-1.005	.322

Furthermore, in terms of statistical inference in this dimension, a non-parametric test is used analysing independent samples and assessing the differences of the control group and the experimental group by means of the Whitney Mann U test which has a value of 137.500, a Z value of -.797 (table 4). In summary, the significance of 0.425 is greater than 0.010 which is the reference significance level in this research. Based on these data, it is emphasised that there are no significant differences with respect to academic performance, so the null hypothesis is accepted, in other words, it is not detected that the use of gamification methodology and ICT improves academic performance.

Table 4

Whitney academic performance, Ranks. Whitney Mann U test

CG-EG	N	Mean Rank	Sum of Ranks
Control	18	17.140	308.500
Experimental	18	19.860	357.500
Total	36		

The number of correct items performed by each group is presented in the following figure (figure 1).

Figure 1.

Level of the academic performance of each group

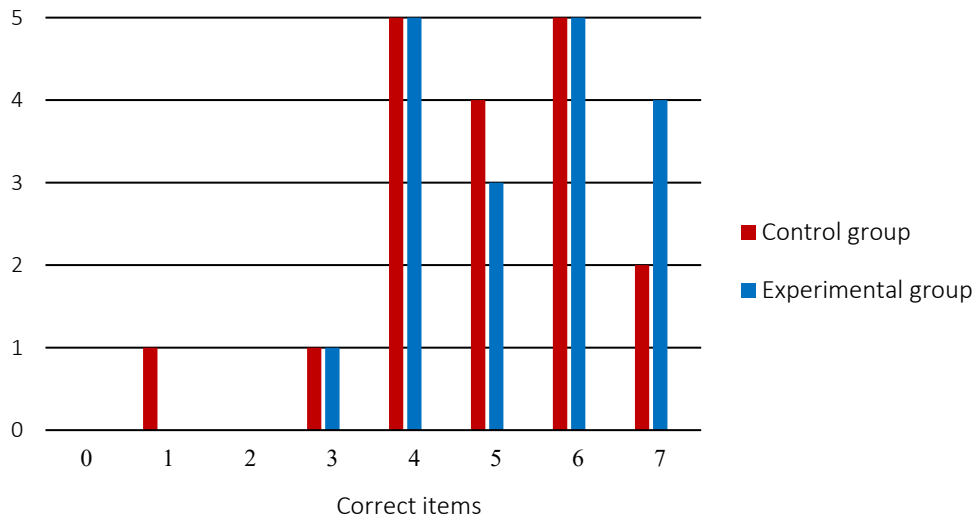


Figure 1 shows that in the experimental group all students get between 3 and 7 items correct, which means that 100% of the students obtain good results in the final questionnaire and pass it. On the contrary, in the control group one student gets 1 item correct, that is, one student fails the questionnaire. In both groups, the trend is to obtain 4 or 6 correct items. However, in the experimental group, 4 students got 7 items correct, in other words an "A". Therefore, although there are no statistically significant differences, significant improvements in academic performance can be seen through the gamification methodology and ICT.

3.2. Satisfaction dimension 2

As in the previous dimension, a comparison of means is used to extract the means of satisfaction of the control group and the experimental group (table 5). This dimension consists of 1 Likert scale item (1 not at all satisfied and 5 totally satisfied). Thus, the control group obtains a mean of (3.389) and the experimental group obtains a higher mean of (4.222). This table also shows the standard deviation of each group.

Table 5

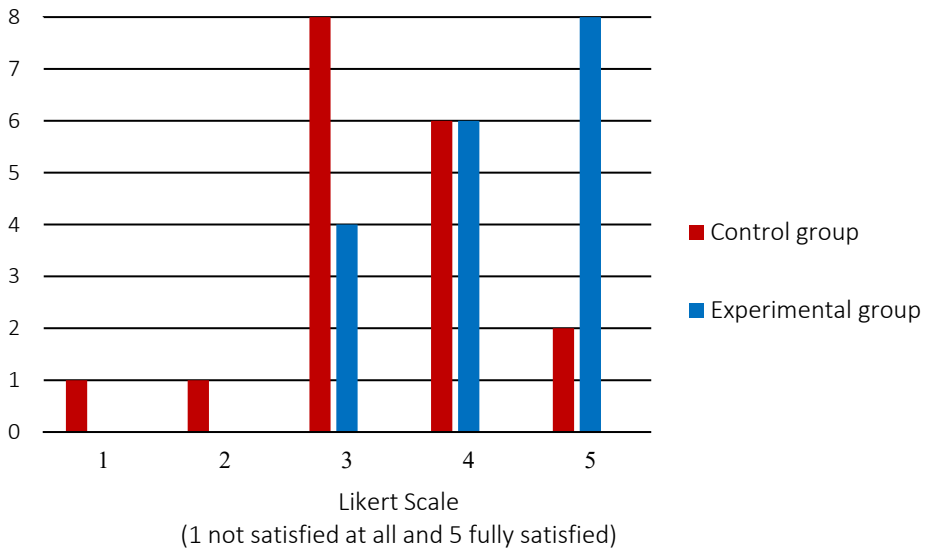
Means of the satisfaction of both groups

Group statistics					
	Group	N	Mean	Std. Deviation	Std. Error
Satisfaction	Control Group	18	3.389	.979	.231
	Experimental Group	18	4.222	.808	.191

Figure 2 shows the data on the level of student satisfaction with the methodology used.

Figure 2

Level of the satisfaction of each group



In the figure 2, two students from the control group are not satisfied with the methodology, as they give a score of 1 and 2. In general, the students in this group indicate a 3 on the Likert scale in terms of satisfaction with the methodology. Moreover, in the experimental group, none of the students indicated that they strongly disagreed with the satisfaction of the methodology used. In general, the students indicate a 5 on the Likert scale. Consequently, many of them express that they are very satisfied with the methodology used. Thus, it should be noted that in the experimental group, 100% of the students provide positive values regarding satisfaction with the use of gamification through ICT.

The values shown in this dimension by the experimental group are sufficiently positive in contrast to the control group. Therefore, from a descriptive approach, the use of the research described by the students is valued very positively, enabling them to approach contents with a dynamic, useful, and satisfactory approach.

In addition, through the Whitney Mann U test, the significance obtained is 0.010 which is the same as 0.010, thus a statistically significant advance is indicated in the same, so that the students have a higher degree of satisfaction when carrying out the mentioned practices.

3.3. Motivation dimension 3

In the same way as in the previous dimensions, a comparison of means is used to obtain the motivation means of the control group and the experimental group (table 6). This last dimension consists of 1 Likert scale item (1 not at all motivated and 5 completely motivated). The control group achieves a mean of (4.578) and the experimental group achieves a higher mean of (7.550). Table 6 below shows the standard deviation of each group.

Table 6

Means of the motivation of both groups

Group statistics					
	Group	N	Mean	Std. Deviation	Std. Error
Motivation	Control Group	18	3.111	1.023	.241
	Experimental Group	18	4.167	.707	.167

Figure 3 highlights the data obtained on the level of motivation of the students regarding the methodology used.

Figure 3

Level of the motivation of each group

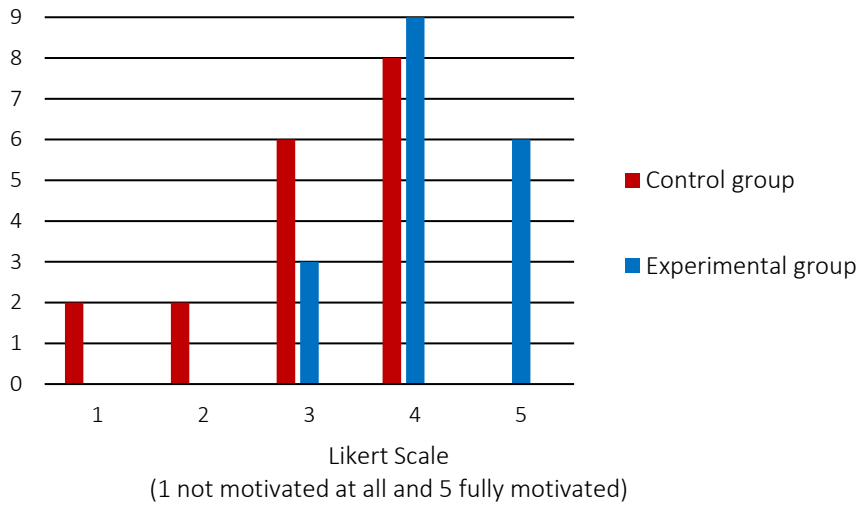


Figure 3 shows that the students in the control group agree completely and most students mark this question with a 4, considering the motivation of the. In the experimental group none of the students indicate a complete disagreement, most of the students mark the motivation of the methodology with 4 and three students mark this question with a 5. Furthermore, it is underlined that in the experimental group 100% of the students indicate positive values in relation to the motivation of the use of gamification through ICT.

Usually, the values stated in this dimension by the experimental group are quite positive in contrast to the control group. Therefore, from a descriptive approach, the integration of the described intervention by the students is positively evaluated, favouring the implementation of contents with an active, fun, and motivating approach.

By means of the Whitney Mann U test, a significance of 0.000 is obtained, being less than 0.010 and thus indicating a statistically significant improvement in the same, so that the students optimise their motivation when carrying out the mentioned practices.

3.4. Systematic observation

This research uses the systematic observation, where the researcher collects data throughout observation of the educational intervention.

The observation units of the checklists are related to the research indicators: active learning, renewable and non-renewable energy content and care for the environment, usefulness, fun, group work, performance, evaluation, and results. As a result, the values of the tool are consistent with the dimensions, indicators, and items of the administered questionnaire. The values for active learning and content are above 7, while usefulness has a value of 8. The highest value of 9 is related to fun.

In the same way, through systematic observation, the information acquired is confirmed, since the experimental group is more predisposed during the didactic unit (motivated, active participation, collaborative etc.) and achieves better results in all the dimensions. Some examples that confirm this information are while carrying out the various activities, all the members of the groups help each other and are very encouraged. There is also a healthy competitiveness among the groups, as everyone wants to get a high score. For this reason, it is underlined that the experimental group is more motivated throughout the didactic unit and promotes personal satisfaction and gamification through ICT.

4. DISCUSSION AND CONCLUSIONS

As Silva et al. (2020) indicate, gamification supported using ICT achieves positive results. From a data triangulation of the results shown, the findings are concluded in a structured way:

- There are no statistically significant improvements in academic performance (dimension 1).
- There are slight improvements in academic performance (dimension 1).
- Statistically significant improvements are noted in relation to students' satisfaction (dimension 2).
- Statistically significant improvements stand out in relation to students' motivation (dimension 3).
- Students value positively the use and integration of gamification and ICT (figure 2, figure 3 and systematic observation).

The study confirms that students who use the experimental methodology based on gamification and ICT improve their results with respect to the control group, but the differences are not significant. Therefore, it does not certify that the practice of this method completely overcomes the traditional approaches of the control group. In contrast, in the other two dimensions of satisfaction and motivation, a clearly significant improvement is underlined. The systematic observation underlines that in the experimental group, it is particularly significant

the active participation centred on the pupils working in groups on the contents, carrying out the various missions, describing the causes of the problems, proposing solutions, etc.

It should be noted that slightly improvements are achieved in the recognition of the contents of renewable and non-renewable energies and care for the environment, carrying out activities through ICT, collaborative activities etc. For example, due to the game, pupils understand the origins and negative actions of human beings regarding the environment. Also, through group work, pupils help each other in case of doubts, exchanging information and discussing. As a result, the pupils investigate first-hand, reflect, and engage in meaningful and self-directed learning. Therefore, gamification methodology promotes various competences in the students, such as, collaboration, critical thinking, communication etc. (Kenny & McDaniel, 2011; Perrotta et al., 2013).

It should be emphasised that the materials are favourable to the teaching-learning process. This methodology also promotes fun, motivating, and satisfactory work sessions for the pupils, encouraging group work, analysis, and exploration of the care of the environment, of the contents of the area of natural science (Brull & Finlayson, 2016; López & Lizcano, 2022).

In conclusion, no significant improvements in academic performance are estimated when applying gamification and ICT. However, other very important advantages are highlighted in relation to motivation, satisfaction, fun, interest in playing the game and usefulness of the materials used from a pedagogical perspective. The benefit of the online game and the interactions with students through ICT promote the understanding of the relevance of the environment. In this sense, teachers should receive training in technology together with pedagogical competences to improve the use of technology in their classrooms (Blasco-Serrano et al., 2022; Gisbert-Cervera et al., 2022; Wang et al., 2018).

It should be noted that the main limitation of the study is the sample, as it consists of a small number of participants. Therefore, a similar study with a larger sample should be carried out as a future prospect.

Finally, it is time to address gamification and ICT in the context of primary education. Moreover, the combination of learner-centred methodologies with attractive resources is an exceptional opportunity for educational transformation in the 21st century. Several authors highlight that in the digital era, knowledge in the classroom relates to ICT: educational apps, tablets, computers etc. (Dussel & Quevedo, 2011).

5. REFERENCES

Alsawaier, R. S. (2018). The effect of gamification on motivation and engagement. *The International Journal of Information and Learning Technology, 35*(1), 56-79. https://doi.org/10.1108/IJILT-02-2017-0009

Area, M. & González, C. S. (2015). De la enseñanza con libros de texto al aprendizaje en espacios online gamificados. *Educatio Siglo XXI, 3*, 15-38. https://doi.org/10.6018/j/240791

Arruti, A., Paño-Castro, J., & Korres, O. (2020). Análisis de contenido de la competencia digital en distintos marcos legislativos. *Aloma, 38*(2), 149-159. https://doi.org/10.51698/aloma.2020.38.2.149-156

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1983). *Psicología Educativa. Un punto de vista cognitivo*. Trillas.

Barroso, J., Cabero, J., Castaño, C., Llorente, M. d. C., Romero, R., & Román, P. (2007). *Diseño y producción de TIC para la formación.* UOC. https://bit.ly/3tiA2wa

Blasco-Serrano, A. C., Bitrián, I., Coma-Rosello, T. (2022). Incorporation of ICT into preservice teacher training using the Flipped Classroom so as to enhance inclusive education. *Edutec. Revista Electrónica de Tecnología Educativa,* (79), 9-29. https://doi.org/10.21556/edutec.2022.79.2393

Brull, S., & Finlayson, S. (2016). Importance of gamification in increasing learning. *The Journal of Continuing Education in Nursing, 47(8),* 372-375. 10.3928/00220124-20160715-09

Cedefop (2019). *Continuing vocational training in EU enterprises*: *developments and challenges ahead.* Luxembourg Publications Office. https://doi.org/10.2801/704583

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*(1), 37-46. https://doi.org/10.1177/001316446002000104

Cohen, S. (1998). Psychosocial models of the role of social support in the etiology of physical disease. *Health Psychology, 7*(3), 269-297. 10.1037/0278-6133.7.3.269

Contreras, R. S. (2016). Juegos digitales y gamificación aplicados en el ámbito de la educación. *RIED. Revista Iberoamericana de Educación a Distancia, 19*(2), 27-33. https://doi.org/10.5944/ried.19.2.16143

Cornellà, P. (2019). Gamificació de l´aprenentatge a la formació inicial de mestres. Reptes, pistes i claus per a desbloquejar methodologies [Doctoral thesis]. University of Girona. https://bit.ly/3RG5Ogw

Council of the European Union (2020). Council conclusions on countering the COVID-19 crisis in education and training 2020/C 212 I/03. *Official Journal of the European Union*, 212, 9. https://bit.ly/3zUTeo1

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approach.* Sage Publications.

Dussel, I., & Quevedo, L. A. (2011). *Aprender y enseñar en la cultura digital*. Fundación Santillana del Mar. http://bit.ly/2M9h34e

European Commission. (2022). *DigCompOrg Framework.* EU Science Hub https://bit.ly/3n8G6Ul

European Commission. (2018). *Proposal for a council recommendation on Key Competences for Lifelong Learning.* European Commission. https://bit.ly/3RD1iiO

Fuertes, M. T. (2011). La observación de las practicas educativas como elemento de evaluación y de mejora de la calidad en la formación inicial y continua del profesorado. *Revista de Docencia Universitaria, 9*(3), 237-258. https://doi.org/10.4995/redu.2011.11228

Gisbert-Cervera, M., Usart, M., & Lázaro Cantabrana, J. L. (2022). Training pre-service teachers to enhanced digital education. *European Journal of Teacher education.* https://doi.org/10.1080/02619768.2022.2098713

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Prentice Hall.

Hanus, M., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education, 80,* 152-161. 10.1016/j.compedu.2014.08.019

INTEF (2017). *Organizaciones Educativas Digitalmente Competentes.*

Johnson, D. W. (2003). Social interdependence: interrelationships among theory, research, and practice. *American Psychologist, 58*(11), 934-945. https://doi.org/10.1037/0003-066X.58.11.934

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015). *NMCHorizon Report: 2015 K-12 Edition*. The New Media Consortium. https://bit.ly/3HAzOGN

Kenny, R., & McDaniel, R. (2011). The role teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms. *British Journal of Educational Technology, 42*(2), 197-213. https://doi.org/10.1111/j.1467-8535.2009.01007.x

López, E. K., & Lizcano, R. N. (2022). Flipped Classroom para el Desarrollo de competencias digitales en educación media. *Edutec. Revista Electrónica de Tecnología Educativa,* (79), 182-198. https://doi.org/10.21556/edutec.2022.79.2453

Ministerio de Educación y Cultura y Deporte, MECD (2014). *Real Decreto 126/2014, de 28 de febrero, por el que se establece el currículo básico de la Educación Primaria.* https://bit.ly/3Qx0ex8

Miranda-Urquijo, I. (2018). Eta zuk lurra aldatzen al duzu? https://bit.ly/3RlHOPW

OCDE. (2005). *La definición y selección de competencias clave.* OCDE. https://bit.ly/3n0F90j

Paris, S., Lipson, M., & Wixson, K. (1983). Becoming a Strategic Reader. *Contemporary Educational Psychology, 8,* 293-316. https://doi.org/10.1016/0361-476X(83)90018-8

Perrotta, C., Featherstone, G., Aston, H., & Houghton, E. (2013). *Game-based Learning: Latest Evidence and Future Directions.* National Foundation for Educational Research. https://bit.ly/3y5Ozhw

Ramírez-Montoya, M. S. (2020). Transformación digital e innovación educativa en Latinoamérica en el marco del COVID-19. *Campus Virtuales, 9*(2), 123-139. https://bit.ly/39EaBi1

Sáez-López, J. M., & Cózar, R. (2017). Programación visual por bloques en Educación Primaria: Aprendiendo y creando contenidos en Ciencias Sociales. *Revista Complutense de Educación, 28*(2), 409-426. http://dx.doi.org/10.5209/rev_RCED.2017.v28.n2.49381

Salinas, J. (2008). *Innovación educativa y uso de las TIC*. UNIA. https://bit.ly/3n4U6yK

Silva, R., Rodrigues, R., & Leal, C. (2020). Gamification in management education-A literature mapping. *Education and Information Technologies, 25*(3), 1803-1835. 10.1007/s10639-019-10055-9

UNESCO. (2011). *UNESCO ICT Competency Framework for Teachers.* UNESCO https://bit.ly/39CbZBR

Williamson, B., Potter, J., & Eynon, R. (2019). New research problems and agendas in learning, media and technology. *Learning, Media and Technology, 44*(2), 87–91. https://doi.org/10.1080/17439884.2019.1614953

Yang, S., & Kwok, D. (2017). A study of students' attitudes towards using ICT in a social constructivist environment. *Australasian Journal of Educational Technology, 33*(5), 50-62. https://doi.org/10.14742/ajet.2890

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