Use of Gamification to Approach the Algebraic Language and Equations in 1st Grade of Secondary Education

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Active methodologies, as innovative agents, are becoming more and more frequent in education, but they are not a majority. However, it is a good resource to adapt the educational system to the current society based on knowledge and information.

This article shows a useful and effective tool to connect with the needs and interests of students through an active methodology. The proposal, a gamification (teaching-learning methodology based on the mechanics of games), approaches the students of 1st grade of secondary education to the algebraic language and equations, combining cooperative learning activities.

Working through gamification means a higher academic performance, an increase in motivation and the development of a positive attitude allowing, in addition, to attend to diversity in the classroom and the use of ICT promoting collaborative work.

Gamification, based on the use of ICT, facilitates the acquisition of knowledge in a more attractive way, favoring their performance.

Keywords: active methodology, gamification, motivation, diversity, ICT

INTRODUCTION

Society is immersed in a process of continuous transformation, whose changes affect all areas, including education. In general, the influence of technology has profoundly affected social and economic reality. The educational system, and the education it provides, is a dynamic system that adapts to change in order

to continue fulfilling its commitment to educate new generations of citizens. Within this knowledge society, mediated by technology, mathematics teaching and learning processes are an essential part of citizenship education. Advancing in a paradigm based on the development of complex competencies demands the use of new teaching methodologies that are supported by the new resources and didactic materials available.

In the field of mathematics, teacher training plays an important role. Student learning "depends, in an essential way, on teacher training" (Font, 2011, p.11). Teacher training includes, in addition to in-depth knowledge of the subject matter, training of a pedagogical nature, following Shulman's PCK model. Technology is added to the teaching-learning process, understood as a resource for access to knowledge and as a means for the development of digital competence. These are the maxims of the TPACK Model exposed by Mishra and Koelher, in which they highlight the relationship of technological knowledge with the didactic knowledge of the content (Shulman, 1986, cited in Arce, Conejo and Muñoz, 2019). In addition to this training, didactic intentionality plays an important role, since the "greater integration and intention the teacher has of the characteristics of mathematical knowledge and its didactification, there will be a better response in the process of teaching and learning mathematics" (Hernández & Lizarde, 2016, p. 8). All these elements, typical of teacher training, are key to respond to the social demand of providing future citizens with a deep mathematical learning and a healthy emotional relationship towards the subject.

Throughout this paper, we will focus on the current state of gamification, as well as on concrete ways of using it in a classroom. This methodology is based on the use of games to reinforce and motivate classroom work. It requires dynamic sessions with game mechanics and components with a story that serves as a common thread, rules that govern the game, a detailed record of the tasks and scores that allow feedback. This promotes and increases student motivation, as well as meaningful learning, which produces an increase in the performance of the teaching-learning process. This methodology is not a simple gamification, but the use of the game for "the development of effective teaching-learning processes, which facilitate cohesion, integration, motivation for the content, enhancing the creativity of individuals" (Marín-Díaz, 2015, p.1).

This methodology has many benefits. In terms of process, gamification creates a safe learning environment, since its dynamic is based on initiative and decision making. Risk is not perceived as a negative factor, quite the contrary. As for the player (student), they are immersed in a feedback process, since they are informed at all times about their progress, i.e., they know the progress made in the game. In terms of performance, it develops social skills by taking place in a cooperative environment (Carrión, 2019).

Some authors point out the existence of difficulties in the use of gamification. They point out the warning that motivation is offered through a system of prizes or rewards that can be negative by affecting the emotional part (Domínguez, et al., 2013). For the same reason it should be controlled that excessive competitiveness, transient motivation or the risk of working only for the reward, coming to create a negative attitude towards the subject itself (anxiety) should not occur (Posada, 2017).

However, the improvement of academic results when working with the basic elements of gamification (roles, prizes, levels, achievement of challenges, rewards…) is recognized by several authors, such as Ferrer (2013) or Kumar and Khurana (2012). The implementation of gamification at different levels, subjects and centers has corroborated the increase in motivation, content mastery, emotion management, interest and predisposition to new learning by students.

This contribution addresses the implication of the use of gamification in the new challenges arising from the ongoing educational change.

The objectives of the project are to provide an approximation of the use of gamification in the classroom at present and, subsequently, to present a proposal of this methodology contextualized in the field of mathematics.

This paper contains a first part, where we question whether gamification is a methodology commonly used in the Spanish educational system. We will focus on education in Spain, as it is a country that in recent years has carried out solid educational reforms with the intention of adapting to the forefront of pedagogical and technological ideas in education. We consider, therefore, that the results obtained are applicable to other countries with situations and laws similar to the Spanish case. Once we have a concrete measure of the use of gamification in the classroom (we will see that this level of use is modest), a concrete and contextualized

gamification proposal will be carried out, with the aim of making this proposal more accessible to teachers who are thinking of implementing this methodology.

RESOURCES AND METHODS

First, it is necessary to address the level of use of gamification in the classroom. We address the essential question of whether gamification is a widely used methodology in education, or whether there is still room for improvement in its implementation. The resource used to study the current state of the use of gamification in secondary education with Spanish curriculum has been the data collected within the Observatory of Educational Innovation (OIE, in Spanish) attached to the Distance University of Madrid (UDIMA, in Spanish) through a computerized survey conducted to 686 students (teachers in training) studying the specialty of mathematics of the Master of Teacher Training after their period of classroom practice in a regulated center of Secondary Education; questionnaire reviewed and validated by independent experts and professors of the Faculty of Education of the Distance University of Madrid. The questions posed are supported by the constructivism paradigm that forms a fundamental structural theory, as required in this type of questionnaire (Marsh 1997). This approach has allowed us to know specific information about educational innovation, in particular, of the use of gamification methodology observed in the different semesters (September-January and February-June) during the period September 2019 to June 2022.

It is worth mentioning that such students and trainee teachers must carry out an internship phase in an educational center of their free choice, but always subject to the regulations imposed by the university to ensure the homologation of the center. From here, the trainee teachers observe the reality existing in an educational center, carrying out a process of assimilation with the different concepts they have learned during their theoretical training. The fact that the practical phase is carried out in the last year of their training enables the impartial validity of the observations. The teachers in training have the capacity to be critical, to apply their previous experiences and conceptions in an open manner, as they are impartial observers not attached to the institution by any contractual record.

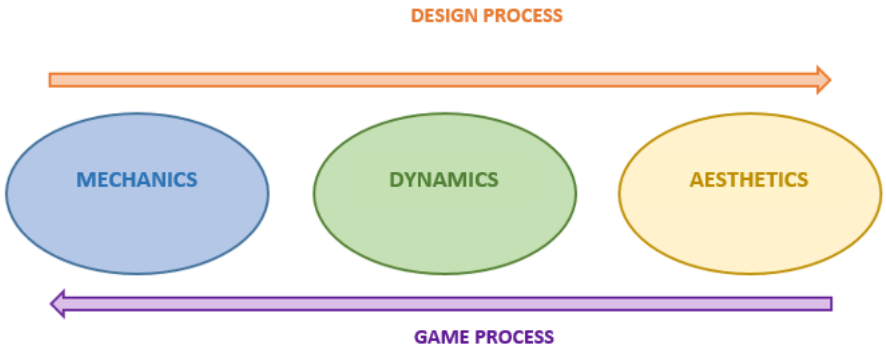
It is important to mention that prior to the elaboration of the questionnaire proposed by the OIE, trainee teachers should make a reflection exercise to recall their previous experiences (specifically their relationship with gamification) in school mathematics. The use of memories, as a source of truthful research, has been widely considered by other investigations, resulting in conclusions of interest to the educational community. Specifically, and in this sense, we can cite the works of Blanco and Barrantes (2003), Gómez, Rodríguez and Mirete (2018), Miller and Shifflet (2016) or Parra (2019).

In order to analyze the use of gamification methodology, the trainee teachers had to answer about the use of such methodology according to the corresponding percentage of use, that is:

- I have not seen gamification as part of the methodologies used.
- I have seen some challenges being worked with but not meeting some of the characteristics of gamification.
- I have seen gamification used on an ad hoc basis (<25%).
- I have seen gamification used in a significant number of sessions (>25% and <75%).
- I have seen gamification used in the majority of sessions (>75%).

Based on the above description of data collection, we will have a current metric on the use of gamification in the classroom (we will see that the use is modest). Then, in response, we will propose an educational methodology based on gamification contextualized in the introduction of algebra in the first year of secondary education and designed on the Classcraft digital platform. With the use of technology, we intend to make students develop collaboration since it will be the whole community that participates for the achievement (Lee and Hammer, 2011, cited in Rey-Lorenzo and Vázquez-Abal, 2020). All this will induce them to enter into the mechanics of the game (Figure 1).

FIGURE 1
NECESSARY ELEMENTS FOR A CORRECT GAMIFICATION



Note: Prepared by the authors.

According to EduTrends (2016), the different elements of the game enhance different factors of the teaching-learning process, which may be determined in different elements of the assessment, as shown in Table 1.

TABLE 1
SUPPORT OF GAME ELEMENTS TO THE EVALUATION

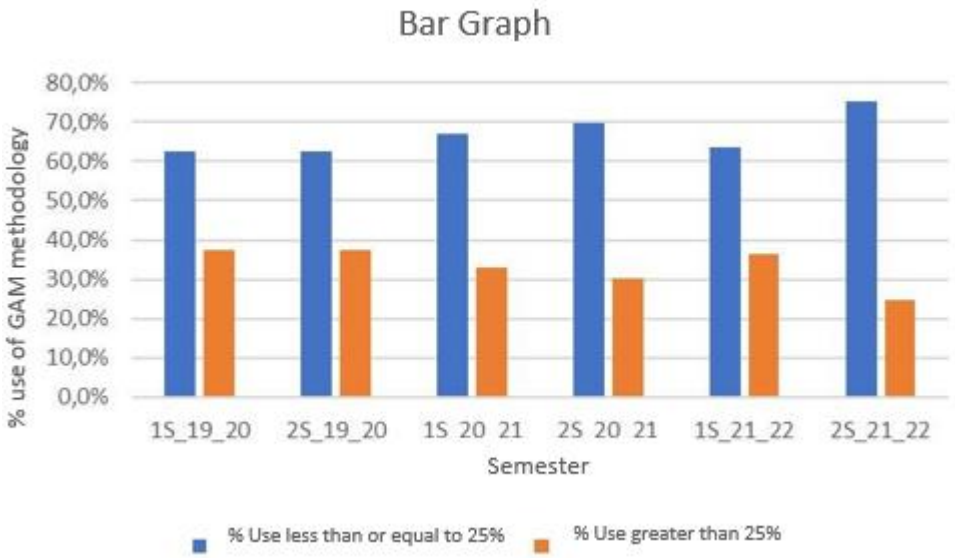
Game Elements	How do they support in the assessment?
Challenges, missions, quests	They demonstrate the ability to apply knowledge and perform specific tasks.
Narrative	It promotes the learning of declarative content and the association of two or more concepts, ideas, or facts.
Game rules & restrictions	They allow for demonstrating attitudes such as respect and honesty.
Choosing between different paths/routes	It encourages the demonstration of skills such as decision-making, problem-solving, and creativity.
Multiple opportunities to complete a task, multiple lives, checkpoints or restart points	They promote the development of specific skills or mastery of knowledge. They demonstrate attitudes like resilience and tolerance for frustration.
Teams, role-playing, battles	They foster collaborative work, problem-solving, leadership, and decision-making.
Experience points, levels, progress bars, and access to locked content	They provide information about students' progress towards achieving objectives, knowledge acquisition, or its application.
Badges, levels, points, achievements, earned outcomes	They demonstrate the acquisition of skills and mastery of knowledge.
Countdown	It's useful for evaluating process efficiency, resource optimization, decision-making, and problem-solving.

Note. adapted from "Gamification" (p. 13), by Observatorio de Innovación Educativa, 2016, *EduTrends*, *9*.

RESULTS

According to the results obtained after the descriptive analysis of the data collected and after categorizing the different options, it is necessary to establish a criterion to discern when gamification has been observed in a significant way. In this way, we consider that gamification methodology is used whenever the observer has determined that its use is greater than 25%. This level of 25% has been selected based on a balance between two effects: 1) it has been observed that the implementation of gamification in the classroom is modest, so that increasing the value of meaningful use above 25% may lead to a low representativeness of the data obtained; 2) our objective is to measure the use of gamification, so the value of 25% is considered valid for these purposes, by providing values that enable further discussion. As can be seen in Figure 2, the % use of gamification, observed at a percentage higher than 25%, from the first semester of academic year 2019-2020 to the corresponding semester of academic year 2021-2022 has been around 34% on average. We also show a significant decrease in the last data recorded (second semester of the academic year 2021/22) reaching a value of 24%.

FIGURE 2
RECORD OF GAMIFICATION USE IN THE CLASSROOM BY SEMESTERS



To facilitate their interpretation, the different response options have been categorized in order of percentage of use observed being 1 “I have not seen gamification being part of the methodologies used”, 2 is associated with “I have seen how work was done with some challenges but without fulfilling some of the characteristics of gamification.”, 3 “I have seen gamification being used on an ad hoc basis (<25%).”, 4 “I have seen gamification being used in a significant number of sessions (>25% and <75%).” and 5 “I have seen gamification being used in the majority of sessions (>75%).”, respectively.
Source: Educational Innovation Observatory. Use of Gamification methodology.

Development of the Gamification Proposal

The objective of this section consists of the development of a gamification proposal, based on the aforementioned benefits of the use of this methodology, and according to the reality of the classrooms which, on the other hand, were the source of the data presented in the previous section. A gamification that combines cooperative learning with the use of digital resources is proposed and developed to be applied at the level of 1st grade of secondary education, for the acquisition of knowledge of algebraic language and equations with the aim of responding to the needs demanded by the current students. The selection of this course and this specific content, respond to an issue widely addressed in the educational field related to the impact of the transition from arithmetic to algebra (Gavilán-Bouzas, 2011 and Martínez-Suárez, et al, 2019).

The proposal is based on the realization of a route between different islands presented under a scenario created in ClassCraft 2021 whose aesthetics is very similar to that of a video game (see Figure 3), trying to capture the students' attention.

FIGURE 3
ALGEBRAIC ISLANDS MISSIONS

Note. Adapted from *Algebraic Islands*. *Missions*, by Classcraft Incl., 2021.

The journey will be completed after overcoming the five different missions in their respective islands (Expressions Island, Monomials Island, Equalities Island, Equations Island and Problems Island), in each of them, you will work on a specific content within the selected algebra block. The system of scores, prizes, rewards and penalties established for each of the missions will be based on the specific dynamics of the game.

The route should be carried out according to an established order. In the first session, the teacher will indicate the objective of the game, the elements they have and how they should move and work in it.

Classcraft sessions do not have to take up all the time of each class (50 minutes), nor do they always have to take place in the classroom. They are flexible, and can be proposed as homework. However, to ensure the effectiveness of the gamification and that it is not used anecdotally, the gamification has been designed so that it can be developed in full class sessions, in 14 sessions as shown in Table 4 of Appendix 1.

Within each of them, one or several tasks can be performed, depending on the design and content of the same. Although, by regulation, the mathematical competence to be worked in the content block corresponds only with the mathematical competence (CMCCT (mathematical competence and basic competences in science and technology, in Spanish)), although it is clear that we also encourage the development of transversal competences and autonomous learning according to Decree 86/2015.

Mission 1 introduces students to the use of algebraic expressions. Mission 2 does the same with the knowledge and operation of monomials. Then, the next mission works on the concept of equality, and mission 4 works on equations, both in concept and in their handling and operation. Finally, mission 5 proposes to the students different contextualized problems in which they must develop the concepts learned throughout the gamification.

The missions are arranged under the following headings: introduction, tasks, and end of objective. The introduction is the narrative that explains each mission objective to the students.

In each of the missions five tasks are proposed, whose order of completion is marked by a specific itinerary guiding the students in complexity and content, providing the material and supporting documentation. The tasks are adjusted to the contents and acquisition of competences with a last task for the students to self-manage their learning process, serving as a self-evaluation. The tasks are evaluated by means of a scoring system based on the achievements.

To all this, we must add that each student can design their own avatar and can be: guardian, healer or mage. Each of them has different characteristics and abilities, which will differ in experience points and life points, so that the guardians will have more life points than the healers, but not as much energy; the mages have balanced life and experience points with the possibility of helping the rest of the team.

The development of the activities will be cooperative in most cases, being the teacher the one who configures the groups. Activities between groups are included at the teacher's choice depending on the characteristics of the groups involved.

A detailed access process and functionality of the tool used for its development is presented in Appendix 2.

Teaching Work

The teacher will be the one to define the content of the game, and give the students access to participate in it. The students will be able to select an avatar that defines them, not only by their physical appearance, but also by the qualities they have, which will be different depending on whether they choose the role of healer, mage, or guardian.

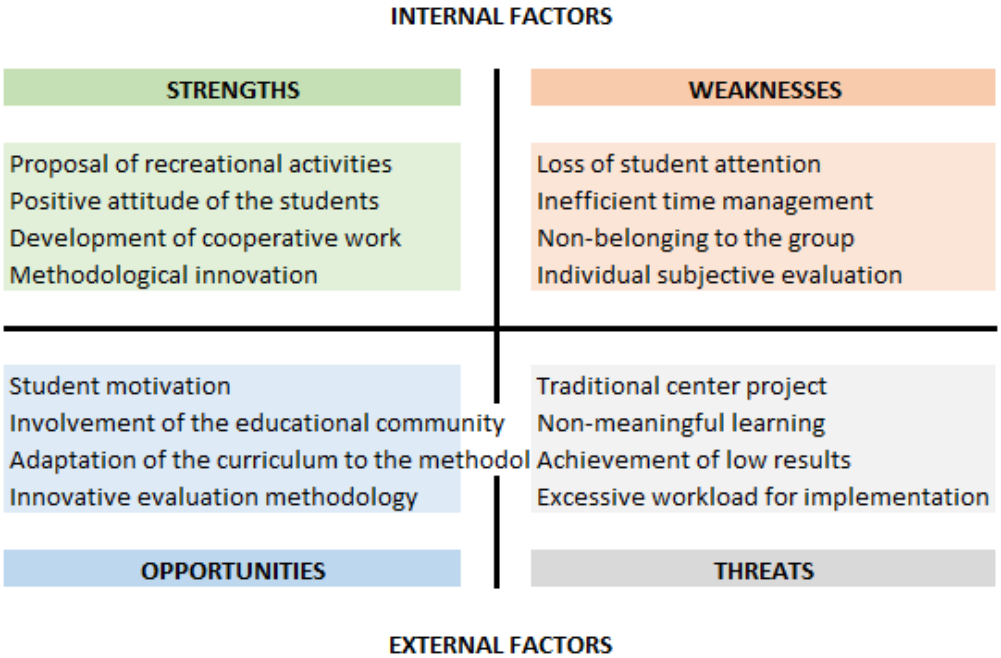
The teacher must also assign an initial score to each player, which will be of different characteristics depending on the character chosen and can set up the game teams so as to ensure that heterogeneous teams are created to encourage collaborative work. In addition, the teacher is given the opportunity to provide feedback in the form of comments if desired. Both the teacher and the student can know their progress at all times, as well as determine their own pace of progress in the game, which corresponds to an attention to diversity.

Evaluation

The results obtained from the evaluation should be critically assessed. Based on them, an analysis of the effectiveness of the implementation of gamification in the classroom should be carried out. Based on the data obtained, the strengths and weaknesses of the implemented methodology will be detected, which will serve as feedback, with the aim of converting errors into successes in future implementations.

As a method for analyzing the results, a SWOT matrix of the methodology is proposed, with the scheme shown in Table 2.

TABLE 2
SWOT ANALYSIS FOR LEARNING OUTCOMES



Source: Own elaboration.

When to Evaluate. Although an initial or diagnostic evaluation (to determine the starting point) and a final or summative evaluation (to be able to know the result of the whole process) are carried out, in order to carry out a meaningful learning it will be necessary to carry out a formative evaluation, throughout the whole process, so that we can learn (teachers and students) from the whole process.

How to Evaluate. As for the initial evaluation, it will be carried out in an informal way, through questions that the teacher will intersperse with the first explanations of the new concept to be taught, with the objective of finding out what previous knowledge the students have about the topic.

The final evaluation will be carried out as a joint assessment of a practical test of individual performance at the end of the teaching-learning process, with the assessment of the student's own attitude, as well as the evaluations obtained (individually and collectively) in the different activities proposed in the gamification.

Continuous assessment will be defined in the gamification itself, which will establish a system of rewards that will determine the evaluation of the learning process, in addition to assessing the attitude and skills of the students.

Who Evaluates. The evaluation may be carried out by different agents, so we will distinguish between hetero-evaluation (when the evaluating agent is the teacher), co-evaluation (carried out by peers, very conducive to collaborative work in which interpersonal skills can be fostered) and self-evaluation (when the student evaluates themself, evaluating how their particular learning process is taking place, while fostering intrapersonal skills, such as autonomy).

The rubric in Table 6, attached in Appendix 4, has been designed for the content evaluation.

In addition, in the definition of the sessions, several moments have been determined in which the students will not only be evaluated by the teacher but will also be evaluated among peers.

This rubric is not the only evaluation element of this methodology, but different types of evaluation will be used to ensure that it is continuous and formative.

The following are proposed as evaluation instruments:

- Evaluation Instrument 1 (EI1): Attitude. The student's attitude in class will be evaluated: participation, interest, individual and group work, behavior.

- Evaluation Instrument 2 (EI2): Class work: Assessment of various exercises performed in class (individual and group) with all the support material at your disposal.
- Evaluation Instrument 3 (EI3): Practical test. Assessment of a final practical test of assessment of objectives and competences, carried out individually.

The final evaluation will correspond to the following weighting of the evaluation instruments:

They will not only be used for student evaluation, but also as an assessment of the teaching process, and as a guide for possible adjustments to the methodology, in addition to assessing the teacher themself.

Evaluation of the Teacher's Role. The evaluation of the teacher's role should be carried out through hetero-evaluation and self-evaluation.

The hetero-evaluation will be carried out by means of a rubric (Table 7, included in Appendix 4) given to the students, in which they will be asked questions about the teaching practice, such as the motivation induced by the teacher, the transmission of interest…

The teacher will carry out a self-evaluation determining the degree of effectiveness and adjustment of the planning carried out, as well as its development. The evaluation of the students' academic achievements will also determine whether the teaching practice achieved the proposed objectives.

Evaluation of the Teaching Process. Evaluating the teaching process is of utmost importance, since the objective is that the process meets its objectives and, if it fails to do so, it should be modified and readjusted until the desired goal is achieved. In this case, an initial, formative, and final evaluation will also be carried out.

In the initial evaluation, the teacher will ask the students to reflect on their expectations of the topic in question, to determine their attitude towards the content to be learned and to indicate how they would like the teaching-learning process to be developed.

Throughout the development of the implemented methodology, students should identify those aspects they like and dislike the most, as well as the activities and contents with which they feel more comfortable and motivated and those with which they feel less. They should indicate the aspects they consider that could be improved.

The final evaluation will seek to contrast expectations and reality, so the students will be asked again about them. Have the expectations been met? The answer should be justified, as well as determining in what way their attitude has changed (or not) with respect to the content to be learned once the training process has been completed. They will also be asked about the strengths and weaknesses of the methodology used.

In addition, students will be given a rubric (Table 8, Appendix 4) to evaluate the process. On the other hand, the teacher themself must also evaluate certain aspects of the teaching-learning process, such as:

- Adaptation to the characteristics of the students.
- Active and proactive attitude of the students.
- Adequacy of the activities to the students' previous knowledge.
- Adequacy of dynamics (individual and group) in the activities.
- Level of interaction between students and teachers.
- Adequacy of teaching resources.

With all this, a gamification is proposed that meets all the requirements indicated in this article to ensure its effectiveness, as shown in Table 3.

TABLE 3
FULFILLMENT OF GAME ELEMENTS IN "ALGEBRAIC ISLANDS"

GAME ELEMENTS		PROPOSED GAMIFICATION		Item compliance
Challenges, missions, quests		Missions on each island		√
Narrative		At the start of the game and at the start of each mission		√
Game rules and restrictions		At the beginning of the game		√
Choice of different routes		An itinerary has been set. There is a possibility to unlock it.		√
Opportunities				√
	Multiple task options	Unlimited attempts		√
	Multiple lives	Unlimited attempts		√
	Restore points	With extra tasks		√
	Restart	There is a possibility, but it has been designed for progressive advancement.		√
Teams, role plays, battles		Fixed and random tasks		√
Experience points		Experience and life points		√
Levels		Fulfillment of objectives		√
Progress knowledge		At all times		√
Locked content		Unlocking through the achievement of progressive goals		√
Badges		By teams and individuals		√
Levels		Different levels: Objectives and missions		√
Points, achievements, results		By evaluation of proposed tasks		√
Countdown		Time limit to obtain the maximum score		√

Note: Prepared by the authors.

DISCUSSION

The proposal to carry out gamification was based on the modest implementation observed in the classroom and supported by data collection. Therefore, here arises the current need to implement new methodologies, such as gamification, in the educational system, in order to adapt to the society of the moment and solve the shortcomings that the traditional educational system drags from its poor adaptation to the new requirements demanded by the educational laws in most developed countries. The new methodologies focus on giving an active role to the student, in addition to promoting educational environments that cater to diversity in the classroom. This is helped by the design of methodologies based on cooperative work, based on the creation of heterogeneous work groups.

After an exhaustive bibliographic review and based on research data on the reality of gamification at present, we propose an educational methodology based on the implementation of a gamification based on the principles of cooperative learning, applicable to the subject of mathematics in the 1st grade of secondary school and oriented to the first approach of students to the algebraic language and the study of equations.

The design of the "Algebraic Islands" proposal seeks to raise awareness and motivate students about the functionality of mathematics, enhancing their own autonomy and social and emotional skills through

cooperative learning, combined with individual tasks. The methodology allows a good attention to diversity in the classroom, as well as integrates the use of ICT and promotes meaningful learning. For its development, the computer application Classcraft has been used, whose aesthetics is very attractive (it resembles a video game) and its design tools are very effective.

Teamwork encourages discussion, the contribution of ideas, critical thinking, and the acceptance that mathematics not only offers exact answers, but that discussion and reasoning can lead to different conclusions. Interpretation and justification skills are encouraged, as well as abstraction.

The use of gamification through ICT, attracts interest, and the development as a game minimizes the feeling of fear or failure, being able to make as many attempts as necessary to achieve the objectives. Motivation is maintained throughout the process (by unlocking missions, surprises, reward system and point penalties…), which ensures not only continuous progress, but also student information and control over it. The biggest change proposed is in terms of the conception of the teaching-learning process and the role of its members. The student becomes the protagonist of the process, while the teacher acts as a guide and accompanist.

But gamification does not ensure success in the teaching-learning process. The planning of it and the adequacy of its content is essential to obtain the expected results. It must be balanced, combining it with other types of work in class, without occupying the entire educational process, nor occurring on an ad hoc basis.

Motivation in this type of methodology is offered by a system of rewards that can be negative by affecting the emotional part (Domínguez, et al., 2013). The positive part is the immediate reward for achievement, but in case of not achieving it, it could create anxiety, counterproductive in the process. Therefore, the design of activities and rewards must be balanced, trying to meet the attention to the diversity of students.

Since it is not a static strategy, the implementation process should be evaluated, as it could turn out that the students' involvement and enjoyment of gamification does not produce sufficiently good academic results. The teacher, therefore, must remain attentive throughout the process to the achievements obtained, reformulating the gamification at any point of it if necessary (Barata et al., 2013).

A change of concept is required on the part of teachers, as it is effective in competency-based educational processes, but not so much in the case of focusing the process on curriculum content. As indicated by Ulicsak, Facer and Sandford (2007) in their study, teachers who based their work on competencies applied gamification more and better, achieving a high degree of student involvement. On the contrary, those who based their system on content tended to disaggregate elements of the game and use them partially, thus reducing the efficiency of the methodology.

The teacher must make a great effort, since they will have to spend time and training to plan and design each of the sessions. If gamification makes use of ICT, it can also entail an economic cost.

It can also produce difficulties in the student body, as Posada (2017) indicates, excessive competitiveness, fleeting motivation or the risk of working only for the reward lurk, coming to create a negative attitude towards the subject itself (anxiety).

Although gamification in education is not a widespread methodology, there are practical experiences that justify its use and corroborate its benefits.

Álvarez-Guamán and Erazo-Álvarez (2021) carried out an implementation in students in the eighth year of elementary school in Ecuador (equivalent to the 2nd year of secondary education), for the study of algebra. From the implementation of gamification in the classroom, they obtained a better understanding and assimilation of knowledge about algebra, motivated not only by the methodology itself, but also by the increased interest (motivation) that it arouses.

The experience has also shown that teachers' knowledge of digital tools and networks is very low. The same happens with students who, although they frequent digital environments, are not users of this type of tools, even less so in the classroom. The document indicates the need for teacher training in this type of methodologies and tools.

Romero-García, Buzón-García, and Olivets (2019) also carried out a gamification for the study of algebra at a 2nd grade secondary education level. After the implementation they detect a great increase in

the mastery of the contents (assessed by a pretest and posttest comparison). The suitability of this methodology for this content is supported by the didactic knowledge and by the higher degree of student satisfaction.

Mathematics should not be learned, it should be understood, and the learning process should be comprehensive in knowledge and skills. With this methodology, students are oriented towards curiosity and reasoning, as opposed to more rote and repetitive methods, placing students as the protagonists and the center on which the teaching-learning process pivots.

Finally, the versatility of this methodology stands out. Once the gamification is done in Classcraft, the same template could be used for other learning blocks.

However, the most important future line of work would be to implement this gamification, "Algebraic Islands Traverse", in educational centers and study the results obtained after its implementation. This would not only provide us with data on the effectiveness of the active methodology proposal but would also allow us to carry out an evaluation (self-evaluation), which would allow us to make decisions about it in order to detect weaknesses and improve the proposal. In this way, a true research-action cycle would take place, a basic procedure for improving educational practice.

CONCLUSION

The use of this gamification, designed as a digital game, has an aesthetic that by itself attracts students. In addition, the elements of gamification (with its mechanics, elements and dynamics) enhance the fun in the teaching-learning process, increasing student motivation. The development of the proposal is based on the achievement of objectives through the completion of missions, which allow students to know and control their progression, respecting the learning pace of each student.

In this way, diversity in the classroom is addressed.

The tools offered in gamification, and its cooperative development, induce an active participation by the student, modifying the traditional role of the teacher, who becomes a guide in the game.

The evaluation carried out in this gamification is in accordance with its design. It is diverse and values different aspects, not only the achievement of academic objectives, but also the development of student competencies, highlighting the continuous feedback received by the student.

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APPENDIX 1

TABLE 4
MISSIONS: SESSIONS - DURATION - TASKS - BRIEF DESCRIPTION…

Mission	1. Expressions Island	2. Monomials Island	3. Equalities Island	4. Island Equations	5. Island Problems
Session	1	3	5	8	11
Duration	50 minutes	50 minutes	50 minutes	50 minutes	50 minutes
Task	1.Origin of algebra 2. Algebraic expressions 3. Algebraic translator.	1. Invisibility 2. Let's go by sections 3. Operation	1. Shelter equality 2. Rebuild the tower.	1. The market	1. The fog 2. The economist
Brief description	Viewing of several videos indicating the origin and practicality of algebra. Resolution of a questionnaire on usefulness. Writing exercise in algebraic language. Expressing internalized mathematical knowledge in algebraic language. Co-evaluation.	Viewing videos: monomial concept. Identifying coefficient and literal part. Writing monomials without using the multiplication sign before unknowns. Identify algebraic expressions. Perform monomial reduction exercises. Operate with monomials.	Viewing of educational video. Making a summary of new contents Interactive digital game that reinforces concepts of identity and equation. The student must send the results.	Visualization of video-review on equations. Solving several problems in which an equation must be stated for its resolution.	Solving various problems by posing and solving equations.

Session	2	4	6	9	12
Duration	50 minutes	50 minutes	50 minutes	50 minutes	50 minutes
Task	4. The oracle of the island 5. Tame waters	4. The Mirror 5. Don't be fooled	3. Don't get cold	2. The night forest 3. The frozen lake	3. Rushing and forgetfulness

Brief description	Exercise of writing and expression in algebraic language. Justification and exposition of the reasoning for the execution of the exercise. Interactive game. Recognition of algebraic expressions	Correctly identify algebraic expressions. Perform monomial reduction exercises. Operate with monomials. Interactive game	Interactive digital game that reinforces concepts of identity and equation. The student does not have to justify the completion.	Performance of exercises of identification of terms of equations. Performing exercises on operations of equations with parentheses. Carrying out exercises on an interactive equation solving page.	Solving various problems by posing and solving equations.
Session			7	10	13
Duration			50 minutes	50 minutes	50 minutes
Task			4. Bridging the gap 5. Cross the bridge	4. The slope 5. Crossing the bridge	4. Workshop
Brief description			Contextualized project-style problem. Objective: construction of a bridge, by posing an equation.	Performance of exercises of operations of equations with fractions. Carrying out exercises through different web resources to exercise equations. Use of different web resources to practice the knowledge learned.	Solving various problems by posing and solving equations. Elaboration of a realizable project in technology or art class.

Session					14
Duration					50 min
Task					5. Bon voyage!
Brief description					Access to web resources with equation activities, with the possibility to check the solution. Self-assessment

Source: Own elaboration.

APPENDIX 2

In it we must LOG IN. This can be done in several ways: as a teacher, as a student or as a student manager. Each of the profiles has different roles within the game. The teacher, although in the development of gamification in the classroom also plays, will be the only one who can design the game. The student will be able to create their own avatar, but not modify the rules or tests of the game. The tutors will be able to monitor the game and the progress of the player they tutor.

Registration as a Teacher

Registration can be done using personal data or by logging in with your own Google account. The latter facilitates the linking of tasks through Google applications, such as the popular Classroom.

Registration as Students

Students must also register in order to participate in the gamification. It will be sufficient to provide an e-mail address.

Registration as Parent/Guardian

The teacher will be able to invite those responsible for the students to participate in the gamification, being able to communicate with them through the platform itself if desired. An e-mail address will also be necessary to carry out the procedures.

In this article, emphasis is placed on the teaching profile, since it will be the teacher who will have to design and manage the gamification conditions.

Teaching Profile in Classcraft

To be able to create content in the application it is essential to view the Class Demo, not only to learn how the application works, but also because otherwise the resources of the application will not be unlocked, in order to use them to create a gamification.

You can then create a new class by clicking on Add class. We give it a name and you can start designing it by clicking on Play.

For the students to be able to use the gamification, they must be included as players, so we must assign the students to the class. The application will generate a code for each student that they will then have to enter in the application, in their student profile, to be able to play. Students can be distributed by teams or let them work individually.

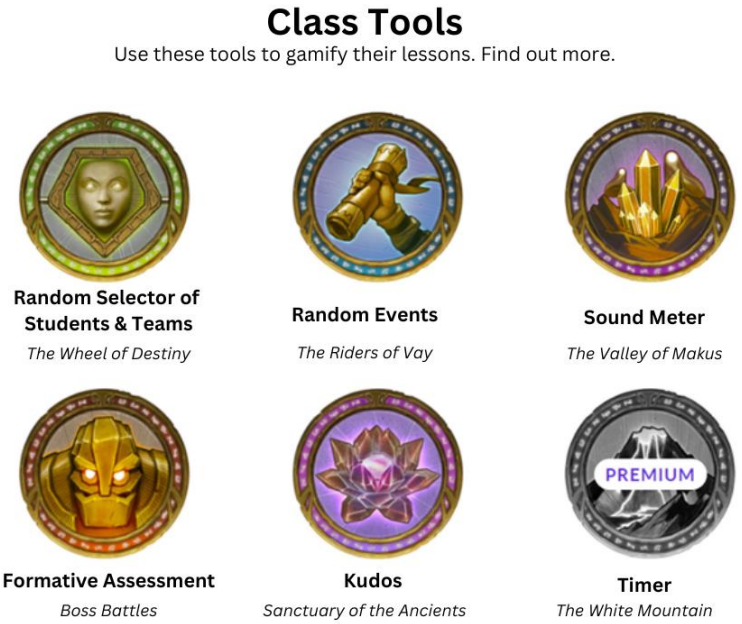
In the proposed gamification, cooperative work is encouraged, so Game Teams have been created. As they are created by the teacher, a heterogeneous and balanced team formation is ensured, considering diversity and creating a real integrated team, ensuring collaborative work and not just a working group.

For the students to start playing the game, they must be given initial points. Subsequently, as they achieve missions, the students will get more points.

The application offers different types of scoring:

- Experience points: indicates a student's growth in the game and in class.
- Gold coins: allow you to buy items to customize your character.
- Crystals: are earned by leveling up.
- Health: determines the character's life. Health is lost with bad results in the game. If you run out of health, you must be rescued by your teammates.

FIGURE 4
CLASSCRAFT CLASS TOOLS



Note. Adapted from *Classcraft Class Tools*, by Classcraft Incl., 2021, Classcraft (https://app.classcraft.com/teacher/class/FcXADCShMBrEAL9LG/class-tools)

The random sector allows randomly selecting a player or a team to perform a surprise test. Random Events are surprise events that can be used to start the class to create a good classroom atmosphere and encourage cooperative learning.

The sound level meter is a very useful tool to control behavior in the classroom. Rewards or penalties can be obtained depending on the general behavior in the classroom (control the volume, greetings when entering…).

The formative review allows to select a boss and to be able to do battles between them (competing between teams) and the Kudos are used as messaging between students. The teacher can request that students send Kudos to each other if they feel it is necessary for them to communicate with each other to solve problems or to foster social relationships and camaraderie.

When performing any activity, an alert will appear on the class dashboard, facilitating the monitoring not only of the game, but also of the students' involvement.

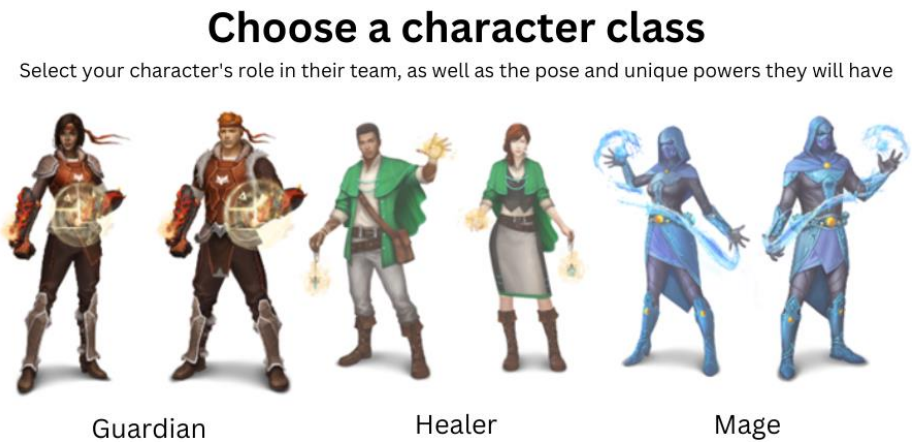
Student Profile in Classcraft

When starting to use the platform, each student must select the option "I am a student" and enter the code offered by the teacher, previously generated by the application.

Then, each student will be able to choose a type of character, which will be associated with different health points, experience, coins… and different powers.

The type of character offered can be: guardian, healer or mage (Figure 5). Each of them has different characteristics and skills, which will differ in experience points and life points.

FIGURE 5
CHOICE OF CHARACTER



Note. Adapted from *Choose a Character Class*, by Classcraft Incl., 2021, Classcraft (https://www.classcraft.com/es/)

Each type of character has different skills and qualities, so it is advisable that all groups have a variety of characters among their avatars, so that heterogeneity manifests itself as a strength for the development of teamwork.

- Guardians: they have a lot of life points and the ability to protect their companions with their powers.
- Healers: they do not have many life points, but they do have energy. As they do not have much life, they should not risk losing it protecting, they must be protected.
- Mages: they have balanced life and experience points. They have great abilities to help the rest of the team.

In addition, each type of character allows you to select its appearance.

Once each avatar is defined, you can access the mission panel. Once located on the map, the first mission is accessed by clicking on it. Within it, the path through it is determined, so it will guide us in the order of achievement of objectives and missions, which consist of tests that validate the mastery of the academic content to be studied.

Figure 6 shows the first of the proposed missions.

FIGURE 7
MISSION ISLAND EXPRESSIONS

Note. Adapted from *Island Expressions*, by Classcraft Incl., 2021, Classcraft (https://app.classcraft.com/teacher/class/FcXADCShMBrEAL9LG/quests/XLg5)

By clicking on the image, the first screen of the introduction appears directly. This step, like all the subsequent ones, is displayed by the students, but must be introduced (generating all the content) by the teacher. In this case, Mission 1 (Figure 7) is the introductory one. The initial narrative explaining the game has been created.

FIGURE 8
INTRODUCTION MISSION 1

A JOURNEY THROUGH THE ALGEBRAIC ARCHIPELAGO

Welcome to this fascinating voyage!

Your mission is to successfully navigate the Algebraic Sea. You will have to cross the five islands of the Algebraic Archipelago to get out of the storm and make a smooth journey to the mainland. Once there, you can move through it with complete peace of mind, and use the precious gifts and rewards you have collected during this voyage.

The journey begins on Expressions Island, which will allow us to access Monomials Island. With their wisdom, we will be able to access the Island of Equalities, and then overcome the Island of Equations.

Finally, we will arrive at the Island of Problems.

Once you have passed all the tests... you will be ready to get around the continent!

You have just arrived at the archipelago, which you access through Expressions Island, and so far you don't know anything about its inhabitants.

Communication is becoming complicated, as you do not speak the same language. Your first mission, therefore, will be to learn the native language to be able to communicate.

Good luck! Onboard!

Note. Adapted from *Island Expressions*. Introduction, by Classcraft Incl., 2021, Classcraft (https://www.classcraft.com/es/)

APPENDIX 3

Royal Decree 1105/2014 (Official State Gazette no. 3, January 3, 2015) specifies the objectives, criteria and learning standards for the Autonomous Community of Galicia. It states that "key competences are those that all people need for their personal fulfillment and development, as well as for active citizenship, social inclusion and employment". (p. 25436)

In Article 3, it further states that the key competencies of the curriculum are:

a) "Linguistic communication (CCL, in Spanish).
b) Mathematical competence and basic competences in science and technology (CMCCT, in Spanish).
c) Digital competence (CD, in Spanish).
d) Learning to learn (CAA, in Spanish).
e) Social and civic competences (CSC, in Spanish).
f) Sense of initiative and entrepreneurship (CSIEE, in Spanish).
g) Cultural awareness and expressions (CCEC, in Spanish)". (Official State Gazette No. 3, January 3, 2015, p. 25441).

According to Decree 86/2015, for the course, material and concept in question, Mathematical Competence and Basic Competences in Science and Technology are focused as key competence. According to Order EC/65/2015: "mathematical competence involves the ability to apply mathematical reasoning and its tools to describe, interpret and predict different phenomena in context." (Official State Gazette no. 25, of January 29, 2015, p.6993)

And also, that:

> "The basic competences in science and technology are those that provide an approach to the physical world and responsible interaction with it from actions, both individual and collective, aimed at the conservation and improvement of the natural environment, decisive for the protection and maintenance of the quality of life and progress of peoples". (Official State Gazette no. 25, of January 29, 2015, p.6994)

Contents

Decree 86/2015, of June 25, determines the curriculum of compulsory secondary education and high school in the Autonomous Community of Galicia. The contents corresponding to this gamification are within Block II, specifically to the topics of initiation of algebraic language and equations, whose specific objectives are:

e) "To develop basic skills in the use of information sources, in order to acquire new knowledge with a critical sense. To acquire a basic preparation in the field of technologies, especially those of information and communication.

f) To conceive scientific knowledge as an integrated knowledge, which is structured in subjects, as well as to know and apply the methods to identify problems in different fields of knowledge and experience.

g) To develop an entrepreneurial spirit and self-confidence, participation, critical sense, personal initiative, and the ability to learn to learn, plan, make decisions and assume responsibilities.

h) Understand and express correctly, orally and in writing, in the Galician language and in the Castilian language, complex texts and messages, and initiate in the knowledge, reading and study of literature". (Official Bulletin of Galicia no. 120, of June 29, 2015, p.26116)

The relationship of the objectives, contents, evaluation criteria, learning standards and key competencies are summarized in Table 5.

As can be seen in this table, the contents to be dealt with in this gamification are the following:

- "Initiation to algebraic language.
- Translation of expressions from everyday language, representing real situations, into algebraic language and vice versa.
- Meanings and properties of numbers in contexts other than calculus: triangular, square, pentagonal numbers, etc.
- Algebraic language to generalize properties and symbolize relationships. Obtaining formulas and general terms based on the observation of patterns and regularities. Numerical value of an algebraic expression.
- First degree equations with one unknown (algebraic and graphical methods). Solving. Interpretation of the solutions. Equations without solution. Problem solving." (Official Bulletin of Galicia no. 120, of June 29, 2015, p.26116)

That is to say, the contents to be worked on in the present gamification are:

- Definition of unknowns and use of letters for their symbolization. Use of symbolization as an expression of quantities in different contexts. Reading, writing, and understanding formulas. Obtaining numerical values in algebraic expressions.
- Expression of realities in algebraic language. Obtaining algebraic expressions in generalization processes. Understanding the numerical value of an expression.

- Solving first degree equations. Expressing mathematical problems with first degree equations. Solving problems.

TABLE 5
CONTENTS- EVALUATION CRITERIA- LEARNING STANDARDS AND KEY COMPETENCES

ESO Objectives	Contents	Criteria for evaluation	Assessment and learning standards	Key skills
"e) To develop basic skills in the use of information sources, in order to acquire new knowledge with a critical sense. To acquire a basic preparation in the field of technologies, especially in the field of information and communication technologies. f) To conceive scientific knowledge as an integrated knowledge, which is structured in subjects, as well as to know and apply the methods to identify problems in various fields of knowledge and experience. g) To develop an independent spirit and self-confidence, participation, critical sense, personal initiative and the ability to learn to learn, plan, make decisions and assume responsibilities. h) To understand and express correctly, orally and in writing, in the Galician language and in the Castilian language, complex texts and messages, and to initiate in the knowledge, in the reading and in the study of the Galician reading and study of literature."	B2.18. Initiation to algebraic language. B2.19. Translation of expressions from everyday language, representing real situations, into algebraic language, and vice versa. B2.20. Meanings and properties of numbers in contexts other than calculus: triangular, square, pentagonal numbers, etc. B2.21. Algebraic language to generalize properties and symbolize relationships. Obtaining formulas and general terms based on the observation of patterns and regularities. Numerical value of an algebraic expression.	B2.6. Analyze changing numerical processes, identifying the patterns and general laws that govern them, using algebraic language to express them, communicate them and make predictions about their behavior when modifying variables, and operate with algebraic expressions.	"MAB2.6.1. Describe situations or statements that depend on variable or unknown quantities and logical sequences or regularities, using algebraic expressions, and operate with them." MAB2.6.2. Identifies properties and general laws from the study of recurrent or changing numerical processes, expresses them through algebraic language and uses them to make predictions.	CMCCT CMCCT
"f) To conceive scientific knowledge as an integrated knowledge, which is structured in subjects, as well as to know and apply the methods to identify the problems in different fields of knowledge and experience. h) To understand and express correctly, orally and in writing, in the Galician language and in the Castilian language, texts and	B2.22. First degree equations with one unknown (algebraic and graphical methods). Solving. Interpretation of solutions. Equations without solution. Solving problems.	B2.7. Use algebraic language to symbolize and solve problems by means of first degree equations, applying algebraic or graphic	MAB2.7.1. Comprueba, dada una ecuación, si un número es solución de ésta. MAB2.7.1. Tests, given an equation, if a number is a solution of it.	CMCCT CMCCT

complex messages, and to initiate in the knowledge, in the reading and study of the reading and the study of literature".

methods for their solution, and contrast the results obtained.

Source: Own elaboration.

APPENDIX 4

TABLE 6
RUBRIC FOR EVALUATION OF FIRST-DEGREE EQUATIONS

	Highlights for excellence	Competent and quality	Shows sufficiency	Inadequately	Poorly
Uses algebraic language					
Correctly writes an algebraic expression					
Distinguishes between identity, equality and equation					
Identifies the terms of an equation					
Understands the concept of equation					
Correctly operates equations with parentheses					
Correctly operates equations with fractions					
Solves first degree equations					
Solves first degree equation problems					
Pose equations as problem solving					

Source: Own elaboration.

TABLE 7
TEACHER EVALUATION RUBRIC

	5	4	3	2	1	
Motivation	The teacher has motivated you a lot	The teacher has motivated you a lot	The teacher has motivated you a little	The teacher has hardly motivated you	The teacher has not motivated you	
Interest	The teacher made you very interested in the activity	The teacher was very interesting for you	The teacher barely managed to interest you a little in the topic	The teacher didn't show much interest in you	The teacher didn't make you interested in the activities	
Activities	You found the activities very entertaining	You found the activities quite entertaining	You found the activities somewhat entertaining	You found the activities not very entertaining	You did not find the activities entertaining	
	You thought the activities were intelligent	You found the activities interesting	You found the activities very accessible	You found the activities difficult	You found the activities too complicated	
Availability	The teacher has always been available to answer your questions	The teacher has solved the doubts relatively in time	The teacher has been solving doubts in a general way.	The teacher was not able to solve the doubts of some students	There were many doubts to be solved	

Source: Own elaboration.

TABLE 8
PROCESS EVALUATION RUBRIC

	5	4	3	2	1	
Participa-tion	You feel very motivated to participate	You feel quite motivated to participate	It motivates you a little to partici-pate	Did any of the activities mo-tivate you to participate?	You are not more moti-vated than other activities	
Interest	You found what you learned very interesting	You found what you learned quite interesting	You find what you have learned interesting	You found what you learned unin-teresting	You do not find what you have learned interesting	
Activities	You found the activities very enter-taining	You found the activities quite entertaining	You found the activities somewhat entertaining	You found the activities not very entertain-ing	You did not find the activi-ties entertain-ing at all	
	You found it very easy to follow the in-structions	You found it quite easy to follow the in-structions	You found it easy to fol-low the in-structions	You found the instructions a bit difficult to follow	You found it very difficult to follow the instructions	
Planning	You thought it was a fair amount of time for this learning	You thought it took a long time to de-velop this learning	You thought it was too little time to learn	You thought it took too much time to learn	The time was too short	
	You would not change the time spent	You would increase the time for several concepts	You would increase the time for a couple of concepts.	You would increase the time for review	You would increase the time for concepts and review in general.	
Effectivene ss	All the concepts were clear	Most of the concepts were clear to you	Half of the concepts were clear	I had a lot of doubts	I understood practically nothing	

Source: Own elaboration.