

Games as a Didactic Resource for the Teaching and Learning of Mathematics: Study of an Innovative Experience

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ABSTRACT

In this article describes that Learning mathematics can be a motivating experience if we base it on constructive and playful activities. The use of games in mathematics education is a strategy that allows students to acquire skills in a fun and attractive way.

KEYWORDS: *games, recreational activities, didactics*

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INTRODUCTION

Gaming can be considered as a universal activity that has been developing over time. Mathematical activity has always had a playful component that has given rise to a good part of the creations that have arisen in it. Pythagoreans and conducted various studies on the numbers, using for this the settings that were the stones. In the Middle Ages, Fibonacci practiced numerical mathematics, using techniques derived from the Arabs, using the game as a tool.

In the seventeenth century, Leibniz should be highlighted as a promoter of this intellectual playful activity, later other figures such as Euler appeared, who through the problem of the seven Königsberg bridges initiated the theory of graphs, or Johann Bernoulli, who in 1696 posed to the best mathematicians of his time the problem of the brachistochron, which Newton claimed to have solved in a few hours.

Gauss, a great fan of playing cards, recorded the moves to later carry out a statistical study, while Hamilton analyzed the problem of traversing the set of vertices of a regular dodecahedron without repeating any (Hamiltonian path). Other illustrious scientists such as Hilbert, Neuman or Einstein have also shown their interest in mathematical games.

Starting from the genetic method, we could affirm that if mathematicians of all times have enjoyed contemplating their game and science so much, why not try to learn mathematics through games?

Through play, situations of maximum educational and cognitive value can be created that allow experimentation, research, problem solving, discovery and reflection. The emotional implications, the playful nature, the emotional unblocking, the disinhibition, are sources of motivation that provide a different way from the traditional approach to learning.

The case that is presented tries to address the contents and competences of a didactic unit of the Mathematics curriculum for Compulsory Secondary Education (ESO) in Uzbekistan, developing them through activities and games that motivate and are a source of entertainment for the students.

The work has the following structure: first, the reasons why this project contributes to achieving a more meaningful learning, as well as an increase in students' interest in mathematics, are exposed; The objectives to be achieved, the resources and materials necessary to carry out the activities, the sequencing and description of the sessions in which the unit is developed, and the evaluation criteria, procedures and instruments are presented below; finally, a reflection is made on the results of the innovation experience and its possibilities of generalization as a didactic tool are analyzed.

Theoretical framework

We understand by game all that activity whose purpose is to achieve fun and entertainment for those who develop it.

According to Piaget (1985), "the games help build a broad network of devices that allow the child the total assimilation of reality, incorporating it to revive it, master it, understand it and compensate for it."

The game involves a series of processes that contribute to the integral, emotional and social development of people, not only of children, but also of young people and adults. Jiménez (2003) maintains that games are enjoyable activities that undoubtedly require physical and mental effort, however, students do them with pleasure; he does not perceive the effort and he does the distraction. In many cases, play is a means to test an individual's knowledge, naturally favoring the acquisition of a set of skills, abilities and capacities of great relevance for both personal and social development (Rojas, 2009).

The main reasons for using games as a teaching resource in the classroom are the following:

- They are attractive activities that are easily accepted by students who find them novel, recognize them as elements of their reality and develop their competitive spirit. In addition, play stimulates the social development of students, favoring relationships with other people, expression, empathy, cooperation and teamwork, the acceptance and follow-up of rules, the discussion of ideas, and the recognition of the successes of others and understanding of their own failures.
- In the mathematical field, the parallelism between the phases of strategy games and problem solving promote the discovery of heuristic processes in students. Games develop cognitive abilities at the three levels of representation: enactive, iconic and symbolic. They require effort, rigor, attention and memory, and stimulate the imagination.
- They stand out for their usefulness in treating diversity. In the mathematics classroom, Contreras (2004) points out the usefulness of games "as a motivating resource for students with greater difficulties, and also as a source of possible research for outstanding students."

Analysis of objectives

To check the degree of acquisition of the previous objectives, a series of indicators and measures have been proposed (Table

Table 1 Indicators and measures of the general and specific objectives

Overall objective	Impact indicators	Measurements
➤ Improve the attitude and interest of the students in the process of learning and teaching of the mathematics	<ul style="list-style-type: none"> ➤ The students: ➤ to. improves performance in the field of mathematics ➤ b. faces the subject with motivation and interest ➤ Teachers gain greater satisfaction in their work 	<ul style="list-style-type: none"> ➤ Student grades ➤ Results obtained in a questionnaire on student satisfaction ➤ Teacher evaluation of the experience, materials and activities and the attitude of the students, through a questionnaire
Specific objectives	Impact indicators	Measurements
<ul style="list-style-type: none"> ☞ Acquire an adequate level of self-esteem. ☞ Improve the capacity for reflective and intuitive thinking, to develop strategies for problem solving Use the different teaching media and resources appropriately as an aid in learning mathematics 	<ul style="list-style-type: none"> swim recognizes the usefulness of mathematics for daily life acquires transversal skills that enrich your learning. ☼ internalizes the concepts from an applied approach is more efficient when solving math problems ☞☞ Teachers improve their coordination by jointly developing materials and activities for the class. 	<ul style="list-style-type: none"> ☞☞ Notes made by the teacher based on the observation in the classroom ☞ Results obtained in the various assessment tests carried out by the students, which include: contents of the matter, resolution of problems and transversal competences. The results will be analyzed both jointly and separately for each of the blocks. ☞☞ Minutes of the meetings, where the teachers value all aspects of innovation

Mathematics is a discipline rejected by many students, due to its apparent complexity and boredom, its abstract and demotivating nature. Discovering that mathematics is a fascinating science is difficult work, since it is necessary to put an end to those myths that characterize it.

Often this subject is taught with mainly or exclusively deductive methods, exposing the contents of the curriculum through a master lesson, and leaving it up to the students to carry out school tasks that can become repetitive, mechanical and tedious.

Deductive teaching in mathematics is focused on what Bloom (1980) calls low-level mental process, that is, it is based on rote and repetition procedures, which do not allow for problem solving, through analysis, interpretation or the representation in mathematical language of an idea, that is, to high-level mental processes.

With this solid theoretical foundation, we will present the design of a didactic unit entirely based on games and the possible extension of this methodology to other items of the curriculum.

Learning objectives

The project has tried to develop in the students a series of capacities:

- Acquire an adequate level of self-esteem, which allows you to enjoy the creative, aesthetic and utilitarian aspects of mathematics.
- Value mathematics as an integral part of our culture, both from a historical point of view and from the perspective of its role in today's society.
- Improve the capacity for reflective and intuitive thinking, for the development of strategies for solving problems.
- Use in an appropriate way the different means and teaching resources as an aid in learning mathematics.

Development of innovation

In this section, the methodology used for the development of innovation and teaching resources is described. It also includes the sequencing of the games and the description, in more detail, of some of them.

Methodology

- The innovation project is designed so that in each of the sessions that comprise a didactic unit, one of the following formats is developed:
- The session is divided into two phases. First the teacher explains a concept or procedure relating to the unit teaching that will be working.
- The game is integrated or taken as a starting point to explain the relevant notions or algorithms. In this way, students are active subjects in their learning, and use their intuition and knowledge to solve problems.
- The teacher must manage and direct the situation at all times. It is important to clearly establish the dynamics of the game, guiding the development of the activity and marking the rules or rules of the game that students must respect at all times.
- Students must live the game as such, reacting efficiently to the different conditions that arise. The feeling of wanting to win the game allows you to be active in your learning, and develop cognitive processes using intuition in an increasingly agile way.
- Playful activities must combine both individual and collective games. In this way, students learn to be autonomous and to solve situations by themselves, in addition to prospering in their social competence. Education in values is an important pillar in game dynamics. Cooperation, maturity, tolerance, solidarity, respect, participation, justice, equality, discipline, etc. they must be present at all times.

Resources, means and teaching materials

Each game is accompanied by a series of activities or worksheets that the students will carry out or attach to their notebook. The notebook is very important for the development of innovation. On the one hand, the teacher will use it as an instrument for evaluating the student's activity, and on the other hand, the student has the notebook as a fundamental element to review the classes.

The use of calculator will be necessary in some occasions. It is essential that teachers report when its use is allowed and when it is not. In addition, it will sometimes be necessary to use computer equipment and programs such as GeoGebra (Geogebra, 2013).

If necessary, students could have a textbook as additional material in order to carry out reinforcement activities. The particular needs of each student, as well as the assessment that the teacher makes of the situation, will specifically answer this question.

Student assessment

To carry out the evaluation of the students, the following aspects have been taken into account:

- Assessment exam of the didactic unit that the students took at the end of the unit sessions (60% of the grade).
- The attitude of the students throughout the sessions (10%). Rewarding interest in the subject, effort, participation in the classroom, as well as companionship, cooperation, disposition and personal effort.
- Activities carried out or information collected in the notebook (20%). Periodically and at the end of the unit, students' notebooks were monitored.
- Score or position achieved in each of the games that were developed in the classroom (10%).

Evaluation of experience

It has been broken down into three stages, for each of which a series of evaluation instruments are proposed (Table 2).

Table 2 Stages and instruments for evaluating the experience

STAGES	EVALUATION INSTRUMENT
Previous evaluation	➤ Minutes of the previous meetings with the teaching staff involved, to know their opinion about the project
Process evaluation	<ul style="list-style-type: none"> ➤ Anecdotal where a daily record is made of both the positive and negative aspects of the project ➤ Discussion in the classroom in which the teacher and the students participate to comment on the development of the project and activities ➤ Classroom observation
Evaluation of results	<ul style="list-style-type: none"> ➤ Test scores of the students ➤ Survey carried out on the students at the end of the project, where the most descriptive aspects of the project must be assessed ➤ Interview the teachers who carry out the project to find out their opinion about it.

Results of the evaluation

Based on the evaluation carried out, the following aspects should be highlighted.

- Prior to its implementation, the teaching staff was reluctant to the project. The use of games in the

classroom seemed like a good strategy to increase motivation; however, they feared that the new work dynamics would lead to a decline in academic performance. They claimed that these types of activities were going to be a reason for loss of concentration,

accommodation in studies, a decrease in order in the classroom, etc. Experience and results have shown us that the use of this strategy has had a positive impact on student performance.

- Throughout the different sessions, through observation in the classroom, an increase in motivation was perceived in the students. Most of the students were involved in the activities, showing themselves to be participatory. The interest in winning made them get directly involved in their learning, being quick when planning strategies to solve the problems that arose. The math classes incorporated a playful aspect without losing or lowering the learning objectives of the subject.
- Once the didactic unit was finished, the students were asked to respond to a survey, where they had to assess the experience (from 1 to 10) through a series of items, comparing the new methodology (Met_N) with the one followed previously (Goal). The results obtained were positive (Table 3).

Table 3 Results of the students' assessment

	Arithmetic mean Met_N	Arithmetic mean Met_A
Interest level and motivation	8.5	6.2
Degree of difficulty of the contents	6.1	7.2
Learning outcomes	8.1	7.0
Degree of satisfaction	8.1	5.9

Based on the previous results, an increase in motivation and interest towards mathematics is observed with the implementation of the new methodology. Students affirm that learning mathematics by playing is interesting and fun for them, some even consider it exciting.

Regarding the difficulty of the learning process, the students recognize that the use of games has made it easier for them to understand the concepts. Working in small groups has allowed them to personalize the pace of learning, both for those students with difficulties and for those who are more advanced. In general, they are satisfied with what they have learned.

Comparing the individual grades of each student obtained in the evaluation control of the didactic unit with respect to their trajectory throughout the course, no significant differences are observed.

Finally, it should be noted that the experience has been very enriching and satisfying for everyone. The participation of the students, their motivation in the classes, their interest in learning, their concentration and their determination to solve the problems that allowed them to win the game were very positive aspects. In particular, feeling the growing taste for mathematics in the students was an element of full satisfaction for the teaching work, which counteracts the work and effort involved in planning a didactic unit using didactic games.

Conclusions

Based on the results obtained, we can affirm that the use of games as a didactic resource for the teaching and learning of mathematics in 1st year of ESO increases the motivation and interest of students towards the study of this subject, thus favoring the acquisition of knowledge.

The variety of teaching resources used in the classroom is a relevant element, since it directly influences the performance of students. After analyzing the learning consequences of using recreational activities in the mathematics classroom, the idea now is to extend this mechanics to other teaching units.

Finally, we can ask ourselves if this experience can be generalized to other educational stages. Although the study has been confined to a 1st year ESO classroom, the results have been so satisfactory that we believe that the methodology can be extrapolated. However, the main work in this case would be the search for games suitable for the contents of the corresponding course.

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