Game-based learning and Breakout as comprehension techniques in solving math problems in Primary Education

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Abstract

The change experienced in society as a result of the pandemic generated by Covid-19 means that education must adapt to ICT methodologies and tools that allow students access to knowledges in two ways: from the classroom and from their home in e-learning modality if necessary. On the other hand, mathematics education has the challenge that primary school students have sufficient and significant training in solving mathematics problems that allows them to function and integrate into society and their daily tasks with total normality without any problems. This proposal aims to make explicit how through a game-based learning methodology and using ICT as a vehicle through digital breakout, pedagogical alternatives can be established that develop mathematical thinking through meaningful experiences. For this, the learning of an experience carried out in primary education will be analyzed, Brunner's experimental method will be used as a starting point for the autonomous learning of students by discovery. All this will show the fundamental role that ICTs play in autonomous, lasting learning and significant of mathematics.

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Keywords: *mathematics, ICT, digital education, breakout, primary education*

1. Introduction

The use of information and communication technologies (ICT) in the classroom should not be limited to the use of digital screens, but rather this resource should be used for the teaching-learning process and to contribute to pedagogical quality. Technology must be applied from a socio-constructivist point of view in which students are encouraged to be the protagonist of their learning as well as to learn to solve problem situations [1].

In most cases, the students do not understand the resolution of mathematical problems, this is due to a traditional teaching and to the fact that other motivational and significant methods are not enough to solve difficulties. This creates frustration, blockage and passivity in the students. Therefore, the problem could be the methodology used in the explanation of the mathematical problems [2].

Active methodologies such as gamification allow the design of experiences with which to achieve, aided by the use of ICT, a learning purpose, in whose development the students must make a series of decisions, including a system of rewards as a reward for the final achievement of homework. Within the gamification techniques you can find Game-Based Learning (PBL), to which digital breakouts belong [3]. Digital breakouts, which consist of solving a series of challenges in order to move forward until reaching a final goal, are an attractive method, since today everything digital is part of their lives. They have fun with them and therefore, implementing them in the classroom to learn a part of a subject can be enriching, since it is based on their interests [3]. In addition, for [4] Challenge-based learning is a methodology that offers students the opportunity to face problems under the teacher's guidance, to learn about outstanding experiences by proposing solutions [5]. Regarding by [5] it can be said that challenge-based learning awakens the interest of students by giving it a practical and experiential meaning to educational activity, while developing essential skills, such as collaborative and multidisciplinary work, communication, decision-making, leadership and ethics. Similarly, Johnson et al. (2009) cited by [5] points out that this method provides students with a greater development of social and communication skills.

Students must be equipped to know how to discriminate between relevant and non-relevant information, to be able to build their own learning by solving problems. On the other hand, the important thing always has to be educational, not making use of ICT, taking into account that we want the students to learn and to what extent technology is relevant for such learning. In this study and after a brief analysis of the theoretical framework, the experience carried out through a digital breakout for the learning of reasoning in mathematical problems will be exposed. Finally, some of the results obtained in a questionnaire given to students after completing the Digital Breakout will be presented.

The experimental method will be taken as a starting point for the autonomous learning of students by discovery [6].

2. Context and Experience

The experience was developed in a Primary School in Málaga (Spain) with 18 students in the second year of primary education. Due to the circumstances caused by Covid-19 and hygiene measures, the individual use of digital tools in the classroom was encouraged. Next, the previous explanations and the steps carried out in the digital breakout created with the Genially tool with the theme of the Pink Panther are detailed to exercise the solving of addition and subtraction. The complete breakout can be found at [7]: https://view.genial.ly/601af8a8eb4c540d10a8ddb0/game-breakout-breakout-problemas-matematicos.

First of all, the eight steps to solve mathematical problems of the presentation will explain (Figure 1,left). Then, the poster that has been designed so that students can see the steps of the problems on a daily basis will be shown so that they can reinforce them.

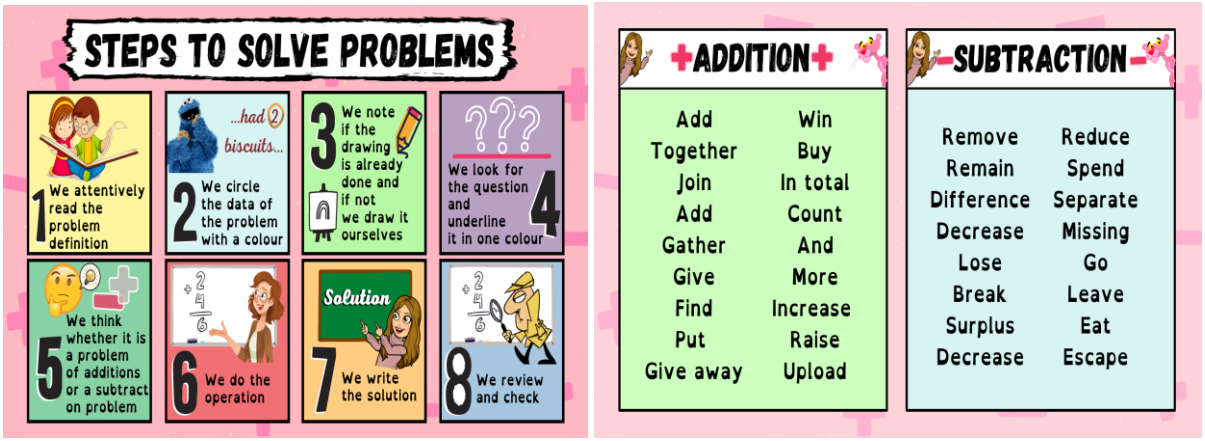


Fig. 1. Eigth steps to solve math problems (left) and keywords to solve addtion and subtraction problems (right)

Thirdly, we will continue with the presentation to explain that in the problem statements there are keywords that will help us to know whether the operation to be carried out is an addition or a subtraction (Figure 1, right). In addition, students will be told that they may encounter any type of mathematical problem in the additive field: combination, transformation or comparison problems.Subsequently, they will be reminded that they must not forget to carry out the operations and that for this, the eighth step of the problem (review and check) will be crucial.Then, in order to reinforce everything that has been explained, an example of an addition problem and a subtraction problem will be shown, asking the students the steps to carry it out and why it is necessary to add or subtract, having also to indicate which is the key word to recognise the operation (Figure 2).

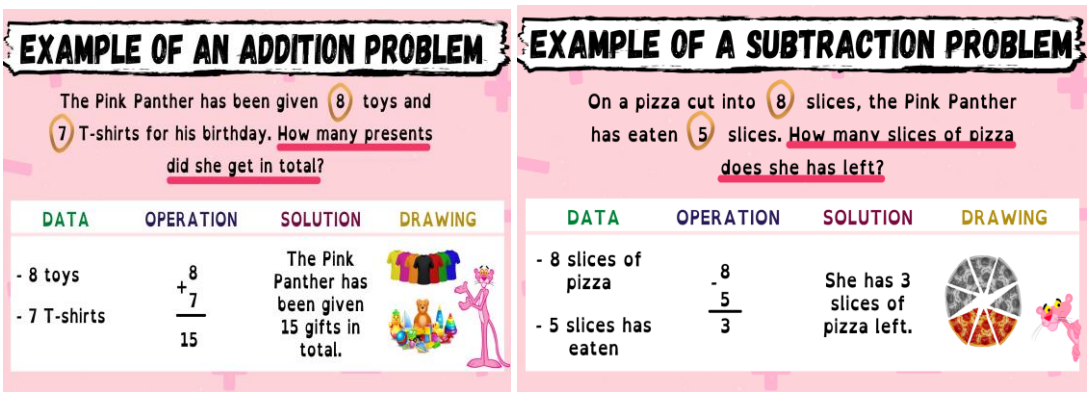


Fig. 2. Examples of addition and subtraction problems

After finishing the presentation, the digital mathematical breakout of addition and subtraction problems will be performed.Next, the rules of the Breakout will be explained and it will be emphasised that they will not be able to move from their seats, due to the situation of the Covid-19, therefore, to organise the groups it will be based on the fact that each team will be formed by the 3 people who are closest to each other.In addition, it will be explained that each team will have a mission (a mathematical problem), which will be to say the resolution of the same that corresponds to the number of their team, that is, group 1 will have to explain the resolution of the first mission, group 2 of the second, group 3 of the third, and so on. As there are 18 students in the class, each group will be made up of 3 people, so there will be a total of 6 missions (Figure 3).However, although each team has a mission, before explaining the solution to the problem, all the groups should have completed each mission individually, as the aim is for them to work both individually and as a group (each having a role, even though they solve the problem of each mission individually). Also at random, members 1, 2 and 3 will be appointed, and then the task of each member of the group will be explained in more detail. Member 1 will be in charge of announcing when his or her group has completed the problem of his or her mission, member 2 will be in charge of ensuring that his or her team behaves correctly (respecting their turn to speak, helping each other, if necessary, from their seats and without shouting) and member 3 will be the spokesperson, who will explain the result of the corresponding mission of his or her group.

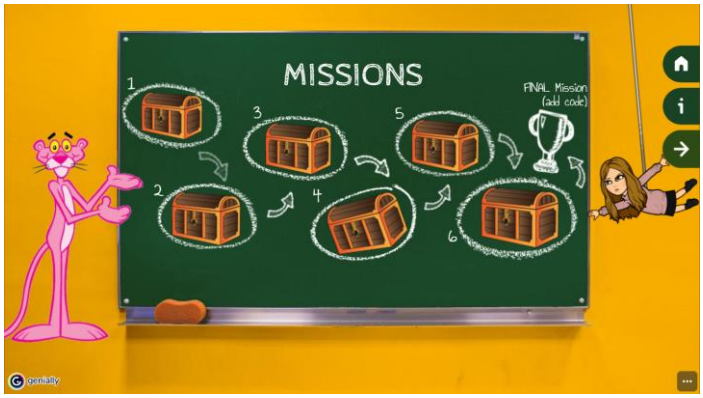
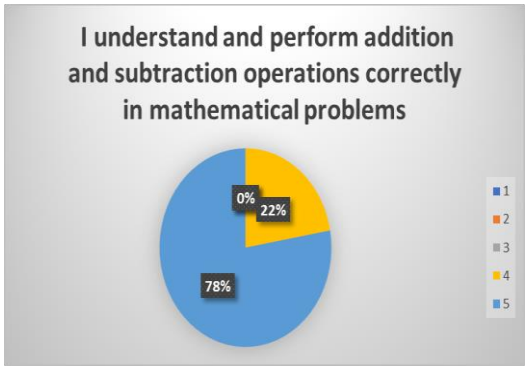


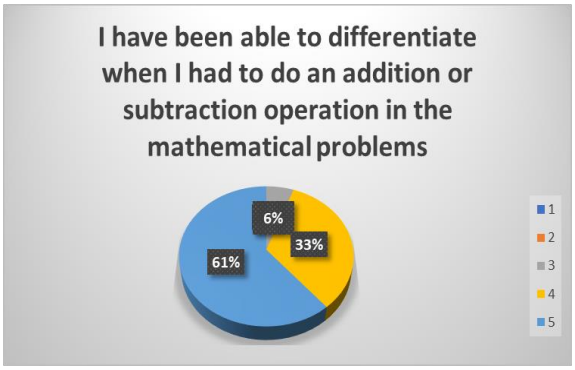
Fig. 3. Missions in Breakout

After having finished explaining all the rules and resolving any doubts that may arise with them, they will pass out the worksheets that the students will have to complete in each mission.Then, we will start to elaborate the 6 missions. In each one, when the mission (the mathematical problem) is completed correctly, the students will be congratulated for having completed the mission correctly and the chest corresponding to the mission will be opened, which will have a number inside, which they will have to write down so that at the end of the missions, they can enter the code that will help to open the last chest, which will contain a treasure inside that will indicate the end of the Breakout. Finally, the self-evaluation form will be handed out and all the students who have fulfilled the rules to win the game will be rewarded with a sticker of an animal as a positive reinforcement.

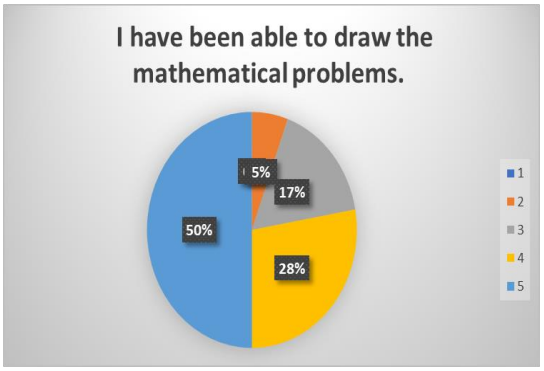
3. Results

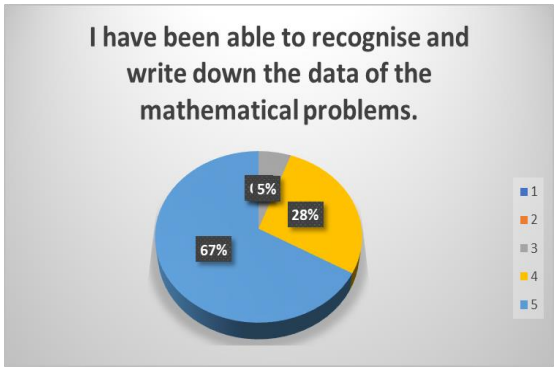
The results of a questionnaire with 6 items made to the students are shown on a 5-point Likert scale, with 5 being the level with the highest acceptance and 1 the lowest.



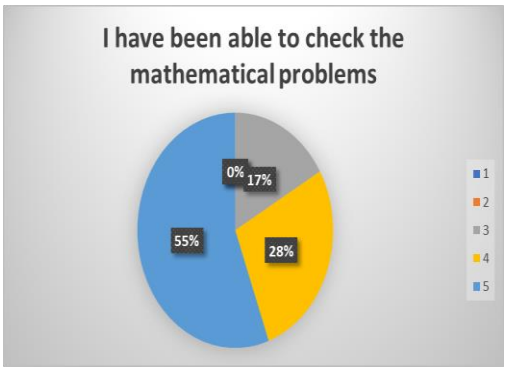


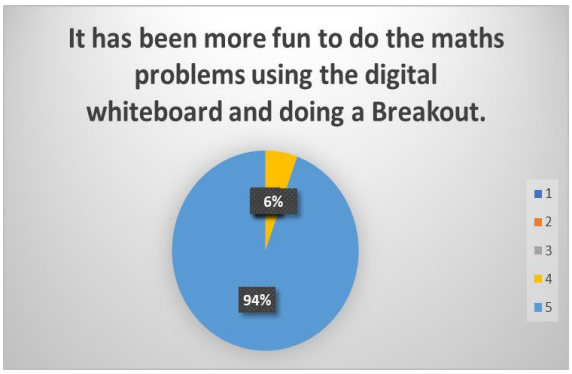
In the first two graphs we see how 78% have correctly understood the operations carried out and 61% perfectly distinguish the sum of the subtractions in the operations.





Regarding the diagrams made of the plans of the proposed problems, 50% did it perfectly and almost 28% almost perfect. Also, more than 67% of the students were able to correctly put in all the data of the problems posed





Finally, more than half of the class was able to verify the solutions to the problems raised in the Digital Breakout and almost 100% of the students think that with this method and digital tool they are much more motivated to solve and understand the problems of addition and subtraction in math.

4. Conclusion

From these results it follows that as various authors have already glimpsed in relation to the students' commitment to the proposed tasks, gamification shows a greater degree of participation in maths [8]. Gamification techniques, including educational breakouts, are an excellent way to increase concentration, effort and motivation based on recognition, achievement, competition, collaboration, and self-expression [9]. It has a playful nature, which facilitates the internalization of knowledge in an attractive and fun way and motivates students, generating positive experiences [10]. Therefore, the use of visual elements provided by digital breakouts in explanations is a strategy that encourages meaningful learning in mathematics [11].

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