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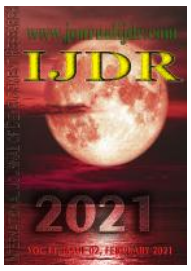

RESEARCH ARTICLE OPEN ACCESS

# TEACHING GAMES AS AN EFFECTIVE ALTERNATIVE FOR TEACHING MATHEMATICS AND INCLUSION OF THE THEME OF ENVIRONMENTAL EDUCATION

**Ana Flávia Ferreira da Silva[1*], John Hebert da Silva Felix[1], Elcimar Simão Martins[1], Antonio Alisson Pessoa Guimarães[2], Olienaide Ribeiro de Oliveira Pinto[1] and Juan Carlos Alvarado Alcócer[1]**

[1]Academic Master's Degree in Sociobiodiversity and Sustainable Technologies, University of International Integration and Afro-Brazilian Lusophony, 62790-970, Redenção, Ceará, Brazil; [2]Institute of Engineering and Sustainable Development, University of International Integration and Afro-Brazilian Lusophony, 62790-970, Redenção, Ceará, Brazil

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***Corresponding author:***
***Ana Flávia Ferreira da Silva,***

**ABSTRACT**

The present work aimed to investigate the limits and possibilities of using games as sustainable technology as an alternative to work the Mathematics discipline, which is considered complex, in a contextualized, creative way and in a way that would arouse the interest of students towards the content of the curriculum matrix, but also to the importance of sustainability in the current context. A mathematical game called Geometry Trail was made from low-cost materials aimed at teaching flat figures present in the final years of elementary school and then an interview and training was held with 20 teachers in the area of mathematics in which it was found that, in their opinion, the idea of didactic games as a strategy to work with Mathematics content allied with the theme of environmental education, is an effective alternative that enables meaningful learning and allows the student to recognize himself as a transforming agent and that he can contribute for a preserved environment.



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# INTRODUCTION

The teaching of mathematics with each passing day becomes the protagonist of academic studies, due to the certain difficulty that some students have to understand it. According to D'Ambrósio (2001) mathematics is the discipline with the highest index of exclusion from school institutions. We know that Mathematics represents a vast field of studies and that arouses the interest of students in solving problems, designing and disseminating solutions, foreseeing results, thus favoring the structuring of thinking of logical reasoning. Referring to the construction of a mathematical curriculum, considering themes of social relevance, gives it an integrative perspective and, in this sense, its organization is established around situations and problems of interest that allow a reading, understanding and interaction of reality social, cultural, political and natural. In this sense, a topic of relevance is, without a doubt, Environmental Education. Since "the environmental issue presents itself as a central theme in school programs" (D'AMBRÓSIO, 2001, p.17). Thus, it is up to the school to adapt the mathematical curriculum and classroom practices to the new challenges of society. Environmental education is a process that aims to change mentalities in relation to quality of life and is directly linked to the type of coexistence we have with nature and that implies attitudes, values, action. It is a life option for a healthier and more balanced relationship, with the context, with others, with the closest environment, starting with the home and work environment. Moacir Gadotti (2010) argues about the need for "environmental literacy" for a better understanding of social reality. Therefore, it is possible to align Gadotti's thinking on "environmental literacy" with what is stated in the National Curriculum Parameters (PCN's) that: "Games are an interesting way of proposing problems, as they allow them to be presented in an attractive way and favor creativity in the elaboration of strategies and resolutions and search for solutions "(BRASIL, 1998, p.47). Given the above, the present study, which is part of a master's dissertation from the University of International Integration of Afro-Brazilian Lusophony (UNILAB), aims to investigate the limits and possibilities of using games as sustainable technologies for learning in mathematics in Final Years of Elementary School.

# METHODOLOGY

The research was outlined in the precepts of the qualitative approach. According to Bodgan and Billen (1994, p.16) "qualitative research in

education takes many forms and is conducted in multiple contexts", so, it was sought the best way to conduct it. As it is a qualitative research, we will use the strategy of a research-training, in function of training with teachers. According to Barreiro (2008, p. 79), the research-training resource "is capable of enabling meaningful teacher training, the dimension of listening being an important element that allows the experience of alterity and the expansion of the records thought by the subject who narrates through the group's perspective ". The activity was carried out with 20 (twenty) mathematics educators from the Final Years of Elementary Education in the city of Chorozinho, Ceará, as a focus to reach our main objective, which is to investigate the limits and possibilities of using games as sustainable technology for learning in mathematics we chose to follow the three steps presented below:

1- Presentation of the proposal for continuing education;
2- Interview with teachers;
3- Ongoing training to work on mathematical content through games, as well as making them using low-cost materials.

In games, we chose to work with flat figures. After deciding the content to be worked on the games, the survey of recycled materials for making the games was carried out. Afterwards, the workshop proposal was presented. Subsequently, the interview and the workshop with the teachers were carried out, the objective was to show a different method of teaching Mathematics, in order to awaken the creativity of these future professionals. The materials used by teachers for making the games were diverse, such as pet bottles, reused papers, among others.

# RESULTS AND DISCUSSIONS

Continuing education for teachers is something of great importance for education, because according to Sandes and Moreira (2018) qualified teachers are fundamental for meaningful learning to happen. Therefore, an interview was conducted with teachers to learn the limits and possibilities of using games as sustainable technologies for learning in the Final Years of Elementary School, as well as continuing training with the use of low-cost games. In the first moment, in October 2019, the research was presented to teachers from the municipal network in one of its bimonthly training courses. At the meeting there was an explanation and the perspective of working with mathematics and environmental education with teachers. The second moment, January 2020, was the two meetings with teachers. The continuous training lasted six hours divided into two days, as it was happening during the Pedagogical Journey of the municipality, and the trainer would have some other reports, suggestions and referrals to be passed on to the teachers. In the first meeting, there was an interview with the teachers, the presentation and delivery of materials for the game. According to Gil (2008), the interview is an excellent option to obtain answers from a group, and the data can be analyzed in depth. When surveying the responses of the twenty teachers interviewed, we can say that the average length of service for professionals is 10 years, where 30% has a workload of 20 hours per week, 65% a workload of 40 hours per week and 5% work 60 hours a week. We also observed that 90% of the teachers interviewed work in a single school unit. Educators were asked what their academic background was, since in the municipality in question teachers in the areas of natural sciences, that is, physics, chemistry and biology teach mathematics. Let's see in the Figure 1. We can see that less than half of the teachers in the municipality have degrees in mathematics. Therefore, we observed that 65% of the professors have degrees in similar courses. Vidal and Vieira (2016) point out that 28.7% of teachers in Ceará's state education network teach outside their initial training area. The authors also comment that "states like Ceará still have 20.7% of teachers without the training recommended by the legislation to act in basic education" (VIDAL; VIEIRA, 2016, p.36). Therefore, we note that in relation to teachers of mathematics in the city of Chorozinho, this data is even more alarming. According to Nóvoa (1992), teacher training can encourage the maturation of the professional side, in a perspective of contextualized autonomy regarding the teaching profession.

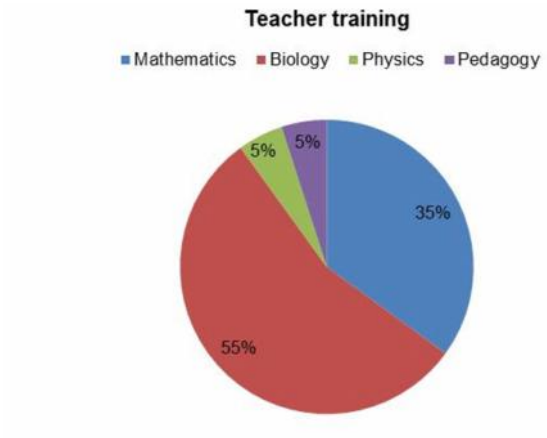


**Figure 1. Teacher training**

In this sense, the academic training of education professionals has great relevance for the development of quality work, and consequently promising learning. Then the following question was asked: how often were mathematical games used as a teaching tool in mathematics classes? Where he would always have an answer, sometimes and never. We plotted the data and generated the Figure 2 below.

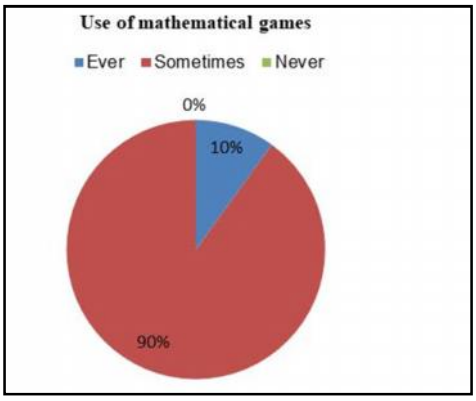


**Figure 2. Use of mathematical games by teachers**

We can see that at some point in math classes all teachers in the municipality use mathematical games as a teaching resource. Pimentel et al. (2010, p.5) reports that "the teacher is the main agent of curriculum change at the classroom level. It is he who, with his knowledge, concepts and attitudes, can promote change in his students ".

We also analyzed that when we asked the mathematics trainer in his interview about the frequency with which he takes games to training courses as teaching strategies, in which he replied that he always uses this resource. We realized that both on the part of the Municipal Education Secretariat and the network teachers, the use of games is a frequent strategy used by them to develop students' learning. As previously mentioned, the vast majority of teachers in the municipality who teach mathematics are graduated in related areas, so for a better understanding of the teachers' responses, we made a brief profile of the research participants. At that moment, the teachers were identified with P1, P2, P3, ..., P20 with their respective degrees to protect anonymity. Continuing the interview, we asked the opinion of the teachers regarding the use of mathematical games as a pedagogical resource. We obtained the following responses:

> *P1- games help students to reason better because the fundamentals of games in relation to the pedagogical resource to encourage students to learn in a different and motivating way;*
> *P2- is very good, as it makes the class more dynamic and attractive;*
> *P3- the use of mathematical games in the classroom helps us to have a more dynamic class, thus drawing the student's attention to the class and consequently giving us a better result in terms of understanding the proposed content;*
> *P4- is not everything, it is just another instrument that helps in the teaching-learning process;*

*P5- are essential tools for the development of content addressed in the classroom, facilitating the understanding of the subjects worked;*
*P6- very good, as it diversifies with great opportunities for realization with didactic content with pedagogical practice;*
*P7- one of the best ideas ever had, because it develops a whole skill and interaction of the students, their participation, socialization, work as a team;*
*P8- important, as it contributes to develop reasoning and makes classes more dynamic and attractive;*
*P9- mathematical games came to facilitate student learning, in which the game itself makes the student more participatory, thus making their learning more satisfactory;*
*P10- is a good alternative to transmit knowledge without mentioning that the student has an experience that the student himself does not have in his family life;*
*P11- are very important resources in the teaching of mathematics, since it encourages learning in mathematics in a relaxed way;*
*P12- bring more dynamic classes to the students in the form of games, through which we can work on development, discipline, creativity and mathematical reasoning;*
*P13- I don't always use it, but the times I use it, the interest on the part of the students is notorious. I soon find the use of games quite productive;*
*P14- is an option to make the math class more attractive and get out of remote activities a little;*
*P15- I believe that mathematical games are excellent resources when associated with the studied contents. It is necessary to have a clear objective with the game, to have a reason, it is certainly a valuable tool;*
*P16- is an indispensable tool to improve the students' development;*
*P17- I think it is valid because our students change at an unmatched speed, our teaching methods in which to be modified;*
*P18- mathematical games have an important relevance, as they awaken and influence significant learning. I believe that the use of games as a pedagogical resource makes a student an active subject in his learning process;*
*P19- I think this practice of working with mathematical games as a resource to improve our classes is fundamental;*
*P20- working with games enables the student to develop new skills, and the learning process becomes enjoyable.*

In general, teachers see the use of games as a didactic resource of great relevance for the development of mathematical skills in students, making classes more dynamic and pleasurable, making it even a little easier to introduce new content.These thoughts corroborate with Nogueira (2013, p.19), who states that "the game can also promote the development of logical-mathematical reasoning, autonomy, reflection, overcoming difficulties, understanding new concepts, evaluating and development of socialization ". In the same line of thought Selva and Camargo (2009), points out that many teachers have been looking for new pedagogical alternatives in order to achieve a better result of the learning process, and one of these alternatives is games. We soon realized that the actions of the surveyed teachers in relation to the use of games in math classes are in line with the thoughts of the authors mentioned above. Next, teachers were asked whether making games with low-cost materials would be a good option for a pedagogical and sustainable strategy? The following answer options were presented: yes or no and if possible justify your answer. The figure 3 below shows the quantity obtained.

As we can see, all the interviewees stated that it is a good option for a pedagogical and sustainable strategy to make games with low-cost materials. According to Hart and Milstein (2004), "the idea of sustainability has been represented by rising expectations in relation to social and environmental performance", so the perspective of making games with low-cost materials is for teachers of a high expectations both in terms of learning mathematics and environmental education.

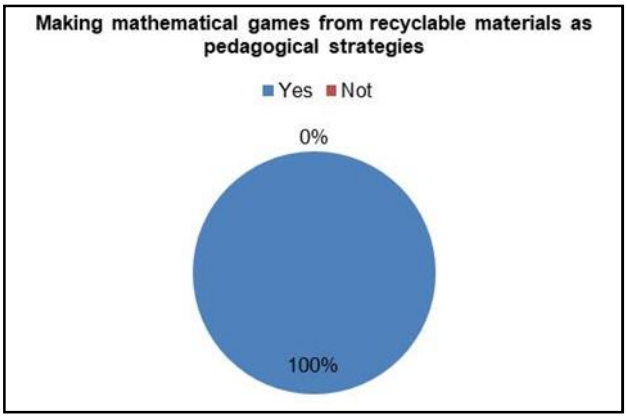


**Figure 3. Mathematical games from recyclable materials**

Some of the teachers interviewed justified their opinion. Let's look at some of the justifications:

*P4- would be a way to reinforce the student's interest in preserving the environment;*
*P7- undoubtedly a rich material, which makes many pedagogical games to develop various skills in the students and thus helping the environment with recycling;*
*P13- in addition to using games in the form of learning, it would be a way of working with environmental awareness,*
*P14- it would be very productive, as it would help the environment and it is also a way of working better on learning;*
*P15- is important to encourage the reuse of resources and their use;*
*P16- because in addition to transmitting mathematical knowledge with games, they will still be leading students to realize the importance of reusing, recycling, the "mistakes" of science;*
*P17- stimulates the student's science by preserving the environment in which he lives and stimulates mathematical knowledge.*

According to D'Ambrósio (2018, p.197), "as mathematicians and mathematical educators we owe our responsibility to issues of sustainability", so it is one of the responsibilities as mathematicians and mathematical educators to develop actions that portrays mathematics, as well as sustainability. In one of the interviews, when a teacher justified his opinion about making games with low-cost materials with a good option of pedagogical and sustainable strategy, he described a practice he had already done for his math classes. Let's see:

*I made a knowledge machine. Made with a paper box, two luminous paper, two batteries, a 6 volt lamp from an old car, screws and wires. It works like this: the teacher prepares 10 questions and 10 scrambled answers and sets up a circuit, when the student puts the end of the wire in the question and the other end of the wire in the correct answer, the lamp lights up and if it is wrong it does not.*

When we read the account of the teacher who portrays a successful experience in his math class using recyclable materials, we realize that "we need new ideas, new approaches, to face the problems that affect the world" (D'AMBROSIO, 2018, p. 199). We can also see that some of the materials cited by the teacher are not considered recyclable materials, such as batteries (MEDEIRO, 2011). Therefore, the question arose whether teachers really know what materials can be recycled or not. According to Gonçalves et al. (2019, p. 406) "the lack of training of teachers on environmental issues does not allow a better understanding of Environmental Education". We realized that it is relevant to work EA for both with a view to the environment, as well as to make mathematics classes attractive and aware. At the end of the interview with the teachers, the material structured by the researcher was re-presented, that is, the Geometry Trail game on which it was based, as mentioned before, in Ferreira (2016) to work

on mathematical content in the classroom, with the aim of increasing the learning rate in that math skill. It also addressed which low-cost materials could be reused for the construction of the geometry trail, as one of the specific objectives of the research is to align environmental education and sustainable technologies with mathematical education (Figure 4).


**Figure 4. Presentation of the Geometry Trail Game**

In the second meeting, teacher training focused on the use of educational games for the teaching of mathematics and the inclusion of environmental education was held (Figure 5). The Geometry Trail was chosen for this training and a kit containing the materials that we would use to make it was delivered to each school. The kit consisted of four game boards: the geometry track, four cards with the rules, four cards with the questions, four cards with the answer and four data specific to the game. All of these materials were reproduced with the reuse of paper from schools in the municipality itself. We observed that the teachers found the practice and the use of this didactic resource of great relevance, being able to work in a more pleasant way the mathematics, as well as the education. It was reported by educators that the trail could be adapted for everyone, thus changing only the mathematical skills that one intends to work in the classroom.

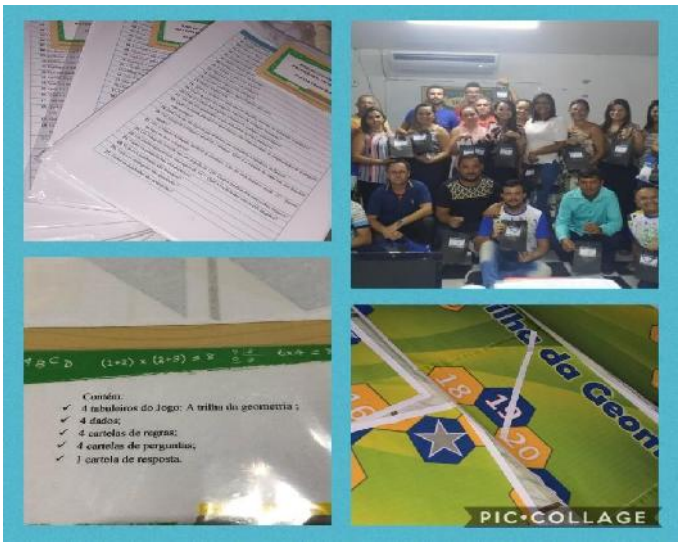


**Figure 5. Continuing education of mathematics teachers**

**Final Considerations**

This research was developed with the objective of investigating the limits and possibilities of using games as sustainable technologies for learning in the Final Years of Elementary School. The work carried out with 20 teachers from the municipal public school in Chorozinho-Ceará revealed that the interview, in addition to providing information about the academic and professional trajectory of teachers, showed us that 90% of the interviewees affirm that sometimes they use games as a teaching strategy and 10% always makes use of this resource in the classroom. It was found that all respondents believe that making games with low-cost materials is a good option for pedagogical and sustainable strategies. Regarding academic training, it was found that only 35% of teachers who teach mathematics have training in the area and that 65% of teachers have degrees in similar courses. As far as we can see the relevance of teacher training is a pedagogical alternative to achieve a satisfactory result in the teaching and learning process. In view of the data and results presented, we realize that teachers in the municipality are open to new technologies, such as games, to work with mathematics and the environment.

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