Teaching chemistry in a playful and experimental way: Proposals for elementary education in public schools

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ABSTRACT

Teaching chemistry often presents challenges, especially in the context of public education, where limited resources and a lack of infrastructure can be obstacles. However, conducting simple and accessible experiments can overcome these difficulties, allowing students to experience chemical concepts in a concrete and interactive way. Thus, the problematic question that guided the development of this work was: "how to perform experiments with these limitations?" Based on this problem, the general objective was defined: "to arouse the interest of students in the discipline, promoting a practical and dynamic approach, which stimulates active participation and meaningful learning regarding the science content of the 9th grade of Elementary School of the Darcy Ribeiro Municipal School, located in the city of Imperatriz-MA". In this work, chemistry experiments that address the basic principles of the science discipline were chosen. These experiments have been adapted to be carried out with low-cost and easily obtained materials. Topics explored included chemical reactions, properties of matter, physical states, solutions and absorption, and bases. The choice of experiments was based on the school curriculum and the ability to arouse students' curiosity. The research involved different approaches, such as bibliographic research, field research, action research, and case study. The steps included the collection of information from bibliographic sources, the elaboration of experiments according to the content of the classes taught, the creation and application of interactive activities after the class, and the combined analysis of the results. The results suggest that a class that addresses experimentation possibly contributed to the development of a reflective and critical posture on the part of students, in addition to promoting a broader and more integrated understanding of the science subject.

Keywords: Teaching, Experiments, Science, Chemistry, Practice.

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INTRODUCTION

Chemistry instruction continues to be conducted in a conventional manner, even in the face of several attempts at innovation aimed at arousing greater interest on the part of elementary school students. The emphasis is still on memorizing definitions and formulas, which are not aligned with the reality experienced by the student in his daily life. The use of various teaching tools, which seek pleasure, willingness and motivation to learn, can, when properly planned and applied, mitigate this situation (SANTOS and SCHENETZLER, 2003; ROSSI and ROSA, 2012).

In this context, experiments emerge as an example of pleasurable practice for teaching and learning chemistry along with the science subject taught in elementary school. Contextualized experimentation, as a learning method for a deeper understanding of the contents, combined with the correlation between theory and practice, linked to everyday examples, enhances the acquisition of scientific knowledge (NEVANZA; TCHAVANGO, 2022).

When approaching the teaching of chemistry through science in elementary school, it is crucial to note that the use of books and exercises alone is not enough to ensure quality teaching to students. In the case of children, their attention is not easily retained by theoretical classes alone; It is essential to incorporate practices that demonstrate in a playful way how the concepts apply in our daily lives.

In addition, these practical activities contribute to the development of students' competencies, practical skills and critical reasoning skills. In this way, experimentation arouses curiosity and interest in learning, encouraging a taste for the discipline. According to Guedes (2017), experimental activities play, in a constructive and favorable way, the role of stimulating meaningful learning. This is due to the student's search for curiosity and enthusiasm, encouraging them to deepen their knowledge in the knowledge acquired.

Experimental practice provides students with the chance to consolidate their knowledge through active participation and the prior construction of their understanding in the exploration of scientific aspects, concepts and chemical applications. This stimulates interest in the discipline of science and later in the subject of chemistry, promoting the active construction of knowledge. By participating in experiments, students have the opportunity to observe chemical phenomena, formulate hypotheses, collect and analyze data, interpret results, and derive conclusions from the activities carried out (GONÇALVES, 2022).

Thus, a research was initiated about the connection between science and chemistry and the lack of experimental classes in elementary school. In this context, the following questions arise: "Is it possible to carry out classes in a practical way using low-cost materials?" Is it feasible to establish a connection between theory and experiments in the content taught?

Thus, the objective of this work was to foster a more meaningful, engaging and in-depth learning of the contents of the curriculum, through the use of examples and experiments in the discipline of science. It was sought to establish a solid foundation for the teaching and learning of Chemistry of the students, ensuring that each one has the opportunity to acquire and consolidate the essential knowledge to continue their studies in the area of chemistry.

METHODOLOGY

The research developed was carried out in the 9th grade *class of the* Darcy Ribeiro Municipal School, located in the city of Imperatriz-MA; the research subjects were 27 students from that class. In order to provide a more attractive and meaningful chemistry education for elementary school students in public schools, first, bibliographic research was carried out to assist in the understanding of the contents taught, it was essential to plan interactive activities that arouse their interest in the discipline of science. An effective approach was action research for the elaboration of an expository class with student participation, along with the realization of an experimental activity, involving the contents of chemistry through low-cost experiments, in order to make learning more meaningful and concrete. According to Moura, Santos, and Lima (2022), the use of playful strategies in chemistry teaching has proven to be an efficient approach to make learning more attractive and meaningful for elementary school students in public schools. Practical activities and didactic games have provided greater student interaction with chemical concepts, thus allowing for a deeper understanding and autonomy in the contents (Moura et al., 2022, p. e9526).

The stages of the research were as follows, carried out in a way that did not necessarily follow this order: STAGE 1: The bibliographic research was oriented towards the understanding of the problem-situation, elaboration of the intervention activity and delimitation of the research instruments; STAGE 2: planning the theoretical class to prepare the experiments; STEP 3: preparation of the technical file of the experiments to be followed step by step; STEP 4: Elaboration of the questionnaire; STEP 5: interpretation of the results through the crossing of data obtained by the questionnaire applied, students' behavior in the classroom and directed questions, with the intention of satisfying the research objectives through these steps used.

THEORETICAL FRAMEWORK

The importance of experimental activities is explicit in the National Common Curricular Base (2018), which highlights the need for students to acquire content procedures and practices, including arousing curiosity about the world, formulating and evaluating hypotheses, exploring problematic situations, and conducting experiments with data collection and analysis.

It is common to relate experimental activities to the practical demonstration of a theory, and this misconception occurs not only among students, but also among teachers. According to Galiazzi and Golçalvez (2004), when experiments are carried out in class, it is necessary to overcome the view that the experimental activity has the sole and exclusive function of proving the theory, as this would not be possible in just a few minutes of classes. What actually happens is a problematization of the content that is done through an observation of something that is happening.

According to Santos et al., (2012) The educator plays a central role in this context, participating as a transforming agent and keeping constantly updated to keep up with social evolutions. It is crucial that educators adapt their pedagogical practices to the reality of students. Therefore, it is essential that teachers, especially chemistry teachers, realize that they are trying to identify methodologies that enable students to develop essential skills for the formation of critical citizens.

Among the notable options, there are accessible experiments, recreational games, and the use of software and programs to facilitate the implementation of the contents. It is extremely important that educators, through these activities and approaches, demonstrate to students that chemistry is a science intrinsic to everyday life (FREIRE; FONSECA, 2016).

Catelan and Rinaldi (2018, p. 308) state that the voice of experimental activities is mainly associated with the "change in attitude that this methodology provides to both the student and the teacher, as the learner ceases to be just an observer of the classes, starting to argue, think, act, interfere and question".

For Da Silva etal. (2020, p. 4), the inclusion of intuitive practical classes, as part of varied methodological approaches, greatly facilitates the understanding of knowledge in Chemistry:

> It is a way for the teacher to bring active methodologies to the classroom in which students will actively participate in the learning processes, stimulating students to be creative, to think, to have reflective criticality and thus build knowledge.

Dos Santos and De Menezes (2020, p. 185) "when there is significant learning, the memorization of content debated and understood by the student is completely different from that which is reduced to the mere automatic repetition of texts demanded in a test situation"

> [...] School experimentation, in its essence, cannot be centered on the mere reproduction of experiments to illustrate or prove theories, nor to train scientists, but must allow students to produce knowledge from practice and attribute scientific meanings to them.

Para Abraham *et al*. (1997) *apud* Salvadego (2007, p. 17):

> The teaching of Chemistry, centered on scientific concepts, without including situations that relate the content taught to their daily lives, makes the discipline demotivating for the student. In this sense, the experimental activity in the teaching of science and chemistry is

> confirmed as an important pedagogical tool, inherent to the process of school knowledge of the students' sciences, to captivate them to the themes proposed by the teachers and expand the capacity for learning, that is, the experimental activity is an essential part for the teaching of Chemistry.

In this context, it can be observed that the present research corroborates the results released by Silva and Neves (2005) apud Nascimento (2013, p. 17), who report that although many teachers believe that experimental activities facilitate student learning, they are carried out in a small way in the day-to-day life of schools. These authors also explain possible justifications for this fact when the subject is the controversy over the use of experiments in schools. According to Ataide (2010) apud Nascimento (2013, p. 17), there are three aspects involved:

> [...] of a philosophical nature (the performance of experimental activities freely or without guidance); cognitive nature (the adequacy or not of the experimental activities to the students' abilities at school) and pedagogical nature (the physical space such as laboratories, material conditions such as glassware, reagents and teacher preparation).

In the analysis of these experimental activities, we consider three important perspectives. The first concerns the philosophical approach, which refers to the freedom or orientation in the execution of these activities, allowing students to participate in a more free or targeted way. In the cognitive dimension, we assess whether the activities are aligned with the students' abilities at school, ensuring a more adapted and fruitful experience. Finally, from a pedagogical perspective, we look at the physical environment, quality of materials, and teacher preparation, understanding that these factors play a crucial role in effective and engaging experiential education.

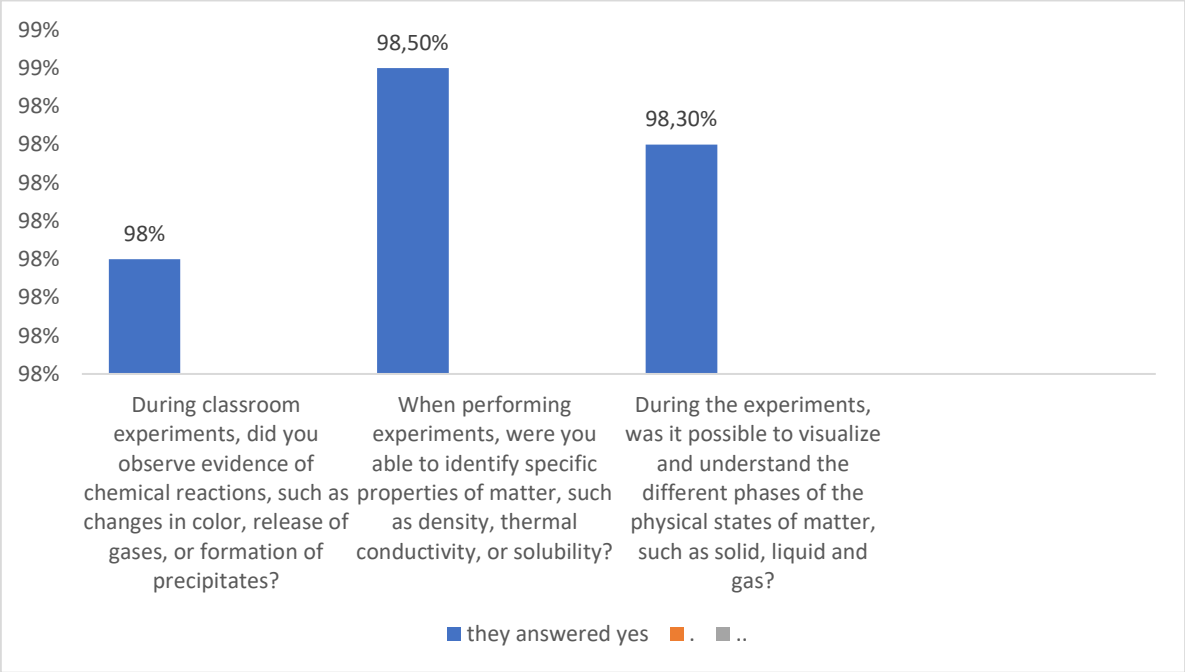
RESULTS AND DISCUSSION

Two questionnaires were conducted with the class involved: the first before the beginning of classes and practices, aiming to understand the students' perceptions and previous experiences in relation to experiments. Subsequently, at the end of the work, a second questionnaire was applied, inquiring about the effectiveness of the classes in conjunction with the practices developed in the classroom. This approach made it possible to assess not only the initial receptivity of the students to the experiments, but also to obtain feedback on the practical application of the lessons. These questionnaires contributed to a more comprehensive understanding of the students' learning experience.

After analyzing the questionnaires answered by the students, we found that 97.5% had never had experimental classes in the classroom. Thus, revealing a very high number because it is a subject that makes it possible to have numerous practical classes. After that, it was found that 98.3% of the students find totally theoretical classes discouraging because they do not have a playful view of what happens in the practice of the subjects studied. This indicates that there is a deficit in learning in

science teaching due to the lack of classes that aim to show how chemistry works through experiments. Within this same questionnaire it was observed that 99% of the students want to have more experimental classes for a better absorption of knowledge about the contents studied.Based on the results, classes were started on chemical reactions, properties of matter, physical states, solutions and absorption and bases, unifying chemistry and sciences, and then practical classes were applied to reinforce learning.

Graph 1 – Questionnaire applied to the experiments



Source: (Survey data, 2023)

In Graph 1, the data show positive results for the new teaching approach. The results indicate that the differentiated learning, compared to the traditional approach, was well received by the students. In addition to demonstrating a better understanding of the content, the students actively participated in the classes, showing considerable curiosity about the experiments. This positive response suggests that the new methodology not only promoted more effective learning, but also sparked students' interest and involvement in hands-on activities, providing a more enriching educational experience.

FINAL THOUGHTS

This work sought to explore the fundamentals of chemistry through the discipline of science, highlighting the importance of examples and experiments to promote more meaningful and engaging learning. The main objective was to establish a connection between the disciplines of chemistry and science, taking low-cost experiments to improve the teaching and learning of students in public schools.

The approach adopted for the construction of knowledge was humanized, with the way of taking knowledge in an easy and accessible way, thus using low-cost experiments and showing that chemistry can also be done using materials that we have at home and not being done only in the laboratory.

We hope that this example- and experiment-based learning approach has contributed significantly to the development of a deep and lasting understanding of the fundamental principles of chemistry.

We hope that this teaching methodology, grounded in examples and experiments, has played a significant role in developing a deep and lasting understanding of the fundamental principles of chemistry.

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