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Practical Experiments and School Reinforcement: Promoting Inclusion and Learning for Vulnerable Girls

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ARTIGO ORIGINAL

ABSTRACT

This extension project aimed to promote the improvement of the teaching-learning process of girls in situations of social vulnerability, through actions aimed at inclusion and school reinforcement. Interdisciplinary activities were carried out that integrated chemistry, physics and mathematics content, with a focus on practical experimentation and problem solving. Among the practices developed, the "Furious Water" experiment stood out, applied to illustrate concepts of chemical equilibrium and the Le Chatelier Principle, favoring the understanding of chemical phenomena in a playful and contextualized way. Activities based on Graph Theory were also worked on, addressing Euler's paths and circuits, stimulating logical reasoning and planning skills. The results showed positive impacts on the academic performance, engagement and self-esteem of the participants, confirming the importance of integrating practical methodologies and school reinforcement to reduce educational inequalities and promote social inclusion.

Keywords: Basic education; Chemical practices; Interdisciplinary; Social vulnerability; Social inclusion; School reinforcement.

INTRODUCTION

Children and young people in situations of social vulnerability face various challenges, which are directly related to structural issues such as poverty, social exclusion, and inequalities (Vieira & Honorato, 2023).

Such factors compromise not only the integral development of these individuals, but also their access to quality education. In this context, it is evident that one of the main problems faced by this population lies in the precariousness of living conditions (Pereira et al., 2023).

According to UNICEF data (2021), approximately 32 million girls and boys live in extreme poverty, considering multiple dimensions such as income, child labor, housing, access to water, sanitation, and information.

In addition, the violence and insecurity present in the environments where these children and young people live generate emotional and psychological conflicts that compromise their learning capacity (Andrade et al., 2022).

Abramovay (2005) points out, in his studies on school violence, that many students live with situations of domestic, community and institutional violence, which undermines the school's function as a space of protection and welcoming.

In addition, discrimination and prejudice, often experienced by children and young people belonging to ethnic, racial or gender minorities, reinforce social and educational exclusion (Abramovay, 2005).

Given this scenario, it is essential to implement educational programs aimed at improving teaching and learning, since education proves to be an effective instrument to break intergenerational cycles of poverty and exclusion (Garção et al., 2021).

Education plays a central role in building fairer and more inclusive societies, promoting collective well-being. As Paulo Freire (1979, as cited in Costa et al., 2021) emphasizes, "education does not transform the world. Education changes people. People transform the world."

Education has a dual dimension, being intrinsically linked to human rights, as prescribed by the Universal Declaration of Human Rights (1948, art. 26), which guarantees everyone the right to education with a view to the full development of the human

personality and the strengthening of respect for fundamental rights and freedoms.

At the same time, Silva (n.d.) points out that social and economic factors, such as basic education, in addition to contributing to the quality of life, increase the individual's capacity, making them capable of facing challenges with confidence and autonomy, seeking the life they rightly value.

However, the educational process transcends the mere transmission of academic content, requiring pedagogical initiatives to consider local realities and students' experiences, in order to foster the formation of individuals capable of questioning and transforming the reality in which they live (Vieira et al., 2024).

For education to promote positive transformations, it is essential that it is accessible and inclusive, meeting the specific needs of each child and adolescent in vulnerable situations (Andrade et al., 2022; Silva et al., 2023).

According to Ivic (2010), in the sociocultural approach to development, the child should not be considered in isolation from his sociocultural context, as in an individualistic model.

Thus, both child development and their education must be analyzed taking into account their social interactions, since these play an essential role in their growth and learning (Ivic, 2010).

In this scenario, social programs play a crucial role in mitigating inequalities, creating conditions that not only guarantee access to education, but also provide shelter and support throughout the educational trajectory of children and young people (Ivic, 2010).

Non-Governmental Organizations (NGOs) have stood out by complementing the gaps left by the public education system, promoting access to comprehensive education and contributing to the transformation of the reality of several individuals in unfavorable contexts (Goleman, 1995).

Goleman (1995) points out that welcoming emotional environments favor the development of emotional intelligence, one of the determining factors for academic, personal and professional success, by stimulating skills such as empathy, resilience and emotional regulation.

In short, education, when grounded in human rights principles, is not limited to the transmission of knowledge but also empowers individuals to become agents of change (Andrade et al., 2022).

In this context, the present extension project acted as school reinforcement and integrated the realization of practical experiments in chemistry, physics and mathematics, contributing to the improvement of learning and the development of academic and socio-emotional skills.

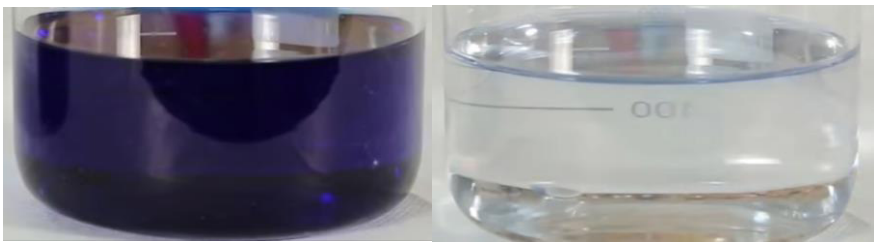
METHODS AND PROCEDURES

The present extension project included the presentation of experiments in the areas of chemistry, physics and mathematics, with the objective of contributing to the teaching-learning process, both in the educational aspect and in the emotional development of the participants.

To plan the activities, the team used weekly meetings, in which references of experiments that were aligned with the proposed objectives were identified.

Initially, the experiment called "Furious Water" was carried out, a classic chemical equilibrium experiment that visually demonstrates how a system can change its appearance quickly when disturbed, later returning to equilibrium.

This phenomenon occurs due to the interaction between iron ions and thiocyanate, resulting in color variations in the reaction medium. Images are presented below to facilitate the visualization of the experiment.



Source: Authorship, 2025.

To carry out this experiment, easily accessible ingredients were used, allowing the participants to reproduce it later. The materials used consisted of: 3.5 g of caustic soda (sodium hydroxide), 6.0 g of glucose, 200 mL of water, 0.3 g of methylene blue dissolved in 300 mL of water and a 250 mL PET bottle for transportation and storage of the experiment.

First, caustic soda and glucose were weighed individually in different containers.

Then, the amount of water needed was measured, using part of it to dissolve each reagent separately.

Subsequently, methylene blue was weighed and dissolved in water. Finally, the lye and glucose were mixed in the PET bottle, and the methylene blue solution was then added.

This experiment not only favors the teaching-learning process, but can also be interpreted as a metaphor for emotional dynamics and patience in human interactions.

Just as the reactional solution returns to the initial state after a disturbance, the experiment symbolizes the relevance of resilience and emotional balance in overcoming everyday challenges.

The second experiment explored mathematical concepts related to the Euler Path and Circuit, based on Graph Theory, with the objective of facilitating the understanding of connections and paths. For its execution, simple and accessible materials were used, such as pen, bond paper, ruler, pencil and eraser.

The methodology followed the steps below: initially, paths were drawn on a sheet containing vertices and edges, using pen and ruler to ensure the organization of the graphs.

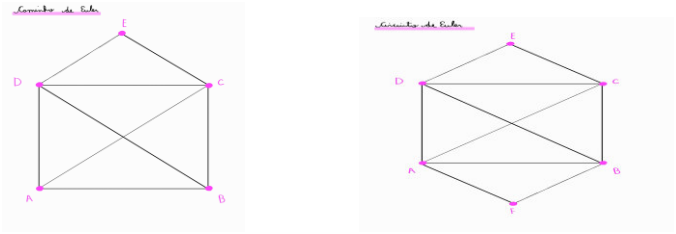
Next, the participants were instructed to trace a path that passed through all the points exactly once, without removing the pencil from the paper.

In addition, the mathematical rules related to Euler's Path were presented, which is characterized by using all the edges of a graph only once and starts and ends at distinct odd vertices. This graph is classified as semi-Eulerian and has an open path (Cardoso, 2017).

The mathematical analysis revealed that vertices A and B had grade 3, identifying themselves as odd, while vertices C and D had grade 4, being even. Vertex E, with grade 2, was also classified as even.

Activities involving the concept of Euler's Circuit. Basically, a path is defined that begins and ends at the same vertex. The graphs of this practice that meet this definition are classified as Eulerian and have all vertices of even degree (Cardoso, 2017).

In the example presented, vertices A, B, C, and D had degree 4, while vertices E and F had degree 2, characterizing a Eulerian graph with a closed path and length equal to the number of edges. Images are available below to assist in the visualization of the experiment:



Source: Authorship, 2025.

Although this experiment is based on mathematical concepts and the structural logic of graphs, it also brings practical teachings about life, reinforcing the need for planning, organization and persistence.

Life, like graphs, is made up of paths, connections, and choices, and it is essential to develop strategies to deal with challenges in a structured and assertive way.

In addition to the experiments presented, school reinforcement activities were also promoted. In the intervals between the experiments, support was offered in school tasks and studies for tests, ensuring greater confidence and understanding of the academic content by the participants.

In addition, any doubts related to different topics in the disciplines of chemistry, physics and mathematics were clarified throughout the process, providing a more dynamic and inclusive learning environment.

RESULTS AND DISCUSSIONS

The results observed were based on the feedback of the NGO's attendants and the participating students. The analysis allowed us to verify that both the school reinforcement and the experiments carried out contributed to the improvement of teaching-learning.

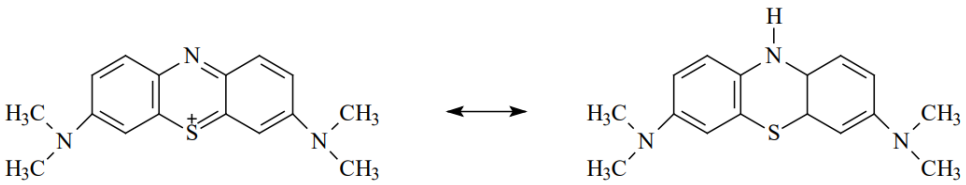
Through the "Furious Water" experiment, the participants understood Le Chatelier's Principle, which states that a system in equilibrium, when suffering an external disturbance, adjusts itself to minimize the effects of this interference, returning to the initial condition or reaching a new state of equilibrium (White, 2005).

The experimental activity aimed to provide students with an in-depth understanding of dynamic equilibrium, the reversibility of reactions, and the interdependence between

reactants and products (Reis & Costa, 2018).

Also according to Reis and Costa (2018), during the experiment, the blue methylene indicator (AM), when it comes into contact with glucose in a basic medium (with caustic soda), forms colorless leucomethylene.

The agitation of the system favors the dissolution of oxygen (O2(g)), which reacts with leucomethylene, regenerating methylene blue and returning to its original coloration. The reaction can be represented by the following chemical equation (REIS and COSTA, 2018):



This phenomenon illustrates a reversible reaction, in which the formation of the products is accompanied by the reconstitution of the reactants. The students were emphasized the importance of the double arrow, which symbolizes this mutual interaction between reagents and products, occurring inside a 250 mL container (PET bottle).

The results corroborate Cruz et al. (2021), who demonstrate that experimentation is an effective pedagogical strategy, capable of increasing students' motivation and engagement in the construction of knowledge.

When asked about their satisfaction with the experiment, all students expressed a positive appreciation for the activities carried out. In addition, they expressed interest in participating in more experiments of this type, because in addition to feeling more motivated, they were also able to view the content in a more playful way.

Through this project, in accordance with the considerations of Cruz et al. (2021), it was possible to observe that experimental practice effectively encourages students to actively participate in the teaching-learning process, to the detriment of the mere memorization of formulas and the exclusive focus on final results.

Teaching based on experimentation facilitates the visualization of the process of acquiring knowledge, contributing to students feeling more motivated to learn the discipline and establishing a closer connection with the content. Through experimentation, concepts become more concrete and understandable (Cruz et al., 2021).

With regard to the mathematical experiment Euler's Path and Circuit, the activity made it possible to learn through trials, requiring the students to complete the course without lifting the pencil from the paper and without overlapping lines. Thus, the need to reevaluate strategies and learn from previous experiences became evident, a concept applicable both to the academic sphere and to personal and professional life.

In addition, this experiment emphasized the importance of prior planning, avoiding impulsive decision-making. It was highlighted that the careful analysis of the problem and the identification of patterns are fundamental, since, for the resolution of the Circuit and the Euler Path, the identification of the correct structure of the graph is indispensable.

This approach can be applied to everyday situations, from performing routine tasks to making more complex decisions throughout life.

Although Graph Theory is not a mandatory content in the Basic Education curriculum, its introduction as a pedagogical tool can play a significant role in the development of students' cognitive skills (Vieira, 2024).

Contact with this mathematical abstraction favors the exploration of new knowledge and stimulates mathematical thinking aligned with logical and critical reasoning, promoting a broader and more reflective approach to the discipline (Vieira, 2024).

The National Common Curriculum Base (BNCC), a normative document that establishes the essential learning for Basic Education, presents specific Mathematics competencies that can potentially be developed through Graph Theory (Silva, 2021).

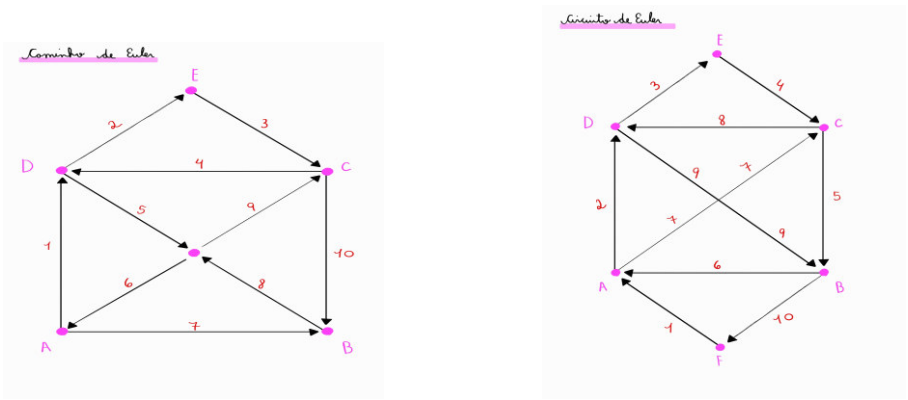
Among them, the following stand out: "Use of mathematical processes and tools", including digital technologies, to model and solve everyday, social, and interdisciplinary problems, validating strategies and results obtained, and solving problem situations in multiple contexts, including imagined or abstract scenarios, with the ability to express answers and synthesize conclusions using different languages and registers (Silva, 2021).

As Cardoso (2017) states, during the application of activities related to Graph Theory, it was possible to observe a largely positive response from the students.

The active interaction of students and engagement in solving the problems presented reinforce the feasibility of integrating this content in a light and accessible way into the educational environment (Cardoso, 2017).

Additionally, the drawing below illustrates one of the solutions obtained for Euler's Path and Circuit according to Vulcani (2015) and Cardoso (2017), showing continuous

movements performed without lifting or rewinding the pencil, going through each line only once:



Source: Authorship, 2025.

With regard to school reinforcement, it was found that it plays a fundamental role in the teaching-learning process, providing additional support for the understanding of curricular content and the development of essential skills (Andrade et al., 2022).

This action becomes even more relevant in contexts of social vulnerability, in which children and young people face difficulties in accessing quality education. According to Libâneo (2013), school reinforcement allows the personalization of teaching, favoring the assimilation of concepts and the development of cognitive skills that are fundamental for academic performance.

In this sense, the project developed contributed to the improvement of the academic performance of the students, proving studies that indicate that students who receive complementary educational support present significant advances in the understanding of the contents and in school performance (Vygotsky, 2007).

Another relevant aspect was the positive impact of school reinforcement on the students' self-esteem and motivation. According to Freire (1987), education should be a liberating process, allowing students to develop critical thinking and confidence in their ability to learn.

It was observed that, when they received adequate support and perceived their ability to overcome difficulties, the students showed greater engagement and motivation to continue with their studies, which can contribute to the reduction of school dropout rates.

In addition, school reinforcement helped to improve study techniques, enabling students to acquire more effective strategies to review and understand the contents. It is worth mentioning that this initiative not only enhanced academic learning, promoting more equitable and inclusive teaching.

In this scenario, the school reinforcement initiative provides a favorable environment for cultural insertion and integral human development, through continuous monitoring of learning (Lourenzini, 2012).

This monitoring allows the investigation and diagnosis of the individual needs of each student, identifying aspects that should be developed or enhanced (Lourenzini, 2012).

In the context of the extension project carried out in the NGO, also as stated by Lourenzini (2012), about what happens in the municipal school network of Foz do Iguaçu, the school reinforcement program was implemented with the purpose of mitigating factors such as school repetition and low academic performance, in addition to promoting significant improvements in the quality of education offered and in the school and social life of the students.

In general, the proposal of school reinforcement aims to foster academic advances, promoting a continuous interaction between the content addressed in the school environment and the reality experienced by the students, strengthening the link between theory and practice (Lourenzini, 2012).

In summary, the project contributed significantly to both the academic development and personal growth of the students involved, reinforcing the role of education as a tool for social transformation and strengthening individual autonomy.

CONCLUSION

Non-Governmental Organizations (NGOs) play a key role as agents of social transformation, promoting inclusive and quality education for individuals in vulnerable situations.

Through their initiatives, these institutions not only ensure the right to education, but also strengthen the foundations for these individuals to become protagonists of change

in their communities and in society as a whole.

Thus, social programs, such as the extension project carried out, demonstrate the relevance of initiatives that consider not only the academic needs, but also the emotional and psychological aspects of children and young people.

The promotion of comprehensive educational support contributes to the creation of a more welcoming school environment, favoring the sense of belonging and encouraging the personal and academic growth of students.

Furthermore, the intersection between education and human rights transcends simple access to school, encompassing a transformative educational process, based on the principles of human dignity and social equity.

From this perspective, the guarantee of the right to education becomes an essential mechanism for the construction of a fairer society, in which the rights of all citizens are respected and valued.

In this context, the project, through school reinforcement and experiments, demonstrated a significant impact on the education of the participating students. The results showed improvements in academic performance, greater motivation for studies and the development of more effective learning habits.

Such interventions are essential to promote greater equity in access to knowledge, reduce educational inequalities, and provide better academic and professional prospects for children and young people in vulnerable situations.

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