Chemistry experiments as a differentiator to improve teaching-learning

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ABSTRACT

This work was developed with underprivileged girls between 10 and 15 years of age enrolled in public schools in the city of Apucarana, State of Paraná, Brazil, hosted by NGOs. The proposal involved improving the participants' learning in mathematics, physics and chemistry. To gain the interest of this audience, the project carried out scientific experiments such as: chemical chameleon, atmospheric pressure, balloon, lemon stack and pH with cabbage. These experimental practices were involved in explanations and resolutions of exercises involving everyday life. The main doubts involved mathematics that were carried over to chemistry and/or physics exercises. Resolving difficulties in mathematics proved to be a differentiator in boosting interest in other areas, such as chemistry and physics. Among the experiments carried out, it was observed that the chemical chameleon and the pH with cabbage were better evaluated by the participants. The scientific experiments carried out helped to bring university students closer to underprivileged girls in the local community. However, the work promoted opportunities for academics to apply theoretical knowledge and develop and improve themselves as professionals.

Keywords: Underprivileged girls, Scientific experiments, Teaching-learning.

1 INTRODUCTION

The COVID-19 pandemic highlighted significant losses in terms of the quality of teaching and student learning in general. In the case of students in situations of social vulnerability and with economic difficulties, the damage was undeniable (REIS, 2022).

In Brazil, the COVID-19 outbreak occurred in the 2020 and 2021 school years, disrupting face-to-face teaching. This led to irretrievable losses in teaching and learning. In low- and middle-income countries, losses in children's and adolescents' education were extreme: about 70% of ten-year-olds could not read or understand a simple text, compared to 53% before the same year. (REIS, 2022; COELHO & REIS, 2022).

Brazil had high school dropout rates before the pandemic period and the main causes identified by the researchers were related to lack of family structure, unemployment, malnutrition, school, difficulties in assimilating content, among others. (QUEIROZ, 2001; SANTOS, 2020; FERREIRA et al., 2020; ANDRADE *et al*., 2022; GARÇAO et al., 2021).

Regarding the pandemic period, the few data already available show that as student poverty increased, the time spent on studies was lower, either in terms of amount of exercise or time spent on schoolwork (NERI, 2022). A fact that corroborates the widening of social and educational asymmetries. Social vulnerability also collaborates to obtain unqualified work from those who explore the crianças in infância até os que desmotivam projetos e perspectivas prossionais (GOMES & PEREIRA, 2005; RODRIGUES *et al*., 2021).

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In view of these facts, the face-to-face extension project was developed to recover the teaching-learning of needy young people in situations of social vulnerability, hosted by a non-governmental organization that requested support from the UTFPR to establish a parallel with the classroom, complementing other issues related to the main difficulties of practice experienced in the classroom.

This project was carried out with needy and vulnerable girls with the main objective of clarifying doubts in physics, chemistry and mathematics, promoting integration between students and professionals.

2 METHODOLOGY

The project was carried out at the NGO's facilities on a weekly basis, with the aim of clarifying doubts in the field of physics, chemistry and mathematics regarding the content of the schoolwork of the girls in care. The work was carried out with individual assistance and/or small groups of children depending on the level of difficulty. (PARANÁ, 2019).

To encourage learning, scientific practices and/or experiments were carried out such as: chemical chameleon, atmospheric pressure, balloon, lemon pile and pH with cabbage.

To perform the chameleon chemical experiment adapted from ROYAL SOCIETY CHEMISTRY (2022) the following materials were needed: a 100 mg potassium permanganate tablet (purchased at the pharmacy); water, three teaspoons of confectioners' sugar; one teaspoon (disposable spoon) of sodium hydroxide (caustic soda), two disposable 500 mL cups, and two wooden chopsticks.

The tablet was crushed in a disposable cup (pack 1) with the help of a wooden stick and 300 mL of water (violet solution) was added. In the other glass (container 2) 300 mL of water and sugar

were added, after homogenization sodium hydroxide (colorless solution) was added. With the solutions ready, the liquid from container 1 was transferred to container 2, confirming the different colors (purple, green, and brown).

When performing the experiment at atmospheric pressure, the following was required: a straw and a glass of water. First we fill a glass with water to about a third of its capacity, then we take the straw and immerse it in the water by applying light pressure to the tip of the straw with our index finger. This experiment combined knowledge of physics and climate as a function of pressure (SEARA DA CIÊNCIA, 2019) with hands-on activities in pipetting laboratories. (ABNT, 2007).

In the balloon experiment (SODRE *et al*., 2019) the following were needed: a plastic bottle, a bladder, vinegar and baking soda. The procedure of the experiment was carried out as follows: about a third of vinegar was added to a small 237 mL PET bottle and then two dessert spoonfuls of baking soda were added to the bladder. Chemical reactions between the reactants filled the bladder.

To start the lemon battery experiment (FRAZETO *et al*., 2016) the following materials were used: two lemons, a copper wire, two copper coins, two zinc nails and a voltmeter.

Initially, the lemons were squeezed to increase the availability of liquid in direct contact with the clove and coin by inserting a zinc nail and a copper coin into each of the lemons. A copper wire was then attached to the coin and nail with the help of alligators. The energy of this system was measured with the help of a voltmeter.

In a practical pH indicator with red cabbage juice (PRADO *et al.*, 2019), it was possible to identify basic and acidic substances. Red cabbage water (obtained by heating 200 g of chopped cabbage with enough water to cover it for 20 minutes) tested materials such as: bleach, vinegar, wine, water and alcohol.

3 RESULTS AND DISCUSSION

The doubts of the girls welcomed in this project focused on mathematics, with the main subject being polynomials. According to Rodrigues & Magalhães (2012), problem solving is a very effective methodology for teaching mathematics, as it provides a mobilization of knowledge to find a solution, thus causing the student to want to learn more.

In this search, the student learns to put together strategies, reason logically and check if their strategy was valid, which contributes to the maturation of cognitive structures (RODRIGUES & MAGALHÃES, 2012).

The chameleon chemistry experiment was a very important topic in chemistry, as it teaches us clearly and objectively about the variation in the NOx of chemical elements. The phenomena of oxidation and reduction are very present in everyday life, through which we can differentiate, for

example, whether a food is acidic (e.g., lemon) or basic (e.g., pineapple) in pH values (AQUINO *et al*., 2016).

Explanations of the chameleon practice involved the violet permanganate ion (MnO_4^-), which when reduced to a manganate ion (MnO_4^{2-}), changed the color of the solution to green, which when reduced again became a brown solution. due to manganese dioxide (MnO_2), as evidenced by chemical reactions (AQUINO *et al*., 2016):

$$MnO_4^- + 4H^+ + 3e \rightarrow MnO_2(s) + 2\ H_2O$$

$$MnO_4^- \xrightarrow{+e} MnO_4^{2-}$$

For elementary school children, this experiment allowed the use of positive and negative numbers with a colorful approach (DOLZ, 2018).

In the atmospheric pressure experiment, children could be observed associating the physical concept with the use of a pressure cooker to cook food and high or low blood pressure in the human body. These interactions make it possible to integrate scientific knowledge into the real world of the project participants (SEARA DA CIÊNCIA, 2019).

By definition, we know that atmospheric pressure is the force exerted by the mass of gases in the atmosphere on a given surface; We can also contextualize it by highlighting that when we are at sea level we are under the action of high atmospheric pressure, since the amount of gases above us is greater, unlike what we have in a mountain, that is, low pressure (LONGHINI & NARDI, 2009; SEARA DA CIÊNCIA, 2019).

This also applies to climate, for example, in the atmosphere, low air pressure is associated with the formation of many clouds, with rain and ultimately with adverse weather conditions, with thunderstorms. On the other hand, high pressure is identified as areas with blue skies or few clouds, with lower humidity in the air, with dry weather, without rain (LONGHINI & NARDI, 2009).

The concept of pressure demonstrated with the straw and thumb demystified the concept that pipetting in the lab is difficult or beyond the professional possibilities of the children in this project.

Filling the bladder without the use of the lungs, because the baking soda reacts with vinegar (acetic acid) to produce carbon dioxide, allowed us to visualize effervescence, gas retention (by the globe) and discussions about CO_2 in the environment. (CUNHA & SCALCO, 2013).

In addition, the students noted some practical uses of these ingredients, such as the fact that baking soda and vinegar are used for household cleaning (degreaser) with the ability to kill some bacteria (due to their low pH).

The lemon battery experiment was extremely important for the development of current scientific knowledge and allowed students to integrate the knowledge of electricity present in homes, in machines and even in the human body.

Chemistry (electron) and physics (electricity) could be integrated with biology (biochemistry) and economics (cost of the electric bill) in addition to reinforcing concepts of positive and negative numbers in mathematics since the electrons contained transit from the negative pole to the positive pole, lighting up the LED lamp (BROWN *et al*., 2005).

In this battery (FRAZETO *et al*., 2016) the closed loop oxidizes the zinc while the copper is reduced, i.e. there are zinc ions ($Zn\ 2^{+}$) that pass into the solution (lemon pulp) that can be neutralized by the citrate ions. (Ionization of citric acid, bitter taste of lemon). The movement of the loads managed to generate enough power for the LED.

The pH results with the red cabbage juice were easy to identify, since in the vinegar we obtained a pink color that indicated an acidic pH, i.e. around 2; when the wine is introduced, we observe a pH around 8, indicating that it is slightly alkaline (dark blue color); with alcohol, a pH around 8 was observed, also slightly alkaline (dark blue color); with water, the pH was 7, indicating that it is neutral (light blue color); With sanitary water, the pH recorded was between 12 (light green) (DOLZ, 2018).

The explanation of the pH indicator experiment was made because the variation of its scale is up to 14, differentiating the value 7 as the neutral value as well as the values below (acidic) and above (basic) of this level.

We can observe numerous applications of pH, as well as in our body the gastric juice in our digestive system is around 1.5 to 2 on the pH scale, this contributes to better digestion and favors the absorption of food, among other examples. Remember that a very basic or very acidic pH can cause great damage to our skin and/or health (DOLZ, 2018).

The project managed to attract the attention of students by employing simple experiments that can be replicated by students, as easily accessible and widely marketed materials were used. Between the experiments, a greater chemical interaction of the chameleon and pH with the cabbage was observed.

Experiments combined with the learning of chemistry, physics and mathematics can be a differentiator for the assimilation and integration of the contents covered.

4 FINAL THOUGHTS

This project was planned to improve the teaching-learning of the subjects covered in the classroom, in addition to providing additional information such as the scientific experiments carried out, comprehensively benefiting the participants, facilitating their student trajectory and opening horizons for new stages.

Outreach projects involving college students and public school elementary and high school students have the potential to enhance the personal growth of graduates and children and youth in need, generating citizens more capable of facing future challenges.

The scientific experiments of chameleonic chemistry, atmospheric pressure, balloon, lemon pile and pH with cabbage turned out to be a differentiator in learning and a facilitator in the integration and interaction of students with the university students and professionals involved.

The work provides an opportunity for academics involved in the subjects (chemistry, mathematics and physics issues) to excel, improving their ability to contextualize in a simple and multidisciplinary way (exercises and scientific experiments) the learning needs of disadvantaged girls in situations of social vulnerability. addressed in this project.

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REFERENCES

ABNT. NBR ISO 1769. Vidrarias de laboratório. Pipetas. Código de cores. Abr. 2007.

AQUINO, R. A. N., et al. (2016, September). Camaleão químico. In 26ª Mostra Específica de Trabalhos e Aplicações.

ANDRADE, M. P. C., et al. Inter-relação entre acadêmicos com crianças e jovens carentes em situação de vulnerabilidade social para melhoria do ensino básico de matemática e ciências. Brazilian Journal of Development, v. 8, p. 3794, 2022.

BROWN, T.L., et al. Química A ciência central. 9. Ed. Pearson Prentice Hall ed. 2005.

CUNHA, C. A.; SCALCO, P. R.. Crescimento econômico brasileiro e emissão de CO2. 2013.

DOLZ, J. (2018). Escrever uma explicação química no primeiro ciclo: o sumo de couve roxa, um verdadeiro camaleão químico. Literacia científica na escola, 118, 14.

FERREIRA, E. C. S. .; OLIVEIRA, N. M.. Evasão escolar no ensino médio: causas e consequências . Scientia Generalis, [S. l.], v. 1, n. 2, p. 39–48, 2020. Disponível em: http://scientiageneralis.com.br/index.php/SG/article/view/v1n2a4. Acesso em: 2 ago. 2022.

FRAZETO, G. P., et al. (2016). Produção de pilhas com materiais alternativos. etic-encontro de iniciação científica-ISSN 21-76-8498, 12(12).

GARCAO, M. I. L., et al. Fortalecimento do ensino-aprendizagem para meninas carentes em situação de vulnerabilidade. Brazilian Journal of Development, v. 7, p. 30074, 2021.

GOMES, M. A.; PEREIRA, M. L. D. Família em situação de vulnerabilidade social: uma questão de políticas públicas. Ciência & Saúde Coletiva, v. 10, n. 2, p. 357-363, 2005.

LONGHINI, M. D.; NARDI, R. Como age a pressão atmosférica? Algumas situações-problema tendo como base a história da ciência e pesquisas na área. Caderno brasileiro de ensino de física, v. 26, n. 1, p. 7-23, 2009.

NERI, M. C., OSORIO, M. C. Retorno para Escola, Jornada e Pandemia. Rio de Janeiro: FGV Social, 2022.

PARANÁ. Assembleia Legislativa do Estado do Paraná. Projeto de Lei nº7 497/2007. Decreta: a utilidade pública do Centro para o Resgate a Vida Esperança (CEPES).

PRADO, R. M. S., et al. (2019). A importância da experimentação para o ensino-aprendizagem da química: o repolho roxo como indicador ácido-base para verificação de pH com estudantes do ensino médio público. In VI Congresso Nacional de Educação: avaliação, processos e políticas. Fortaleza/CE.

QUEIROZ, L. D. Um estudo sobre a evasão escolar: para se pensar na inclusão escolar. Associação Nacional de Pós-Graduação e Pesquisa em Educação (ANPAD), 2001. Disponível em: <http://www.educacao.go.gov.br/imprensa/documentos/arquivos/15%20-%20Manual%20de%20Gest%C3%A3o%20Pedag%C3%B3gico%20e%20Administrativo/2.10%20Combate%20%C3%A0%20evas%C3%A3o/UM%20ESTUDO%20SOBRE%20A%20EVAS%C3%83O%20ESCOLAR%20-%20PARA%20PENSAR%20NA%20EVAS%C3%83O%20ESCOLAR.pdf. Acesso em: 12 de abril de 2022>.

REIS E. M. Covid-19: Extensão da perda na educação no mundo é grave, e é preciso agir para garantir o direito à Educação, alerta UNICEF. Nova Iorque, 24 de janeiro de 2022. Disponível em: < https://www.unicef.org/brazil/comunicados-de-imprensa/covid-19-extensao-da-perda-na-educacao-no-mundo-e-grave >. Acesso em: 23 jan. 2022.

RODRIGUES A.; MAGALHÃES S. C. A resolução de problemas nas aulas de matemática: diagnosticando a prática pedagógica. Setembro 2012. Disponível em: < http://www.educadores.diaadia.pr.gov.br/arquivos/File/setembro2012/matematica_artigos/artigo_rodrigues_magalhaes.pdf>. Acesso em 10 out. 2022.

RODRIGUES, L. B., et al. Ensino de informática para meninas com ênfase no pensamento computacional / Teaching information technology to girls with an emphasis in Computational Thinking. Brazilian Journal of Development, v. 7, p. 100732-100741, 2021.

ROYAL SOCIETY OF CHEMISTRY. Demonstrating the chameleon redox reaction with a lollipop. Technician notes. 2022. Disponível em: < https://edu.rsc.org/exhibition-chemistry/demonstrating-the-chameleon-redox-reaction-with-a-lollipop/4016633.article>. Acesso em: 03 fev. 2023.

SANTOS, J. A. Reflexões sobre evasão escolar: uma problemática na educação brasileira. Revista Teias. v.1, n.1, 2020.

SEARA DA CIÊNCIA. Efeitos da pressão atmosférica. Universidade Federal do Ceará. 21 out. 2019. Disponível em:<http://educapes.capes.gov.br/handle/capes/498507>. Acesso em: 15 out. 2022.

SODRE, F.G.; et al. Balão que enche sozinho: experimento que favorece a compreensão de conceitos de ciências por alunos de escolas públicas do município de Confresa/MT. Anais do 59º Congresso Brasileiro de química. João Pessoa, PB; CBQ. Nov. 2019. Disponível em: <http://www.abq.org.br/cbq/2019/trabalhos/6/1675-27270.html>. Acesso em 03 nov. 2022.

UTFPR retoma as aulas presenciais depois de dois anos. Veiculado pela RPCTV no dia 03/03/2022. Disponível em: <http://www.utfpr.edu.br/videos/videos-home/utfpr-retoma-as-aulas-presenciais-depois-de-dois-anos>. Acesso em 22 dez. 2022.

UTFPR – Universidade Tecnológica Federal do Paraná. Extensão. Disponível em: < http://www.utfpr.edu.br/extensao/faq>. Acesso em: 24 mar. 2023.