

Evaluation of the Use of Low Cost Material in Experimentation in Science Education: A Powerful Pedagogical Resource

Luiz Cláudio da Silva Crisóstomo¹, Márcia Machado Marinho², Emmanuel Silva Marinho¹,
Gabrielle Silva Marinho³

¹Chemistry Department, Ceará state University-FAFIDAM-UECE, Limoeiro do Norte, Ceará, Brazil - 62930-000

²Pharmacy Department, Federal University of Ceará, Fortaleza, Ceará, Brazil - 62430-160

³Pedagogy department, Ceará state University-FECLI-UECE, Iguatu, Ceará, Brazil - 62500-000

Email address: gabrielle.marinho@uece.br

Abstract— The experimentation in the teaching of Chemistry, becomes an essential tool for success in the process of teaching learning, since they stimulate the interest of the students in the classroom, thus raising in the student the critical, curious spirit, the non-acceptance transferred. Faced with the difficulties of performing practical activities due to lack of space or appropriate material, it is necessary for the teacher to seek new methods to promote a teaching with real meaning and good results. The use of practices with alternative materials becomes an excellent tool. The methodology was applied in four moments, applying a questionnaire in the first moment, assembly of a simple distillation apparatus with low cost materials in the second moment, application of another questionnaire in the third moment and test of the *in vitro* distillate, using a solution of Silver Nitrate in the fourth moment. In this context, the objective of the research was to investigate whether the use of alternative materials, in practical classes, favors the learning teaching process in the construction of knowledge in the teaching of Chemistry and Sciences. Before the experiment, it was noticed that the students already had a limited knowledge on the subject, after realizing the practice; it was observed improvements in knowledge, thus showing the advantage that is to unite theory and practice. We can conclude that experimentation together with theory is a viable, interactive and efficient way of developing knowledge, since one consolidates the other in its actual realization, and proves the possibility and efficiency of using an experiment with low cost materials.

Keywords— Cost material, experimentation, evaluation, science education.

I. INTRODUCTION

Chemistry is a branch of the natural sciences that studies the composition of matter and its transformations, and therefore has an experimental character, after all when it is reported about this science in schools or other environments, then highlights the importance of the experiment to better understand the content, well understood, when it is possible to interconnect it with the day to day, that is, to contextualize it. However, the reality of many schools is a decontextualized and non-interdisciplinary teaching, generating difficulties in the students' learning and consequently creating a certain discomfort, [1] structured around activities that lead to the memorization of information, formulas and knowledge that limit learning and contribute to the lack of motivation in learning and studying Chemistry, [1] "since teaching is not always carried out in which school content is approached with students' daily lives. According to Rocha and Vasconcelos, [2] in the current scenario there is a "need to speak in chemical education prioritizing the teaching process of learning in a contextualized, problematizing and dialogical way", so that students can understand the importance and function of this Science on a daily basis. In order to achieve a contextualized teaching that brings real meaning to the student, it is necessary to insert and use different methodologies besides traditional ones, such as games, movies, simulations, hypertexts and experiments, that contribute to the teaching of Chemistry [3]. In relation to the various methodologies that have been

discussed, the use of experimental activities is emphasized, considered by many teachers as essential for the proper development of teaching [4], since the use of the experiment "is closely intertwined with the pedagogical function of assisting the Student in the explication, problematization, discussion, that is, in the meaning of the chemical concepts [5].

"In addition to being an activity that arouses interest in students of different levels of education, giving it a playful and stimulating character [6], which makes it an excellent methodology for the development of meaningful learning. "The experimental activity approach enables the student to understand the chemical processes and the construction of a scientific knowledge in close relation with its technological applications and environmental, social, political and economic implications." Since, according to Lima and collaborates [8], Apprentice to build a better relation or assimilation between the theory approached in the classroom and the proposed experiment, bringing the content worked with day-to-day situations of the students. Baratiere and collaborates [9] mention that when the teacher encourages students to perceive cognitive conflicts, experimental activities assume a constructivist character, as they lead them to seek and confront information, thus reconstructing ideas and ways of explaining problems.

The idea that the Chemistry laboratory is an expensive environment filled with sophisticated equipment, glassware and reagents becomes an obstacle to frequent experimental

classes [10]. Thus, practical activity needs to be explored to its limits, or Be performed at various locations throughout the school, including the classroom. In this sense, the adoption of experimental practices with alternative materials, becomes a viable exit [11], being the teacher being creative in the process of teaching learning, improvising and creating some materials for use in activities, which in turn can be done up to Own classroom.

The adaptation of laboratory equipment and the use of low cost materials in chemistry classes is a way of making experiments feasible in schools [9], and bringing the material closer to the reality of the school community. Another positive impact from the use of experimentation with low cost materials in the view of Oliveira e Silva [10] is the reduction of the cost of laboratory use and less production of chemical waste. Per Valadares [12], this "strategy allows students to develop new skills and seek alternative and cheaper solutions, which is the basis of research and development conducted in technology labs." Based on the idea of working in the teaching of chemistry with alternative materials for positive contributions to students and the school community, this study aimed to test the efficiency of an experiment made with low cost materials for the teaching of chemistry in a public school of the state network located in Limoeiro do Norte, Ceara. This city belongs to the region of Jaguaribe valley, and is known as little princess of the valley, and is located between the two great rivers of Ceara, Jaguaribe river and Banabuiú. In terms of education, Limoeiro do Norte has from childhood to higher education, and it is in this land that one of the campuses of the State University of Ceara (UECE), the Faculty of Philosophy Dom Aureliano Matos (FAFIDAM), acting in formation of Teachers in the region, in addition to the existing schools here, is no exception, also having difficulties with lack of some essential materials for the accomplishment of experimental activities, thus justifying the need to elaborate educational practices with alternative materials to work sciences in the Schools in these lands and in the Jaguaribe Valley.

II. METHODOLOGY

The work is classified as reflective, of a qualitative nature, having as a way of collecting data evaluation questionnaires with objective questions. It was carried out with 15 high school students from the first year of high school of a public school of the state network belonging to the city of Limoeiro do Norte-Ce. The theme of the work was simple distillation, the subject of blend separation that they had already studied in theory. To carry out a practice on this subject was made a homemade distiller with very simple materials, to make accessible to all and all schools. Noting that the apparatus has been prepared according to the laboratory distiller, with all materials adapted. A detergent tube was used as a condenser, a bulb of a bulb as a distillation flask, a transparent hose to connect the bulb to the condenser, the Bunsen nozzle was replaced with a lamp, the apparatus holder was made with pieces of wood (fig 01).

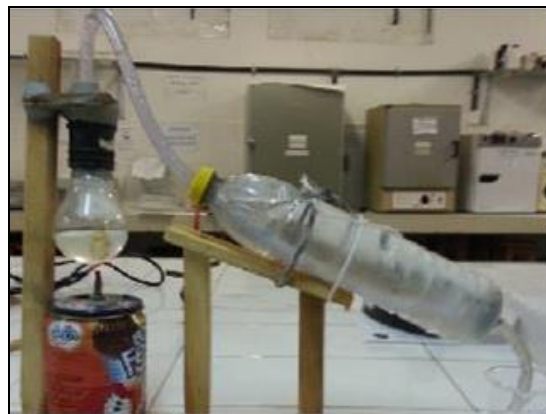


Fig. 1. Homemade distiller made with low cost materials.

The activity was divided into four moments. At the first moment, a presentation was made to explain the purpose and purpose of the research and a questionnaire, pre-test, was applied with the purpose of probing what the students already knew about the proposed subject. In the second moment the assembly and execution of the homemade distiller and explanation of the subject was carried out, at this moment there was the explanation about simple distillation, state of the matter, physical states of the water, melting point, boiling, discussion about water evaporation and condensation, assimilation Between the simple distillation experiment and the rainfall phenomenon among other relevant subjects that can be worked in the room with this experiment, this experiment was used to separate the water from the Sodium Chloride. In the third moment, a questionnaire was applied again, the post-test and to finish, in the fourth moment the distillate test with Silver nitrate solution was carried out, this one had to test the effectiveness of the apparatus made with low-cost materials.

III. RESULTS

With the objective of ascertaining the students' knowledge of the process involved in simple distillation, a first questionnaire was applied to probe the knowledge of the same. This questionnaire contained objective questions about the concept of simple distillation, classification of mixtures, melting point and boiling of water, correlation between the distillation process and daily phenomenon as rainfall formation. When the questionnaires were analyzed, it was observed that most of the students had a superficial knowledge about the subject, limiting themselves to descriptions of the textbook, without being able to relate to their daily life, in this first questionnaire, the level of correct answers was between 25- 50% (fig. 2).

In another moment, the assembly and execution of a distiller with low cost materials was carried out, at the moment it was discussed about concepts involved in the simple distillation process and its correlation with the rainfall formation in the day to day, since this process of the distillation Is similar to the formation of rains when it comes to water heating, evaporation and condensation, and with this in addition to the state of matter, it is possible to work melting

point, boiling, physical states of water and concepts relevant to the theme linked to the day To students' day.

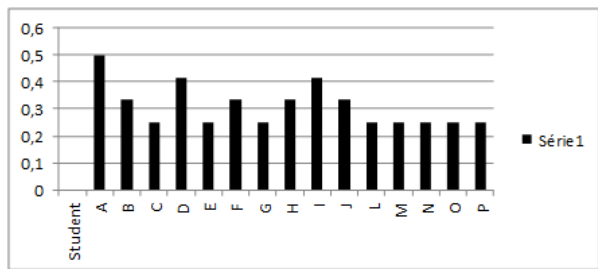


Fig. 2. Performance of students during the pre-test.

The experiment was also performed with an industrial apparatus, a homogeneous mixture of water and sodium chloride, was inserted into the bulb of the lamp, it was heated until reaching the boiling point, using the lamp as a source of heat. The water turned to steam, and through the hose passed through the detergent tube where it contained ice water, and in these situations, the water vapor in contact with the colder temperature, returned to being liquid.

After the experimental activity, a questionnaire, the post-test, was again applied to verify if the use of the experiment with alternative materials would have had some effect on the students' learning. And with the analysis of the post-test (Fig. 3), it can be observed that the level of correct answers turned around 60-100%, thus showing a positive performance in relation to the use of the experimental activity in the teaching of Chemistry.

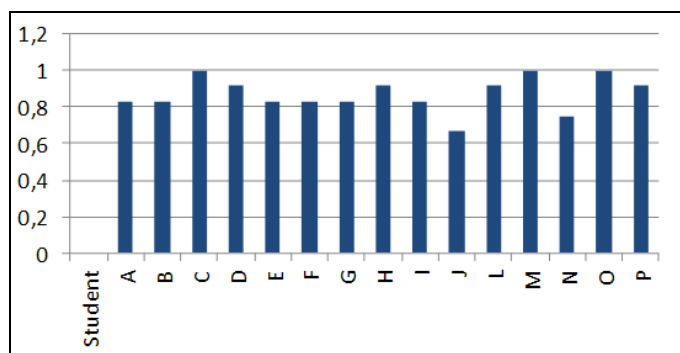


Fig. 3. Performance of students during the post-test.

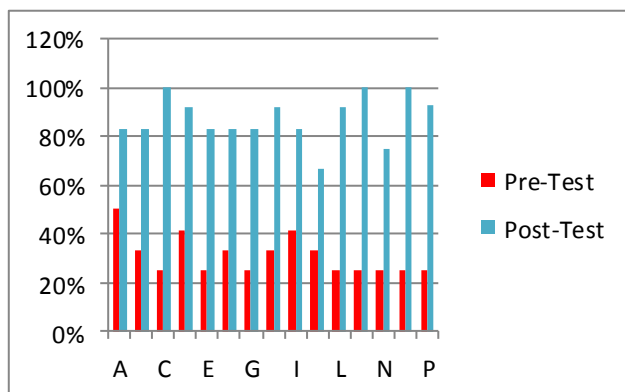


Fig. 4. Comparison between pre-test and post-test of students.

When comparing, the results obtained in the post-test (fig. 4), with the results obtained in the pre-test, a positive variation was observed in the students' conception comparing before and after the practical activity. There was a variation between 33-75%, which may best demonstrate the positive aspect of the union between theory and practice

In order to prove to the students the effectiveness of the distiller made with low cost materials, it was proposed to prove them by means of a test. For this, a portion of the distilled liquid was collected and subjected to silver nitrate testing. Three samples were used for testing with the silver nitrate solution, laboratory distilled water, sodium chloride solution and distilled water using the alternative apparatus. When mixing one mL of silver nitrate in each of the samples, it was observed that there was a change in sodium chloride solution, forming a precipitate, while the samples of distilled water both in the laboratory and in the experiment did not change, Thus being able to prove the effectiveness of the alternative apparatus for teaching chemistry (fig. 1).

When mixing a solution of silver nitrate to a solution of sodium chloride, a reaction known as a double exchange reaction with formation of precipitate occurs, where as product is silver chloride (precipitate) and sodium nitrate. In this way, as the distilled water using the homemade distiller did not change, efficiency of the low cost appliance was proved, When mixing a solution of silver nitrate to a solution of sodium chloride, a reaction known as a double exchange reaction with formation of precipitate occurs, where as product is silver chloride (precipitate) and sodium nitrate. In this way, as the distilled water using the homemade distiller did not change, efficiency of the low cost appliance was proved (Fig 5).



Fig. 5. Image of the distillate test. Laboratory Distilled Water (A), Sol. Sodium Chloride (B) and Water from the homemade distiller (C).

IV. CONCLUSIONS

From the analysis of the results obtained it can be said that the experiment was carried out in a satisfactory way, both on the pedagogical side and on the scientific aspect. Since it contributed to improvements in students learning and at the same time carried out work with similar characteristics to that carried out in a laboratory.

Thus, it is concluded that experimentation together theory is a viable and interactive way of developing knowledge, since one depends on the other for its actual realization. And with the distillate test carried out in the school, in front of the

students, we proved the effectiveness of the alternative apparatus, and proved that the alternative experiment with low cost materials is a tool of excellence of quality, and that can and should be used in teaching Chemistry and the sciences in general.

ACKNOWLEDGMENT

The State University of Ceará (UECE), in particular the coordination of the licentiate course in Pedagogy, the Faculdade de Educação, Ciências e Letras de Iguatu (FECLI), the Pro-Rectory of Graduate Studies and Research (PROGPQ/UECE), Pro-Rectory of Extension (PROEX/UECE) for the support of this work .

To Coordination for the Improvement of Higher Education Personnel (Capes), founding of the Ministry of Education (MEC), for granting a scholarship as financial support for scientific development.

REFERENCES

- [1] J. N. Silva, J. S. Amorim, L. P. Monteiro, Freitas, K.H.G. "Low-cost experiments applied to the teaching of chemistry: Contribution to the teaching-learning process," *Scientia Plena*, vol. 13, no. 1, 2017.
- [2] J. S. Rocha, T. C. Vasconcelos, "Difficulties in the teaching of chemistry: Some reflections," XVIII National Meeting of Teaching of Chemistry (XVIII ENEQ) Florianópolis, SC, Brazil - July 25-28, 2016.
- [3] L.P Castro, C.M.R. Ribeiro, Supporting material for the teaching / learning process of Experimental chemistry for high school: Elaboration, application and evaluation," *Teaching, Health and Environment*, vol. 9, no. 2, 2016.
- [4] C. C. Reginaldo, N. J. Sheid, R.I.C. Gullich, Science teaching and experimentation, IX ANPEDSUL, Caxias do Sul-RS, Brazil, 2012.
- [5] S.O. Martins, J.R. Ferreira, R.L. Monteiro, R.F.Souza, "The teaching of thermochemistry using experimentation with low cost materials," *Scientia Plena*, vol. 12, no. 6, 2016.
- [6] K. G. Gonzales, E.G. Gonzales, J. Sabino, R.F.Ribeiro, "Reflections on the role and contributions of experimentation in science teaching," *UNOPAR Sci., Ciênc. Human. Educ., Londrina*, vol. 16, No. 5, 2015.
- [7] M. V. Dias, P.I.C. Guimarães, F. Merçon, Natural dyes: extraction and use as a pH indicator," *New Chemistry in the School*, No. 17, 2003.
- [8] A. O. Santos, R.P .Silva, D. Andrade, J.P.M. Lima, Difficulties and motivations of learning in Chemistry of high school students investigated in actions of (PIBID / UFS / Química)," *Scientia Plena*, vol. 9, no. 7, 2013.
- [9] S. M. Baratiere, N. R. S. Basso, R. M. R. Borges, J. B. Rocha Filho, Students' opinion about experimentation in Chemistry in high school," *Experiences in Science Teaching*, vol. 3, 2008.