Original article

# Experimental chemistry activities for the improvement of the teaching-learning process in eighth grade

Darialys Fajardo-Casas[1*] https://orcid.org/0000-0002-3731-6127

Danay Bellot Naranjo[1*] https://orcid.org/0000-0003-0836-3714

[1]Universidad de Camagüey Ignacio Agramonte Loynaz. Camagüey. Cuba.

*Autor por correspondencia: darialys.fajardo@reduc.edu.cu

**ABSTRACT**

The objective of the research was to apply experimental activities designed to improve the teaching-learning process of chemistry in the eighth grade. Theoretical, empirical and mathematical-statistical methods were used. Among the empirical methods, observation, documentary analysis and survey were used. It is concluded that the application of the experimental activities allowed to verify their effectiveness based on the results achieved by the students in the final diagnosis, among which it is worth mentioning the appropriation of chemical contents, the identification of the laboratory utensils and the interest in the study of the subject.

**Keywords:** Improvement; Teaching-learning process; Chemistry; Experimental activities.

## Introduction

The Basic Secondary School today is immersed in a process of transformations that takes the results of educational work and learning to higher levels, as required by Cuban educational policy.

Within the group of subjects that students receive at this educational level, Chemistry is included, which is considered an essentially experimental science, therefore, its

teaching-learning process (PEA) is closely related to practical activity, linked to its object of study: substances and their transformations. (Bellot, 2004).

In the PEA of natural science subjects, experimental activity plays an essential role, for this reason, in order to fully understand it, it is necessary that theoretical and practical knowledge be developed at the same time, which is not the case most of the time, since students have difficulties in applying theoretical knowledge to practice. The above described evidences the importance of the systematic realization of experimental activities in chemistry in the training of students because it provides them with ways and procedures for the development of practical skills. (Rodríguez-García & Rodríguez-Betancourt, 2015).

Experimental activity plays a decisive role in certain aspects of this process as: source of knowledge, necessary and sometimes unique means to demonstrate the validity or not of hypotheses, for the formation of skills and habits in this science, to form interests in students towards the study of Chemistry, and it is also important for the formation of the scientific conception of the world.

However, in spite of the importance of the development of experimental activity in Chemistry classes, they are not always carried out in an adequate way in schools of the Basic Secondary education level. This causes that the quality of the PEA of this subject does not provide the necessary elements to achieve in the students the general integral formation demanded by the Cuban educational policy.

The above is evidenced in the following regularities: students have insufficient knowledge regarding experimental activity; they generally do not identify the utensils, nor do they establish the correct relationship with their functions; difficulties in the appropriation of knowledge related to the realization of experimental activities. Teachers have limitations in the theoretical and methodological knowledge that guide them on the procedures to follow in the realization of experimental activities.

This made it possible to identify as a scientific problem:

How to contribute to the realization of experimental activities in the PEA of Chemistry, 8th grade of the Mixed School Victoria de Girón?

The realization of experimental activities in any of its variants contributes to the development not only of manipulative skills in students but also, and above all, to the development of thinking and with it the scientific analysis of reality.

Through the use of experimental activities, a solid relationship is established between theory and practice, the criterion of practice as a criterion of truth is reaffirmed and scientific thinking is developed, so its use consolidates essential aspects of the ideological position from which the subject is based. (Polanco, Martínez & López, 2019)

For all of the above, if it is assumed that the aforementioned regularities bring about deficiencies in the PEA of the subject, the authors considered it important to address the subject in question. That is why the objective of the research is to apply experimental activities designed in Unit 1 Substances and chemical reactions for the improvement of the teaching-learning process of the subject in the 8th grade group 9 of the Mixed School Victoria de Girón.

# Development

According to Plutin & García (2016), among the main transformations in Cuban education since the 2014-2015 academic year is the current model of Basic Secondary School that is in correspondence with the scenarios in which Cuban education develops, tinged by the socioeconomic changes that are developing in a vertiginous way in Cuba and reflects the level of concreteness of the educational policy outlined by the Party and needed by Cuban society.

It is the opinion of the previous authors that one of the problems that most worries the teachers of Secondary Education is the passivity and lack of motivation of the students in the learning of sciences in general, and of Chemistry in particular. For this reason, there are many researches interested in modifying the PEA of chemistry at this educational level.

Today's schools are increasingly assuming the responsibility of educating new generations. This process must provide students with solid knowledge, skills and habits on the basis of science, as well as form in them convictions, values, behaviors, feelings, among other qualities of personality, which allow them to interact with the modern world and transform it for the good of humanity.

In the TLP of Chemistry, experimental activities are of vital importance due to the functions they play in the formation of the new generations and especially for their scientific education, as they increase the motivation of students towards learning chemical phenomena and processes when they observe or perform an experiment. These experimental activities influence students' emotions and make possible the appropriation of solid (lasting and applicable) knowledge.

For the development of this research, it was considered necessary to analyze the concepts of teaching-learning process and experimental activity:

The definition assumed of process, is the one given by Duanes (2009), because really the process is "... as a systematic transformation of phenomena subjected to a series of gradual changes, whose stages follow one another in ascending order; for such reason every process can only be understood in its dynamic development, its transformation and constant movement".

Referring to the term teaching, Castellanos (2002), points out:

> The essence of teaching is the transfer of information through direct communication or supported by the use of auxiliary means, its objective is to ensure that individuals are left as traces of these combined actions, a reflection of the objective reality of their surrounding world, which in the form of knowledge of it, skills and abilities, empower them, and therefore allow them to face new situations in an adaptive way, appropriating and creating the particular situation that has arisen in their environment. (p. 14)

Teaching is there for learning, without it, learning is not achieved to the extent and quality required. The latter process is extremely complex in nature.

Castellanos (2002) defines it as "a process characterized by the appropriation of new knowledge, skill or ability, which must manifest itself in the future and contribute to concrete solutions, even different in essence from those that initially motivated the development of the knowledge, skill or ability".

The above reveals that both definitions, teaching and learning are dialectically related, one does not exist without the other, they should not be seen as isolated processes, they complement each other, to enhance the development of the subject.

In this regard, the authors share the criteria of Gonzalez & Reinoso (2002), regarding the definition of the teaching-learning process as "a socialization process in which the student takes an active and responsible position in his or her education, where he or she is both creator and consignee of the socio-cultural models historically constructed by humanity, under the guidance of the teacher".

The ASP is really a product of social interaction, under the guidance of the teacher, in which the subject learns from others, with others, in their interaction the practical intelligence is developed, the reflective type, building and externalizing new knowledge or mental representations, in such a way that the first ones favor the appropriation of others and so on, it is a product and result of education and not a simple requirement.

After reviewing the different definitions of the term activity, the authors of this research adhere to the definition of Marín & Rodríguez (1986), who consider that activity "is a set of actions, operations or tasks, previously planned, that contribute to the achievement of a certain objective". The researchers ascribe to this definition because it deals with elements (actions, tasks, previously planned, objective) that correspond to the structure of the design of the activities proposed in this work and referred to below.

The experiment, understood as a didactic device, constitutes an ideal resource for students to put into play their previous knowledge and confront it with data and observations of reality. It allows the student to relate to concrete objects of science, learn about the nature of phenomena and accumulate data to establish comparisons, generalizations and conclusions; at the same time, it constitutes a procedure for obtaining knowledge and confirming its veracity.

The collective of authors of the project A Didactic Alternative for the improvement of the experimental activity of Biology and Chemistry at the University of Camagüey, define the experimental activity as the "set of psychic and practical actions for the modeling and execution of the phenomenon under investigation". (Azcuy, et al., 2013).

The authors affiliate with this definition because it is in the result of this project where the structure of the design of the experimental activities referred to in the proposal of this article is based.

The research was carried out in the 8th grade group 9 of the Mixed School Victoria de Girón in the municipality of Camagüey, which has an enrollment of 30 students, of which 16 are females and 14 are males. For the characterization of the current state of

development of the experimental activity from Unit 1 Substances and chemical reactions in the 8th grade, different methods were used:

Theoretical methods: The analytical-synthetic method favored the interpretation and processing of different sources consulted. The inductive-deductive method was used to arrive at conclusions and judgments, related to the theoretical and methodological foundations of the experimental activity in 8th grade and to arrive at considerations.

In the empirical order, the documentary analysis method used in the study of different materials for the argumentation of the present work. The observation of teaching activities, in order to evaluate the treatment offered to the experimental activity in 8th grade. The survey to students, in order to know the level of knowledge, motivation and interest in the subject, as well as the implementation of the experimental activities by the teachers.

In this sense, the following aspects to be evaluated were taken into account:

Need and importance of the experimental activity.

Identification of the utensils and their relationship with their respective functions.

Participation of students in the different types of experimental activities in chemistry classes.

The rating scale used contemplated the following categories:

1. **LOW:** Shows insufficient mastery and knowledge of the experimental activity. Does not manage to make reference to the main experimental activities performed by the teacher and by the students, does not recognize the laboratory utensils, their functions and manipulation. Shows little disposition for the realization of the experimental activities.
2. **MEDIUM:** Demonstrates some mastery and knowledge of the experimental activity. Mentions some of the experimental activities performed by the teacher and students, recognizes some of the laboratory utensils, their functions and manipulation. Shows some willingness to perform the experimental activities.
3. **HIGH:** Demonstrates mastery and knowledge of the experimental activity. Is able to make reference to the main experimental activities performed by the teacher and by the students, recognizes the laboratory utensils, their functions and manipulation. Shows willingness to perform the experimental activities.

Mathematical and statistical methods made it possible to process the data obtained from the application of the instruments on the basis of percentage analysis using tables and graphs.

Results obtained in the research process.

Survey applied to students.

- Only 10 % (3) students identify the laboratory utensils and establish the corresponding relationship with their functions, which is due to the insufficient performance of experimental activities.
- 90 % (27) students affirm that they do not participate in the different types of experimental activities.
- 90 % (27) students show that when experimental activities are carried out, it is the teacher who develops them and sometimes some students participate, which corroborates that generally laboratory practices are substituted by demonstrations or class experiments.

In the surveys applied, 97% (29) students consider that it is necessary and interesting to carry out experimental activities, because it motivates them to study the subject, they appropriate the knowledge better and learn more quickly.

From these results it was generalized that 27 students are in the low level, while three are in the medium level and none in the high level. See Table 1 below, where CE: number of students.

**Table 1**. Results of the initial diagnosis

| Nivel Alto | | Nivel Medio | | Nivel Bajo | | Total | |
|---|---|---|---|---|---|---|---|
| CE | % | CE | % | CE | % | CE | % |
| 0 | 0 | 3 | 10 | 27 | 90 | 30 | 100 |

Source: self elaboration.

Based on these results, experimental activities are proposed that allow the linkage with daily life, industry and home, contribute to professional orientation, promote the development of logical thinking, allow the identification of utensils and the establishment of the corresponding relationship with their functions, with an integrating character since they take

into account the contents of Chemistry, the formative objectives and the transversal axes of the current model of the Cuban Basic Secondary School student.

The proposal is made up of 11 activities, which include demonstrative experiments, class experiments and laboratory practices, all of which take into account the contents of Unit 1 Substances and Chemical Reactions of 8th grade Chemistry, the formative objectives and the experimental activities of the program.

In the 8th grade program, 16 experimental activities are established, including the 11 proposed ones, which are taken to be improved on the basis of a new structure. In the 11 activities that were taken to design them with the proposed structure, the objective to be pursued, the background knowledge that the students should ensure before the realization of the activity, and the most important aspects towards which the observation and analysis should be directed during the experimental activity are offered. All this is explicitly evidenced in the tasks, which are also proposed and are those that are carried out directly with the students.

In the conception of this unit, the following aspects, among others, have been considered: motivate students for the study of chemistry fundamentally, by performing experiments and linking life with the contents of the unit; provide a minimum of essential knowledge about substances and chemical reactions, taking into account the knowledge acquired in Natural Sciences, in Labor Education, in Physics and empirically in daily life, necessary for the treatment and assimilation of the subsequent contents; to strengthen the polytechnic principle; generally the inductive way is used in the exposition of the contents, for this it is important, whenever possible, the development of experimental activities. In summary, the unit has a phenomenological, experimental, qualitative, polytechnical and inductive approach and its contents are treated without complexity.

The eleven activities that make up the proposal are titled as follows:

1. Chemical reactions (I).
2. Comparison between pure substances by means of their physical properties.
3. Physical properties of pure substances.
4. Comparison between pure substances and mixtures.
5. Separation of the components of a mixture by decantation.
6. Separation of the components of a mixture by filtration.
7. Separation of the components of a mixture by vaporization.

8. Separation of the components of a mixture by distillation.
9. Separation of the components of a mixture.
10. Chemical reactions (II).
11. Exothermic reactions and endothermic reactions.

An example of an experimental activity designed according to the proposed structure is shown below.

Experimental activity 5: Separation of the components of a mixture by decantation.

Objective of the demonstration experiment.

Describe the separation of the components of a mixture by decantation.

a) The teacher must master the content related to the separation of the components of a mixture by decantation (physical properties of the components, tools used, procedures to follow to perform the operation, assembly of the apparatus).

b) Organization of the experiment.

When answering the question what do I need to do the experiment? The teacher must select:

Substances with the physical properties (liquid and solid practically insoluble in the liquid and denser than the liquid or two non-miscible liquids), so that they can later be separated by decantation. (Taking into account the relation properties-operation).

The tools and reagents needed to perform the experiment.

Another question to be answered by the teacher is: What do I have to do the experiment with? Here it determines if some useful or reagent is missing and makes the necessary substitutions, for example, in the simple decantation two beakers are needed, which can be substituted by two disposable beakers or of glass that are transparent; in the decantation with separation funnel this can be substituted by a syringe.

d). The experiment is tested.

e). The necessary background knowledge to be ensured is:

- Concept of pure substance.
- Physical properties of substances.

- Concept of mixture.
- Separation operations of the components of mixtures.

f). The observation of the experimental activity and its analysis should be directed towards the following aspects:

- Physical properties of substances before mixing (state of aggregation).
- Physical properties of substances after mixing (state of aggregation, solubility, density).
- Tools needed to carry out the operation and how to use them.
- Procedures to follow to carry out the operation.
- Assembly of the apparatus.

All these elements prepare the conditions for students to be able to describe the decanting operation.

g). Tasks.

In nature, substances are usually found forming mixtures, so the separation of their components is a necessity to obtain pure substances.

Observe the following samples of substances below:

A: iron

B: water

Iron is involved in several specialized functions in the body. The most important function is the transport of dioxygen in hemoglobin.

1. What is the state of aggregation of each substance?

Then proceed to join the two substances.

2. Say if a mixture was formed. Justify.
3. Describe the physical properties of the substances that form the mixture (state of aggregation, solubility, density).
4. How can we separate the components of this mixture?

The observation of the experiment is oriented towards the procedure used in the separation and the tools used.

5. What substance was transferred?

6. What substance was left in the container?

7. What are the physical properties of the substances that make up a mixture, so that they can be separated by decanting?

8. Describe the procedure to be followed to carry out this operation?

9. Define the concept of decanting.

10. What tools are used to carry out the decantation?

11. Cite examples of other mixtures whose components can be separated by decanting.

12. Draw a diagram describing the operation carried out.

13. How important is the consumption of foods rich in iron for the maintenance of our health?

14. Iron deficiency is the most prevalent nutritional disorder in the world, especially in undeveloped countries, affecting mainly children under 5 years old and pregnant or breastfeeding women. What measures are taken in the country to prevent this nutritional disorder in children and pregnant women?

The 11 activities that make up the proposal were applied in the 2017-2018 course and were selected to all the students of the group 8th 9. After applying the proposal presented, the final diagnosis was applied, with the same aspects to be evaluated and the valuation scale, from which the following results were obtained:

a) Students feel the need to develop experimental activities and show interest in them, they are able to appropriate contents related to the experimental activity, develop the practical skills required by the study program, habits of cleanliness, organization and discipline; values such as responsibility, industriousness, patriotism and collectivism that corroborate through practice the object of study of the subject.

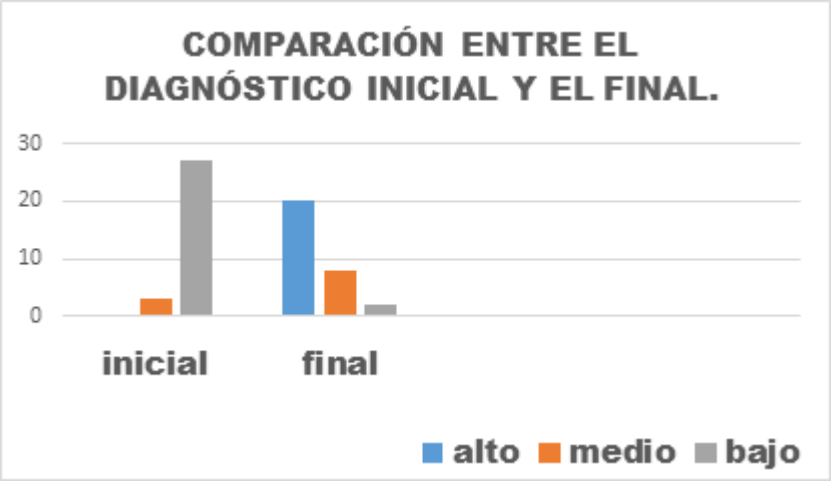
b) Likewise, they form essential concepts such as pure substance, mixture, chemical reaction, decantation, filtration, vaporization and distillation, recognize the utensils and relate them to their function, assemble apparatuses with the established requirements, understand the connection of experimental activities with facts and phenomena of practical life and actively participate in the three types of experimental activities.

c) The working polytechnic principle is strengthened by linking experimental activities with industrial processes.

d) Interdisciplinary links are established with other subjects and treatment is given to master programs and ideological-political work.

A comparison with the results of the initial diagnosis shows that considerable progress has been made in the three established indicators, which is evidence of the effectiveness of the activities implemented. The general comparison by evaluative categories is shown in graph 1.

Source: Self elaboration.




**Graph 1**. Comparison between initial and final diagnoses.

The realization of the experimental activities of Chemistry proposed in the research raises the quality of the TLP of this subject, and corroborates that the student in practice is formed as an individual integrally prepared to face the situations that are presented to them in their daily work.

## Conclusions

The initial diagnosis showed that there are difficulties in the development of experimental activities, since students show insufficient mastery and knowledge of the experimental activity, they fail to refer to the main experimental activities carried out by the teacher and the students, they do not recognize the laboratory utensils, their

functions and manipulation and show little disposition for the realization of experimental activities.

The design of the experimental activities proposed for 8th grade students of the Mixed School Victoria de Girón from Unit 1 Substances and chemical reactions, is a tool that allows the adequate development of these activities, which leads to the enrichment of the quality of the TLP of Chemistry.

The application of the design of the experimental activities allowed verifying their effectiveness based on the results achieved by the students in the final diagnosis, among which it is worth highlighting the appropriation of chemical contents, the identification of laboratory tools and the interest in the study of the subject.