Laboratory practice complemented with chemical ludo – The design of a multistrategic teaching unit for regular high school chemistry students

https://doi.org/10.56238/ptoketheeducati-023

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ABSTRACT
The research refers to the process of presenting and teaching Chemistry to regular high school students who attend the first year. consequently, the project aims to apply the concept of Multistrategic Didactic Units (MDU), which aims to link a variety of didactic sequences in harmony with previously established and delimited learning objectives, recognizing and stereotyping the fundamental concepts necessary to introduce, achieve and practice, in a playful and empirical way, the Teaching of Chemistry to students of the first year of regular high school; execute the appropriate sequences to understand the issues involved; improve school development by relating the contents taught with their social and technological importance, with emphasis on the study of acid bases and indicators, at first; highlight the importance of teacher and student performance in the teaching-learning process, providing recommendations for pedagogical practices to improve Chemistry Teaching. To support the research, we rely on the theoretical contribution of David Ausubel, Amadeo Bego, Cleidson Carneiro Guimarães and modern authors who approach the themes. The methodology for carrying out the research included bibliographic research on the content, practical classes held in the science laboratory on inorganic functions - acids, bases and indicators and the complementation of the methodology with playful activity, the latter being carried out in the media room of the school. This playful activity includes a game, where all the theory taught is explored through objective and essay questions in order to provide an environment suitable for the full development of students' skills and competences.

Keywords: UDM, Playfulness, Laboratory Practice.

1 INTRODUCTION

In this pandemic scenario in which we are living, education, like many other areas of human activity, has been severely affected. The obstacles were diverse during the development of this research, but even in the face of all the drawbacks, the professionals who work in education, especially teachers are proving to be more and more dedicated to improving the quality of teaching. With regard to the Teaching of Chemistry, we verified the great amount of research and fervent debates in favor of this improvement. The various events such as congresses, debates, conversation circles, symposia,

meeting of experts, lectures, among others, always aim to improve and share the didactics and ideas used in the day to day in the classroom. These exchanges of information and experiences among research teachers will always contribute to the search for novelty in teaching, often through alternative methodologies, differentiated didactic instruments, among other things. The different methodological practices such as playful, experiments, group dynamics, non-formal spaces, seminars and lectures of common interest are some that the teacher perform with his students and that aim to deviate from the traditional pattern of classes that are common today and whose principle is based on the figure of the student as a transmitter of knowledge and with a main and active role, To the extent that, the student is a passive individual and simple receiver of information.

> The teaching considered as traditional seeks to pass on the knowledge, that is, the contents to be taught by this paradigm would be previously summarized, organized and incorporated into the cultural collection of humanity. In this way, it is the teacher who dominates the contents logically systematized and structured to be transmitted to the students. The highlight of traditional teaching, therefore, is in the transmission of knowledge. Saviani (1991)

This study arose from my experience in more than 24 years as a teacher of Chemistry in Elementary School (EF) and high school, and, in the same way, by the observations found by me regarding the lack of enthusiasm, both of teachers and students of the public school system.

As a teacher of Elementary and Secondary Education of the public and private network I have observed the great difficulty that students have to understand concepts and applications in the area of Chemistry. There are really numerous obstacles found in the craft of educating, problems that go through the structural precariousness in public institutions of elementary and secondary education, complete lack of interest and predisposition of the student to want to take possession of what is offered, knowledge, lack of professional qualification among many others. Added to this is an absurd number of students per class and approximately 45 minutes, which constantly prevents an effective and different approach from the traditional one, this undoubtedly contributes to making Chemistry a fundamentally theoretical discipline and without any real relationship with the student's daily life. Much of this difficulty in the learning process is in the act of teaching. As a result of these difficulties, a good part of the teachers of this area are feared, because they make the act of teaching Chemistry a task of difficult understanding.

The research aims to develop a proposed approach involving Multistrategic Didactic Units (UDM) using experimental practice and complemented with a playful activity in the teaching of Chemistry. The proposal is to use simple experiments, referring to the content of acid bases and indicators for students of the first year of regular high school that can be performed with simple materials, easy access and low cost. To measure the content, a question-and-answer game will be addressed in the classroom or in the school's media room.

Most students show difficulties in learning Chemistry, because they did not understand the purpose of having to study the discipline, due to a teaching disconnected from reality and difficult to understand, generating failures in the learning process (CHASSOT, 1995). The way the contents are disseminated results considerably in the discouragement of the student, because too many topics taught in an abstract and superficial way contributes to the apathy in the study of the contents Chemistry (CARDOSO and COLINVAUX, 2000).

In this perspective, the UDM are presented as a convenient proposal, given that it directs an approach to the concepts of Chemistry from a prism that advocates teaching through plurality, since students have different levels in the learning process. Thus, the teacher has a way to make his work with teaching more accessible, uniting theory and practice, based on a purpose that will be achieved in defined stages that comprise the use of the laboratory through experiments that will enable students a closer proximity to the practical application of knowledge in their daily lives.

2 THEORETICAL FRAMEWORK

2.1 THE TEACHING OF NATURAL SCIENCES, IMPORTANCE OF THE USE OF DIFFERENT TECHNIQUES

Scientific knowledge is one of the fundamental knowledge indispensable for the construction of a critical and conscious individual, with regard to the phenomena that happen daily, being responsible and operative directly or indirectly. (SAINTS; OLIOSI, 2013). Scientific education goes beyond the difficulty of constructing knowledge pertinent to outlined objectives, referring to contents taught. In Brazil, science education is, nowadays, the subject of several disputes and criticisms that show the need for reorganization in its format. These changes are inclined to institute a new proposal for teaching natural sciences, which emphasizes contextualization, because only in this way can teaching promote learning, so that the real subject of the process understands and becomes involved in human activities, enjoying the progress of science in its material world. It is relevant to point out that science exceeds the idea of a curriculum, it is a human activity with all the particularities that are pertinent to it. (SANTOS; OLIOSI, 2013).

2.2 THE ROLE OF THE TEACHER IN THE TEACHING OF CHEMISTRY

The essential purpose of the teacher is to promote student learning (DELIZOICOV; ANGOTTI; PERNAMBUCO, 2007). Therefore, questions arise such as: What are the actions, the practices of the teacher in the development of teaching and learning? What obstacles does the teacher face in their daily battle in the classroom? We probably won't find ready answers to these questions. The accumulation of events that we encounter within this complicated educational system that we experience allows us to affirm that we are far from an adequate answer to such questions. However, it

is clear that these solutions can be granted if the teacher receives the precise minimum requirements for the smooth running of his beautiful work.

The student needs to build, through the help and advice of the teacher, his knowledge to gradually become competent and independent in problem solving, application of concepts, in the realization of deliberate actions and in countless others (SOLÉ; COLL, 2009, p. 22). Therefore, it is vitally important to point out that in order to achieve these goals, the student needs to know a united, shared process of the teacher's teachings.

The help of the teacher is essential for the education of the student and is subject to variation in quantity and quality (SOLÉ; COLL, 2009). This action of the advisor is also called mediation and, according to the thought of Libâneo (2010), it is significant in the face of the realities of the current world.

> The teacher makes the interposition between the active relationship of the student with what really involves him, enclosing the contents of his discipline, but always taking into account the knowledge, the experience and the knowledge that the students bring to the classroom, their cognitive potential, their competences, aptitudes and interests, their ways of thinking, their way of working (LIBÂNEO, 2010, p. 30).

2.3 THEORY AND EXPERIMENT IN CHEMISTRY CLASSES

According to Bizzo (2000), Science learning has become a simple act of memorizing concepts, words and terms that are difficult to pronounce, without clear objectives, and that do not promote the progress of students' ability to understand, which is one of the main reasons why the objectives in learning are not achieved, since it is essential to provide incentives for students to unveil the meanings present in the concepts addressed. This teaching perspective based only on the simple duplication of scientific knowledge in a decontextualized way, makes students not stimulate the willingness to learn science and often question the reason for teaching it (POZZO; CRESPO, 2009). This contests one of the primordial pretexts of science teaching, which is that of usefulness, which preserves the need for a society that understands science from an empirical point of view (MILLAR, 2003).

These strategies are beyond the theoretical field, but they need it; thus, equal attention should be given to theory and practice in the school space to provide meaningful learning (SOUZA et al, 2014). Thus, the teacher needs to make a critical analysis of his teaching practice required by the act of teaching (FREIRE, 1996). In this perspective Gouveia (1994) says that:

Together with an approach with Multistrategic Didactic Units (UDM) that relies on practical activity and didactic recreation, it seeks, in an effective way, to shorten the space that exists between the theory that is practiced in traditional classes and is also presented in the literature and the day to day of the high school student, emphasizing that the theme studied is associated with several situations. At this level of education, the concepts of Chemistry would be introduced, organizedly, in an experimental and playful way.

The activities and/or teaching strategies are determined as diverse situations, created by the educator to favor the students to live with knowledge. The professional chooses the teaching methodologies and uses them as a means of mediation for a good relationship of commitment of the students with the learning taking into account the educational objectives, verbal or written indications about the particular or collective conduct of the class, the period necessary for the accomplishment of the activities and the physical space.

Being able to tie this theoretical foundation, which is very important, together with a previously planned and organized experimental activity can lead the teacher to succeed in his task of bringing this student to the beautiful world of knowledge. From the moment that this student can associate the theory of the content approached with the experimental procedure paying attention to the existing relationship with his day to day, this process of teaching learning had a significant success in its purpose, because in a certain way it had a meaning for this student, had a real importance in this process. Ausubel (2003) recognizes two varieties of meanings that are associated with learning: the logical and the psychological meaning. Although there are distinctions between one and the other, it is possible to obtain relations between both. At the same time, Ausubel doesn't rule out the chance of there being social or shared meanings, such as an idea that is shared by every student in a classroom. What will make learning "psychologically significant" is how much logical meanings will be fixed in a non-literal and non-arbitrary way in cognition.

2.4 PRACTICE OF GAMES IN SCHOOL ENVIRONMENT

Considering the various points that encompass the teaching and learning process treated so far, it is emphasized that a new perspective is necessary under the training of the teacher and his conduct in the classroom. Just the understanding of the pedagogical potential of playful procedures is not enough for their execution and promotion of active learning. It is necessary a training that meets the playfulness and its pedagogical capacity that the teacher is able to plan and qualify the moments of the game or playful activity. It is of paramount importance that the teacher evaluates, for example, how and why deliberate material can be used, without forgetting to analyze and evaluate his own role and that of his learners in any project that uses an apparently playful resource.

It is noteworthy, nowadays, that the game is only one of the numerous pedagogical resources that point to the improvement of the teaching and learning process, always used in order to stimulate interest and promote motivation in the student for the study. When we relate the pedagogical and psychological potential of the game, we are led to believe that the game is the pedagogical resource with the ability to help solve the problems of the learning process and with the task of increasing the quality of teaching and making it "ideal". However, it is known that it is not within our reach to solve all the adversities in the educational environment, including the existing relationships between

teacher/learner and learner/content through the game. Employing it without reflecting on its various aspects, just for fad or fun, will bring harm both in terms of learning and in the relationship between those involved in the process.

3 MATERIALS AND METHODS

For the execution of the proposed study, students of the 1st year of regular high school were invited, from a public school, located in the neighborhood of Nova Cidade, north of the city of Manaus. The invited students participated spontaneously. To keep the appreciation for the ethical issues of the thesis, each student received a consent form to participate and was signed by themselves, since all were under 18 years old.

The classes were designed so that the contents of the chemistry curriculum that addresses the inorganic functions – acids, bases and indicators were taught mainly under a practical aspect, in the laboratory and in the physical space of the school classroom. After this moment, the interaction of the students and teacher was sought, seeking an effective learning, a playful procedure was performed with the participating students, a procedure that involves a game of questions and answers related to the experimental activity in order to measure the knowledge worked.

Due to the pandemic moment we're going through, classes are happening in a hybrid way. Only the interviews before and after the application of the methodology can be done with everyone because it was held in the auditorium of the school that has a physical space that quietly supports more than 100 people and gave us conditions to perform them, always complying with all the protocols required by the school.

The interpellation with the students participating in the project was carried out in a didactically sequenced way with the intention of always seeking to extract the best possible result from the student and leaving him at ease so that he was always comfortable to expose his opinions, reports and positions on the activities performed, both in the classroom and in the laboratory. The sequences of the activities performed are shown in the table below, along with the number of participating students.

Table 1 - Sequence of activities and participants.

Activities	Participants
Meeting to expose the project and clarify the didactic sequence to be applied.	44
Approach to the application of a questionnaire in order to measure the expectations of the students.	40
Lecture 1 on Inorganic Functions – acid, bases and indicators.	36
Lecture 2 on Inorganic Functions – acid, bases and indicators.	34
Experimental activity 01 – Acids and bases, using bromothymol blue as an indicator.	32
Experimental activity 02 Acids and bases, using phenolphthalein as an indicator.	36
Experimental activity 03 – Acids and bases, using as an indicator red cabbage juice.	36
Playful activity to try to measure the content exposed in the room and in the laboratory	38
Meeting with project participants to hear the positives and negatives of the UDM used.	34
Application of the Final Questionnaire	36
Interview	32

Source: prepared by the author

4 RESULTS AND DISCUSSION

The technique of Discursive Textual Analysis (DTA) designed by MORAES and GALIAZZI (2007) was used to measure the elements and clarify the events of the research. This is an adjusted method of analysis and synthesis that interprets various textual materials in an intense and investigated manner in order to report and clarify them and to arrive at a deeper understanding of the actions and statements according to which they were elaborated. Thus, the results were organized as follows:

1) characterization of the participants

2) Analysis of the sequences and discussion.

The follow-up Didactic-pedagogical analysis is arranged in a twofold way: the notions already acquired from the members on the theme of the UDM and the cognitive requirements of the contents addressed. Blanco and Pérez (1993) point out that the verification of students' previous conceptions is vital not only to recognize errors, but to value them and use them for the benefit of learning, with regard to the anticipation of possible difficulties of students and the proposition of strategies that allow them to be overcome. In the table below, the sections Didactic-pedagogical analysis are shown.

Table 2. Didactic-pedagogical analysis

Students' previous knowledge of the concepts of acids, bases and indicators.	Certain students have a notion of acidity and basicity, but still cannot understand its applicability in everyday life, that is, they have severe difficulty in understanding the difference between acids and bases in a more detailed identification.
Cognitive requirements of the contents addressed	Complication in the passage from the level of observation of phenomena to the level of interpretation of the theory; students' intuitive understandings; difficulty in understanding to differentiate substances of an acidic or basic character.

Source: prepared by the author

Initially, in order to observe the main teaching techniques used by teachers in the previous grades, the expectations about the application of the research and the knowledge already acquired about the content to be applied, a series of questions was asked to be used in the debates related to the project. When observing the table (3), it is noted the situation and the most frequent alternative(s) in the students' answers, which ranged from 26 to 34 participants during the stages performed.

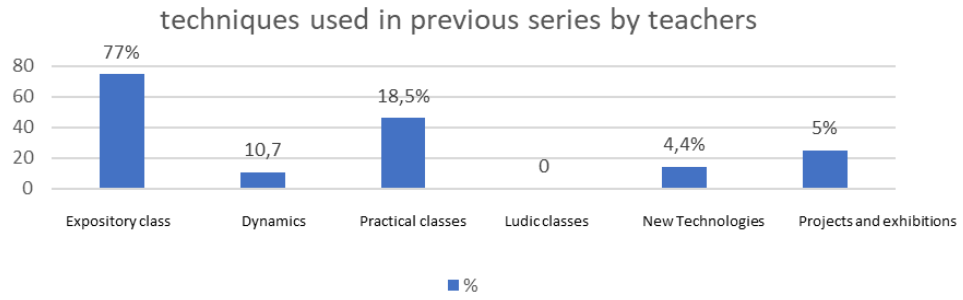
Table 3. Most frequent responses to the initial questionnaire

Question about:	**Alternatives**	**Time**	**%**
Previously used teaching techniques	**a**	2.5h	**5**
	b		**10**
	c		**10,5**
	d		**0**
	and		**4,4**
	f		**55**
Expectation about scientific research.	**1. Yes**		**100**
	2. No		**0**
Knowledge about acids, bases and indicators	• **71.5% of the interviewees have a notion about acids, bases and indicators.** • **14.4% were able to understand the importance of acids, bases and indicators and to identify substances that have an acid or basic character.** • **14.1% did not have knowledge about the content about acids, bases and indicators or could not tell where this subject can be applied on a daily basis.**		

Source: researcher

When asked about the strategies to which they have been subjected in recent years, the results are presented in the graph below. It is important to note that the student could choose more than one option.

Graph 1: Previous activities



Source: prepared by the author (2021)

4.1 ANALYSIS OF DIDACTIC SEQUENCES

4.1.2 The Experimental Activities

The experimental activities were carried out, in different classes, in the school laboratory and the students were organized into six (06) distinct groups, where each team performed its own activity and, after debate, reported its results. In order to analyze the learning on the subject, the group was subjected to questions that should be answered before the practical part and, after that, they were submitted to questions to analyze the understanding about the experimental practice they did.

In order not to have some kind of "advantage", the teams were drawn, in addition to avoiding the so-called "little groups" among friends and thus were organized:

Table 4 - Teams in experimental procedures Figure 1 - Beginning of experimental activities

Teams	Participants				
1	P3	P12	P6	P30	P19
2	P16	P5	P8	P20	P28
3	P5	P2	P15	P26	P7
4	P11	P23	P9	P17	P24
5	P8	P4	P29	P22	P27
6	P25	P29	P13	P1	P10

Source: Prepared by the author Source: Prepared by the author

EQ1 (P02). "Because that way the fish doesn't smell bad, unpleasant."

EQ2 (P17). "Because if you don't put lemon it is pitiú and no one likes it."

EQ3 (P15). "The more lemon you put in, the better it gets. I think that with this the seasoning adheres better to the fish and so it tastes better, especially when it is fried ",

EQ4 (P22). "So the fish doesn't rot soon and we think that without the lemon it doesn't get the seasoning right."

EQ5 (P20). To take away the smell of fish, the famous pitiú. You can even leave it in the refrigerator later if there is a need, so the fish can still be consumed without problem."

EQ6 (P24). To be able to better preserve take away the smell of spoiled fish that can stay when cooking or baking.

It is important to describe at this stage the complete delivery of the students to contribute to the research, because, even with some obstacles that occurred during the procedure, such as the reduction of class times on the day the activity occurred, practically 100% of the students participated in the procedure in the laboratory.

Figure 2 - Analysis of the addition of red cabbage juice.

Source: researcher

4.2 ON THE EVALUATION OF EXPERIMENTAL ACTIVITY

Most of the students found it interesting, were positive in their opinion, here are some reports:

P23 - "very interesting, helped the understanding about the concepts of acids and bases"

Q25 "I found it very interesting, it's a deferential, effective and... joyful, in my understanding, to learn chemistry"

P24 "'amazing!', this engagement between teams has allowed us a better way to learn"

P09 "It was exciting, because in the activity and the explanation in the classroom, we remembered the contents that we had already studied, such as Arrhenius' acids and bases"

P07 "The laboratory had plenty of space to carry out the activity, and we had no difficulty in carrying it out. I wish these activities could happen more often."

4.3 THE PLAYFUL PROCEDURE

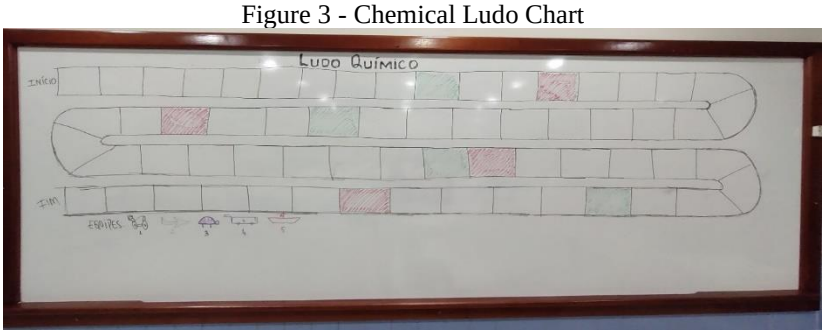
The activity took place with the presence of thirty-three (33) students divided into 5 groups in the classroom according to the row in which they were. At first, the students were agitated and at the

same time intrigued about what the procedure would be like, since they had not participated in any playful experiments throughout all their experiences in high school.

In the sequence, the board on which the game is held was made on the blackboard of the room itself with the help of suitable brushes, consisting of forty (40) compartments, with about 10% (four) of them separated for game punishments and another four for bonuses. The first of each group was responsible for communicating the answer that the team chose to intercede and, when necessary, roll the dice and tell the mediating teacher the value of the sum of them. This allowed a greater interaction between the teacher and the students. About thirty slides were made in a total of 36 questions for the progress of the game, which were displayed on slides projected on the wall in the classroom.

According to ZANON (2008), the Chemical Ludo benefits cooperation, that is, the arrangement of students in teams promotes interaction between them where one member helps the other (of the same team) to win.

Figure 3 - Chemical Ludo Chart



Source: researcher

Figure 1 - Participants during the playful procedure

Source: researcher

The research professor acted as an intermediary of the match and stressed that the act of "playing for play" has no real answers for the development of learning at all times, since certain games provide certain unwanted behaviors, such as the exaggerated competitive spirit. In the case of Ludo Química – a didactic game we are describing – cooperativity represented one of the positive factors indicated by the teacher. Thus, victory is achieved the moment one member helps the other to achieve success, both belonging to the same team.

The groups found themselves to be quite competitive from the beginning to the end of the playful procedure, always interacting among their participants and hoping that the other teams would miss the answer to the questions that were projected on the slide. Everyone was very attentive to each particularity of the game, to the questions, the dice with the values, from the disappointment of giving a low sum value, to the euphoria to see a maximum possible result when throwing two dice, the counting of the houses and the advice of the intermediary. These relationships that occurred both in the playful and practical experiment come from the autonomy that the UDM grants to the student, not letting him only help himself with textbooks available for research. There was no obstacle about the conduct of the participants during the playful process, that is, all behaved in a very organized and respectful manner, without any type of mess or delaying behavior that could hinder the smooth running of the procedure.

At the end of the process, even if there was no winning team for specific punishments on specific parts of the board and the duration of the game was only two class times, the enthusiasm and involvement of the participants with the activity was evident. It is interesting and curious to point out that the groups that no longer had a chance to win the match made clear the satisfaction when the team that was winning missed the question, received low points in the dice or was penalized during the game, which shows the competitive spirit present in the event. Phrases such as *"P.02 we need to do this more often this year, teacher" or "P.16 I do not remember the last time I interacted so much in a chemistry class"* represent well the satisfaction of the group with the playful procedure that was developed, making it evident that the students truly appreciated the end given to the content taught in the experimental activity and exposed in the classroom.

At the end of the experimental and playful activities, excitement and happiness were evident on the faces of the participants. The practice of employing the UDM using these methods directly and dependent on each other promoted an effective and effective interaction of individuals at all times of the activities.

4 CONCLUSIONS

Because they were accustomed to traditional teaching, they had only a teaching conditioned to the mechanic and the memorization of concepts. The students were welcoming about the methodology used and it is believed that a better organized Didactic Unit and the use of several strategies contributed to learning, including motivating and involving throughout the procedures.

It is considered that the experimental procedures, used in the first part of the UDM, were interactive strategies, since most of the students have greater understanding in practical classes, because the subject taught obtained better assimilation due to the strong collective interaction that promoted a beneficial exchange of information between the members and led to a higher quality in

learning. Regarding the aspects that impact on the speed of a chemical reaction, since a good part had a notion about the subject (70%), this favored the implementation of the UDM, we believe that the understanding about the meaning of concentration and the use of dynamizations were the themes that the participants had greater difficulty to understand during the procedures, and it was complicated, in his view, to make an association with his daily life; and in relation to the dynamizations it was necessary to review its concept and application.

In the second stage of the UDM used, the playful procedure, although it counts on the presence of a smaller amount of participants (32), was surrounded by a lot of anxiety and animation, since they had not yet participated in an experience where they could interact to learn, which would be used an experimental and playful sequence that would complete each other. At first, because they were not yet familiar with the simple rules of the game, there were some setbacks such as the time allotted for each group to answer the questions and penalties involved in the red houses of the board drawn on the blackboard. However, after the second round onwards they understood the dynamics and harmony became present in the laboratory. The effective integration of all participants in the procedure is perceived. It was evident the satisfaction and involvement of the subjects, always trying to collaborate so that their team won the game, evidencing the commitment of the students with the search for learning.

We believe that, as exposed in the meeting held after the experimental and playful activities, the strategy used really reinforced the understanding of the concepts presented, and that, as mentioned, the interactivity and effective participation of the subjects during the procedures allied to the will to have the implementation of the UDM used in other concepts were the essential points to base the comment.

We note that the approach presented can be used in other principles within the content of chemistry. The elaboration of a UDM in order to enable a better learning is a strategy that promotes a strong interaction between the students and between the students and the coordinating teacher who was mediating the activity as well. The use of the playful and the experiment showed that, if it is prepared and organized the phases effectively, this didactic sequence proved to be a powerful instrument in the process of knowledge construction.

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