

EXPLORATORY ASSESSMENT OF STRATEGY FOR LEARNING REDOX REACTIONS IN HIGH SCHOOL

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ABSTRACT

Describes the exploratory assessment of strategy for learning redox reactions in High School, which seeks to prevent students from developing memoristic and mechanical skills, in addition to emphasize the experiences of daily life that go unnoticed or unexplained to the student in the classroom and at the same time are able to incorporate the key elements for understanding the terminology used in the language of Chemistry, all through proposal for a strategy. The sample consisted of sophomores from CBT High School No. 2 Bicentennial Huehuetoca in Mexico. The students are in the subject of Chemistry I. The didactic sequence was appropriate, for the learning of redox reactions, since it managed to increase by 41.9% the conceptual gain in the students.

INTRODUCTION

A problem arises of the issue of oxidized-reduction reactions with which, the teacher, and the participation of students raise a number of doubts (base of questions) regarding each situation, phenomenon or fact and whose response involves a prior knowledge platform (data and information) from a given context. This everyday situation implies that with the information provided the student will have to make use of previous concepts such as: chemical reaction, equation, reagent, product, then apply the concepts of oxidation and reduction both emanating from the scenario didactic. Through teamwork, it is intended that they understand and apply the basic concepts of chemical reactions as well as identify the transfer of electrons and consequently determine the oxidation or reduction of the species involved in such reaction chemistry, so that it assigns the oxidizing and reducing agent so that it finally manages to balance the chemical equations correctly. During these activities, students will practice values such as honesty, by demonstrating their effort stride in the task to get a job well done, and tolerance, by knowing how to give in and have team meaning, all within a collaborative environment (Obaya, 2019).

"Oxidized or reduced"	
I. General information	
Subject	Chemistry I
Semester	Third
Campus	CBT NO. 2 Bicentenario, Huehuetoca
Concept	Unidad III. De los átomos a las moléculas
Topic	Reacciones oxido-reducción
Strategy	"Oxidized or reduced"
Sessions	7
Time for each session	100 minutes

Competences	<p>Category: Critical and thoughtful thinking</p> <p>Generic: Develops innovations and proposes solutions to problems based on established methods</p> <p>Attribute: Follow instructions and procedures in a thoughtful way, understanding how each of your steps contributes to the reach of a goal.</p> <p>Discipline: It establishes the interrelation between oxidation–reduction, in redox reactions.</p>
Values	<p>Tolerance</p> <ul style="list-style-type: none"> • Knowing how to yield: In discussions or decision-making, make your own behaviors and opinions flexible in a reasonable way. • Team sense: Cooperate with others, contribute ideas and make decisions in a flexible and respectful way. <p>Honesty</p> <ul style="list-style-type: none"> • Effort: Use the right time to carry out and carry out the intended task, with rigor and seriousness especially if it is difficult. • Work well done: Perform the proposed activity properly elaborated and completed in the expected time
Resources	<ul style="list-style-type: none"> • Written scenario for each team member. • Self-assessment and co-evaluation formats • Blackboard • Books • Computer
II. Sequence	
<p style="text-align: center;">Session 1</p> <p>Time: 100 minutes Materials: copy of didactic scenario, markstexts, colors and pens Product: Text of the didactic scenario analyzed Task: Written research work</p>	<p>The group is welcomed and informed of the topic to be addressed which is "Redox Reactions" and then provide them with the didactic scenario using a copy for each member of the group.</p> <p>The teacher will then instruct students to analyze the text (teaching scenario) for which they must perform the following activities:</p> <ul style="list-style-type: none"> • Read the provided text globally. Identify and underline the main ideas of the text. • Enclosing the unknown words red • Later with the unknown words perform a glossary of terms in your taskbook <p>The teacher writes on the board the following detoning and secondary questions, in order for them to search for information, they must write them down in their notebook, which will be used for the resolution of the detoning questions</p>

<p>(secondary questions) Rating: check and rubric 1</p>	<p>Detoning question What happens to jewelry items and coins that are made of silver, after they were stopped using for a long time? Why is this phenomenon happening?</p> <p>Secondary Questions What are oxydo-reduction (redox) reactions? What is oxidation and reduction? What is called an oxidizing agent and a reducing agent? How does the oxidation number affect a chemical change? What is the oxidation number? What is the oxidation number for? How useful are the oxydo-reduction reactions in everyday life? Investigate an application of oxidized-reduction reactions in everyday life</p> <p>For the resolution of secondary questions will be done through collaborative work, so teams by affinity of maximum 5 people will be integrated, who will have to carry out a work plan for the search for information (this activity is carried out of class) and shall deliver written work with the characteristics shown in heading 1.</p>
<p>Session 2 Time 100 minutes Product: Conceptual map "Oxydo-reduction reactions" Evaluation: rubric 2</p>	<p>In teamwork and in a class session with the information obtained above, a conceptual map will be constructed with the elements of secondary questions of sesión 1.</p> <p>The video tutorial on how to make a conceptual map will be projected, which is available on the page https://www.youtube.com/watch?v=-_jMUBI8dGU, during the projection of the same students will have to take the corresponding notes in a way that helps them to build their map(Grooper, 1987).</p>
<p>Session 3 Time: 100 minutes Materials: white bond paper, markers, nibs and diurex Product: Conceptual map on paper bond Task: investigate the rules to determine no.</p>	<p>Once the teacher approved the conceptual map, the team must rewrite it in a white bond paper to be shown to the whole group, then three very conceptual maps will be randomly chosen to be exposed by the team members. The video tutorial redox reactions will be projected, which is available on the page https://www.youtube.com/watch?v=KwQZOARVjRw</p> <p>During the presentation the teacher in conjunction with the students, they give clarity to the concepts addressed and build more complete and profound ideas, which they will have to capture in a graphic organizer called "Redox didactic shoe, which is built of the following:</p> <ol style="list-style-type: none"> 1. Students will be asked to paste two letter-sized colored

**oxidation. Rating:
check-in**

sheets horizontally.

2. Then they should place at the top the title of "Redox Shoe".
3. You should then cut in the middle vertically two different colored sheets and each half will have to cut into box pieces, to finally get 4 rectangles of 11 x 7 cm each of each sheet.

4. This procedure will be repeated for two white leaves. 8 rectangles should be pasted, interspersing the colors on the initial sheets taking care not to cover the title of the technique.

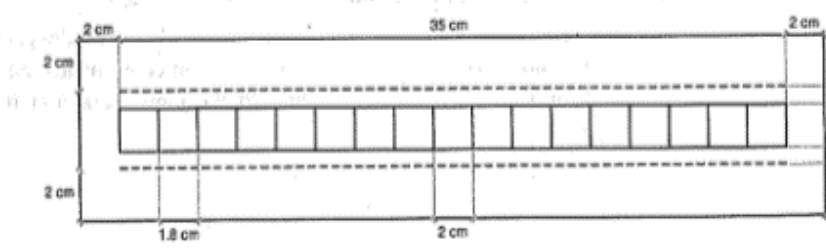

The following names should be placed in each rectangle:

1. Oxidation
 2. Reduction
 3. Oxidizing agent
 4. Reducing agent
 5. Oxidation number
 6. Redox Reaction
 7. Application 1
 8. Application 2
5. In the rectangles of the white leaves you must place the definition and/ or information corresponding to each term exposed by your peers themselves that were placed in the previous eight rectangles, with the corresponding example as the case may be.
6. They will then be saved in their corresponding place according to the term, as shown in the following image.



Subsequently the students will answer the following questions that are set out below, these should be copied in their workbook, this activity is intended to reaffirm the mentioned concepts (Merrill and Jones, 1991):

1. What is a redox reaction?
2. Write the chemical equation of Zn's reaction with CuSO_4
3. What is the species that oxidizes?
4. What is the species that is reduced?

	<p>5. What is the reducing agent? 6. What is the oxidizing agent? 7. Why does the Zn^{2+} ion displace Cu? The group will be asked to investigate the task individually to be used in session 4 for rules to determine oxidation state, which should be noted in the notebook. (Check)</p>
<p>Session 4 Time 100 minutes Materials: Paper cardboard 35cm long x 8cm wide, scissors or blade for drawing (cutter), pencil, glue or adhesive tape, metal ruler, markers or nibs orange, black and yellow Product: Strip to determine the species that improves and which is reduced Exercises to determine the species that oxidizes and reduces Task: investigate the redox method to balance chemical equations</p>	<p>From the knowledge acquired on oxide-reduction students by team will perform the exercise design of a strip called "Following the electrons" this will serve to determine the species that oxidizes and the one that is reduced, i.e. the change in the state of oxidation, requesting the following material: Paper cardboard 20cm long x 8cm wide or similar Scissors or blade for drawing (cutter) Glue pencil or adhesive tape Markers, colors or nibs blue, black and red Rule metal</p> <p>How do we develop it? On the piece of paper, draw the lines giving them the measurements indicated in the figure 1</p>  <p>Figure 1. measures to your rule (didactic)</p> <ol style="list-style-type: none"> 1. Trim the number line, oxidation dates and reduction dates 2. Pastes the number line centered on all four sides (up, down, right, and left). 3. Then color the negative numbers with blue, the zero with yellow and the positive numbers are red. 4. Then paste the oxidation dates pointing to the right side and the reduction by pointing to the left. 5. Carefully cut off the dotted part of the cardboard as indicated in the figure 2  <p>Figure 2 Redox rule</p>

2. This should be printed in colour, so that it works as a needle inside the trimmed part, as indicated in figure 3

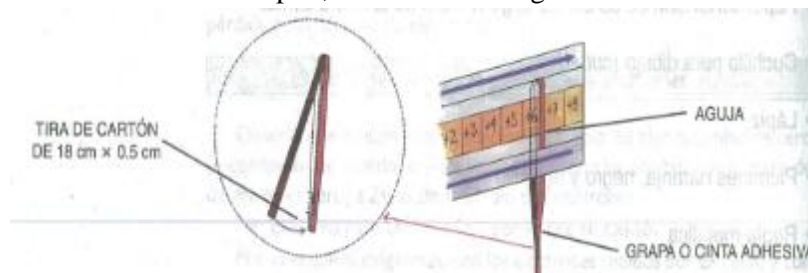


Figure 3. How to place the pointer or indicator

Using the redox scale (following the direction of the arrow) will help you determine how many units an element has rusted or reduced; also to determine the change that occurs in the number of oxidation. The teacher instructs them to perform the following activity, with their redox rule they developed, for which they will have to solve the following exercises, indicating whether the atoms are oxidized or reduced, as well as the change in the number of oxidation.

Element	Oxidation or Reduccion	Number of elect exchanged
Mn^{2+} to Mn^{3+}		
Pb^{2+} to Pb^0		
Cu^{1+} to Cu^{2+}		
S^0 to S^{2-}		
Sn^{2+} to Sn^{4+}		

The teacher will request that the steps to be taken to balance chemical equations by the oxide –reduction method be investigated as a team, this information will be used in session 5.

Session 5

Time: 100 minutes

Materials:
photocopy of
exercises redox
reactions Product:

Balanced
redoxreaction
exercises

An oxide-reduction reaction will be placed in the blackboard to apply the investigated method, in collaboration with the group and by means of exposure of the teacher will be explained some steps in which they have doubts. Two colored leaves, one blue and one red, will be used, which must be cut into eight rectangles, and the positive charge to the red ones and the negative to the blue ones will be assigned, with the help of a black marker, that is, the blue ones will represent the electrons that must be given which and add up to perform the load balancing, this will allow students to visualize when loads are neutralized.

For this once the semi-reactions of the oxidizing and reducing species

	<p>have been written, the red boxes corresponding to the loads of each species will be placed, then the negative charges, which present the electrons on the side where the positive value, neutralizing negative loads until the balance is reached. After this exercise, the process to balance two more reactions will be repeated to give clarity to the topic. Subsequently, 6 redox reactions (see annex 1) will be noted in the paintron, for each equation, in team they must perform in their workbook what is requested in the sub-paragraphs and argue their answers: Assign oxidation numbers to all elements Point out what is the substance that is oxidized. Mention which is the substance that is reduced Indicate which substance is the oxidizing agent Identify which substance is the reducing agent balance each equation</p>
<p>Session 6</p> <p>Time 100 minutes</p> <p>Materials: those requested in laboratory practice</p> <p>Product: Laboratory Practice Report</p> <p>Task: PowerPoint Presentation</p> <p>Evaluation: Check and Rubric 3</p>	<p>With the teamwork that was previously formed which should not exceed 5 people will develop the experimental phase (Richey, 1986; Obaya, 2003), for this will be screened the video that is in the next link https://www.youtube.com/watch?v=UNefgt5Tw04, "How to Clean Silver. REDOX Electrochemical reaction" here will show the development of the practice, so it should be paused to clarify doubts.</p> <p>During the experiment students should take notes and photos of what happens to silver objects, this in order that they can visualize the before and after the objects and make the conclusions of the experiment.</p> <p>At the end of the practice again the video will be projected pausating where the chemical reactions are located, to be recorded by the students in the notebook and subsequently make the balance of the equations applying the redox method.</p> <p><i>Students will answer the detoning question of session</i></p> <p><i>1, What happens to jewelry items and coins that are made of silver, after they were stopped using for a long time?</i></p> <p><i>2. Why is this phenomenon happening, analyze it together with the answers of the questions of the experiment from which they will propose a solution that should be exposed to the group in session 7, through a PowerPoint presentation, therefore this activity will be extraclass, and be evaluated.</i></p>
<p>Session 7</p> <p>Time: 100 minutes</p> <p>Materials: computer, projector and USB</p> <p>Product:</p> <p>Evaluation: check-</p>	<p>By workteam, PowerPoint presentations will be presented to the group and teacher, where the solution to the detoning questions will be given for which they will have 10 minutes per team (check). After the exhibition, the question and answers phase began, first by his classmates and then by the teacher.</p>

Implementation of the didactic strategy "Oxidized or reduced"

The didactic strategy "Oxidized or reduced", consists of 7 working sessions which are composed of various teaching techniques, which are: didactic scenario, detoning question and secondary questions, conceptual map, projection of a didactic shoemaker, construction of a didactic strip, laboratory practices and socialization of results, using a PowerPoint presentation, the purpose of the variety of choice of teaching techniques that make up this strategy was to favor all styles of visual, auditory and kinesthetic learning (Keller, 1979; Richey, 1986; Giammatteo and Obaya, 2018; Jaramillo and Obaya, 2019).

Session 1

It has as an important component the didactic scenario, this has the function of attracting attention and motivation to learn the subject to be addressed, in this case "Oxydo-reduction reactions". The didactic scenario has the peculiarity of being a dialogue text, (dialogue between three people), which is why you can read aloud based on three young people, then the students identified and underlined the main ideas to enclose the unknown words red and perform a glossary of task terms.

Once the analysis of the didactic scenario was completed, the detoning and secondary questions were presented, using a PowerPoint presentation, students were instructed to write them in the workbook, in search of the information that they carried out collaboratively and by affinity, forming 8 integrated teams of 5 people, each in order to avoid subsequent problems for the delivery of the work. The information will be used for session 2.

Session 2

For Session 2, the team delivered their printed research work, in a folder with the characteristics requested in the rubric, which is previously provided to them, guiding the investigation with the secondary questions, with this information the team I do a global reading and underline the main ideas, this information was used for the construction of a conceptual map in the workbook, it is worth mentioning that this graphic computer each team member, in some cases performed several or more , but the instruction was given to unify them, and later rewrite it in the bond paper, these activities were intended to rank the information for the understanding of it. It is projected the video tutorial on how to make a conceptual map (available in https://www.youtube.com/watch?v=-_jMUBI8dGU), this one shows the basic features that it should contain, it should be mentioned that students do not know how to perform this type of graphic computers, this was identified because on previous occasions the elaboration has been requested for the understanding of a topic, and the product obtained is a map saturated with information, that is, they do not analyze and / or synthesize the information, only copying it, without understanding the content, do not hierarchy the information and do not place words link, that is why the decision was made to use this teaching resource to improve the requested product. The choice of didactic technique conceptual maps was because they are didactic auxiliaries that have been developed based on Ausubel's learning theory, in addition the concept of maps serves to specify relationships between new and old strength learning to externalize these relationships. Conceptual maps are useful strategies to help students learn about the structure of knowledge and thought-building processes (meta-cognition). In this way, conceptual maps also help the student learn how to learn (meta-learning). According to Joseph D. Novak, 1991, "conceptual maps are schematic summaries that represent a set of conceptual meanings included in a structure of propositions." Conceptual maps are one of the most valued tools in the development of cognitive skills. They are a learning tool that promotes the development of attention, perception and memory. Encourages reflection, analysis and develops creative thinking

Session 3

After the teacher approved the conceptual map, instruction was given for students to rewrite it on bond paper, for this activity, they were asked in the previous section for material such as white bond paper, downs, colors, colored sheets, scissors, etc., so that students had options to develop their creativity and privilege kinesthetic learning, the products obtained are shown below. The video tutorial redox reactions will be projected, which is available on the page <https://www.youtube.com/watch?v=KwQZOARVjRw>

It is important to mention that during the elaboration of the conceptual map the students showed self-control in their actions, because they left the room to buy the missing material to the stationery, without asking the teacher's permission, but in an orderly and without mishaps on the way back to the classroom, in addition to the room stay was adequate, although they were not in rows as in the daily work, no screams, shoves or games outside the activity that was requested, for this time was set to perform the activity, which was monitored during this session. Once the conceptual maps were completed, the information was proceeded to socialize, for this three random teams were chosen to go on to expose their conceptual map, as shown in the following photographs, during this process the teacher made timely punctuation to give clarity to information.

During the presentation the teacher in conjunction with the students, they gave clarity to the concepts addressed, building more complete and profound ideas, which they embodied in a graphic organizer called "Redox Didactic After a screening of the video entitled "Redox Reactions", It should be mentioned that the video was screened twice, the first was run and the second time this was paused in order for the students to take the corresponding notes, and they were made clarifications to clarify the concepts to be used later.

Session 4

With regard to this Session, for the construction of the strip, the material to be used was requested in the previous session as: cardboard, scissors, downs, liquid glue, this technique privilege in the style of kinesthetic learning, where the teacher I provide the instructions for the construction of the same, for this activity is required patience on the part of the teacher. Because there are students who are auditory or visual and cannot carry out several activities at the same time, a situation that occurs frequently in men, the purpose of the construction of this strip was to determine which species is oxidized and the which is reduced, so that students would land abstract thinking on something visual and thus facilitate their understanding of the concepts of oxidation and reduction. After the didactic strip was used to solve some exercises in which they had to identify which species is oxidized and which species was reduced, it is worth mentioning that this didactic resource motivates young people and avoids confusion between the two Terms.

Session 5

During Session 5, teaching the redox method was developed with a constructivist approach, using a traditional master class, although they were previously asked to research the redox balance method. Where the student must be the active person in the acquisition of knowledge, but during the process it has been observed that students do not have the tools to acquire it, in addition to the lack of this method of balance because it involves a series of steps mathematicians, where basic but signed operations are used, which are not the forte of most students. In teaching the method the students stated that it was a very complicated method, that they did not understand the procedure, this caused the disinterest and the attention required was not presented, it is worth

mentioning that abstract terms were used as an electron, difficult to understand that it brings negative burdens, which do not reach to relate in his mind, preventing the understanding of the method in a first explanation. So colored sheet boxes were used to represent the loads of each species, i.e. red cation and blue anion, this for students to visualize when the electrons are added, i.e. the contribution of the negative charges of these particles, which causes positive load neutrality and consequently the load balance of species, it is important to clarify that this technique was used as a remedy because it was not programmed since the initial proposal. After explaining several examples, students were requested to voluntarily switch to the painting to solve equation balancing exercises by the oxide-reduction method, as shown in the picture 7.

Session 6

Session 6 included the experimental phase due to several reasons, an important one was that kinesthetic learning was considered, and another is that Chemistry is a theoretical-practical matter, so laboratory practices are indispensable for their learning. It should be mentioned that the CBT 2 Bicentennial institution, Huehuetoca, where this strategy was applied, does not have the necessary resources, such as laboratory material and analytical reagents, to perform more sophisticated practices, so it has to use homemade substances and materials, this complicates and delimits the selection of them, so it was proposed the first practice entitled "How to clean silver?", also has the virtue of being applied in common objects especially in jewelry that we all have in our homes, the following images show the materials used for the development of the practice. After performing the practice was asked to write the chemical reaction in his notebook and take stock of it by the redox method, he relied on a video showing this reaction, made use of the video. At the same session it was requested that students propose a practice of the theme Oxide-reduction, this was freely elected and they had to carry the material and substances to be used, so below are the following evidences of two practices "Painted water discoloration" and "Oxygenated water decomposition".

Session 7

To finalize the didactic strategy, Session 7, where the results of the experimental phase were presented, was held and the detoning question was answered, the exhibition was made by the teams using a PowerPoint presentation, the duration of the same should not exceed 10 minutes, and at the end of each team the question and answer session was held by the students and teacher.

RESULTS

The witness and experimental group in terms of the level of knowledge in both groups, the subject of Chemistry I, presents the same average of 7.3.

Comparison of Grades Obtained by Students in the Witness and Experimental Group

Table 1. Qualifications obtained for the witness and experimental group once the pedagogical intervention has been applied

Student	Experimental group		Witness group	
	Pretest results	Postest results	Pretest results	Postest results
1	3.3	7.8	3.3	7.8
2	3.3	8.9	3.3	6.7
3	8.8	10	2.2	10

4	2.2	8.9	7.7	4.4
5	5.5	10	1.1	5.6
6	2.2	6.7	1.1	5.6
7	3.3	7.8	3.3	6.7
8	2.2	6.7	5.5	5.6
9	4.4	6.7	4.4	6.7
10	3.3	4.4	2.2	3.3
11	2.2	7.8	1.1	3.3
12	4.4	6.7	1.1	4.4
13	1.1	7.8	3.3	6.7
14	3.3	6.7	2.2	5.6
15	2.2	8.9	4.4	5.6
16	2.2	8.9	2.2	6.7
17	4.4	10	0	6.7
18	4.4	10	3.3	6.7
19	2.2	7.8	2.2	6.7
20	3.3	7.8	0	3.3
21	1.1	7.8	2.2	4.4
22	4.4	5.6	1.1	4.4
23	2.2	4.4	1.1	7.8
24	3.3	4.4	5.5	4.4
25	5.5	8.9	6.6	4.4
26	3.3	8.9	2.2	6.7
27	3.3	6.7	1.1	6.7
28	2.2	6.7	3.3	6.7
29	3.3	7.8	2.2	2.2
30	2.2	6.7	1.1	8.9
31	3.3	10	2.2	6.7
32	0	4.4	2.2	6.7
33	1.1	8.9	1.1	5.6
34	4.4	5.6	2.2	5.6
35	2.2	5.6	1.1	3.3
36	2.2	7.8	1.1	5.6
37	3.3	4.4	1.1	4.4
38	4.4	6.7	4.4	5.6
39	1.1	5.6	4.4	3.3
40	3.3	4.4	3.3	5.6
41	4.4	8.9	4.4	6.7
42	1.1	7.8	1.1	3.3
43	2.2	5.6	4.4	4.4
44	-	-	5.5	2.2
45	-	-	5.5	3.3
46	-	-	3.3	5.6
47	-	-	0	2.2
Average	3.07	7.3	2.8	5.4

Table 1 show that exploratory assessment of strategy for learning redox reactions in high school by students in the posttest, with respect to the pretest, based on the results it can be concluded that the teaching strategy, is suitable to teach the topic of reduction to groups in which there are a large number of students with a lack of interest in their academic development. In order to assess whether the students' grades (Perkins, 1991; Salazar and Obaya, 2019) when using the proposed teaching sequence were statistically significant, with respect to the traditional class, the analysis of the square Chi test was performed.

Table 2. Statistical analysis for pretest results

Experimental group vs Witness group						
	N	Average	SD	Min	Max	Median
Experimental Pretest	43	3.07	1.52	0	8.8	3.3
Witness Pretest	47	2.7	1.80	0	7.7	2.2

n= Sample size

SD.= Standard Deviation

Min= Minimum grade value

Max= Maximum grade value

The statistical analysis carried out, an average of 3.07 was obtained for the experimental group and 2.7 for the witness group, concluding that the students of the experimental group had a better level of prior knowledge than the witness. The average maximum average was 8.8 for the experimental group and 7.7 for the witness. The median, the average number in the whole turned out to be 3.3 for the experimental group and 2.2 for the witness group. The standard deviation, the value for the experimental group in the pretest was 1.52 and for witness 1.80 which means that the dispersion or variation of the obtained values indicate that the experimental group data are grouped close to its mean arithmetic and that those of the witness group extends over a wider range of values.

Table 3. Statistical analysis for posttest results

Experimental group vs Witness group							
	N	Average	SD	Min	Max	Median	Ji-square
Posttest Experimental	43	7.3	1.72	4.4	10	7.8	N/C
Witness Posttest	47	5.4	1.73	2.2	10	5.6	11.1

n= Sample size

SD.= Standard Deviation

Min= Minimum grade value

Max= Maximum grade value

N/C= Not calculated

In relation to the posttest results used for each (experimental) study group were appropriate, because in both groups, the average ratings increased by 19%, for the experimental group the value of the pretest was 3.07 (see table 1) and for the posttest 7.3 (see table 1), so the increase was significant of 41.9%. For the witness group the value of the average ratings in the pretest was 2.7 and for the posttest of 5.4 (table 1), with a difference of 27% with the experimental group, in addition to the average rating remaining reprobate, thus concluding that the knowledge was not properly acquired. It can be noted in Table 3, that when comparing the average posttest ratings for each study group, there is a difference of 1.9 points, so it is concluded that the proposed strategy was adequate, due to the increase in the results what the students got.

The following are raised as null hypotheses and alternating hypotheses:

H₀: The design and implementation of a teaching strategy under the competency approach does not promote learning the topic of chemical reactions oxide-reduction

H₁: The design and implementation of a teaching strategy under the competency approach promotes learning the theme oxide-reduction chemical reactions

The analysis of the hypothesis test was carried out by means of the Ji-square association test χ^2 to determine whether it is accepted or rejects the initially proposed approach, for which 5 degrees of freedom 5 are used, with a significance of 95%, (α 0.05, obtaining the value of 14.7).

From the data obtained, the contingency table (table 4) was prepared, showing the frequencies obtained and the frequencies expected for the achievement of posttest learning of the experimental group.

Table 4. Frequencies obtained and expected for the experimental group

Grades	Obtained frequencies (OF)	Expected frequencies (EF)	(OF-EF)	(OF-EF) ²	$\frac{(OF-EF)^2}{EF}$
4.4	6	3	3	9	3
5.6	5	10	-5	25	2.5
6.7	9	15	-6	36	2.4
7.8	10	5	5	25	5
8.9	8	5	3	9	1.8
10	5	5	0	0	0
Total	43	43	0	104	14.7

The calculated value is obtained (χ^2)=14.7

You get from the table (χ^2)= 11.1

If the value (χ^2) calculated $>(\chi^2)$ from the table, the null hypothesis H₀ is rejected and the alternating H₁ is accepted. As the obtained values (χ^2) calculated $>(\chi^2)$ table, namely, $14.7 > 11.1$ the alternating hypothesis H₁ is accepted

CONCLUSIONS

Based on the null hypothesis and the alternating hypothesis initially raised, therefore, the data present sufficient evidence indicating that for this study there was dependence between the teaching strategy used and the achievement of learning of the topic of redox chemical reactions in CBT No. 2 Bicentennial students, Huehuetoca in Mexico. That is, if the learning of students was better through the use of the teaching strategy used. Because the average values that the grade students obtained were probationary of 7.7, better than the witness, whose rating was on average was probative, 5.4 rating.

It should be noted that the didactic strategy that was created, is suitable to teach groups of students that have characteristics similar to this experimental group, that is, with a predominance of the style of learning, kinesthetic and visual. With the above, it can be said that the objective set out in the study was fulfilled, because learning in high school students on the subject of chemical

reactions oxide-reduction was favored through the design of a teaching strategy, under the competency approach. Based on the results obtained from the hypothesis test by means of the Ji-square association test, it is stated that "The design and application of the teaching strategy under the competency approach favored the learning of the topic chemical reactions "therefore confirms that the pedagogical intervention used didactic strategy proposed, is adequate. However, it is necessary to apply to a larger sample for obtaining more information for ensure that learning this topic occurs definitely in high school students.

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Annex 1. Chemical equations for balancing by redox method

Instructions:

- a) For each of the following equations perform each of the following subsections
- b) Mention which substance is reduced
- c) Identify which substance is the reducing agent

Balancing by redox method the reactions:

