



THE HISTORY OF CHEMISTRY AS A MOTIVATING INSTRUMENT IN THE TEACHING-LEARNING PROCESS OF CHEMISTRY IN FIRST-YEAR HIGH SCHOOL CLASSES

A HISTÓRIA DA QUÍMICA COMO INSTRUMENTO MOTIVADOR NO PROCESSO DE ENSINO-APRENDIZAGEM DA DISCIPLINA DE QUÍMICA NAS TURMAS DE 1º ANO DO ENSINO MÉDIO

LA HISTORIA DE LA QUÍMICA COMO INSTRUMENTO MOTIVADOR EN EL PROCESO DE ENSEÑANZA-APRENDIZAJE DE LA QUÍMICA EN PRIMER CURSO DE BACHILLERATO



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Antonia Gomes do Nascimento¹, Lueny Amorim de Oliveira²

ABSTRACT

The approach to the history of chemistry in high school often boils down to simple descriptions of dates, figures, and discoveries, leading students to distorted views of the scientific method and mythical ideas about science. This project aimed to determine whether a planned approach to this topic can make chemistry classes more challenging and reflective, thus allowing for greater student engagement with conceptual content, fostering the construction of knowledge and the effectiveness of the teaching-learning process. To achieve this, the research employed a contextualized and targeted teaching approach, prioritizing the historical-philosophical aspects of science in the learning process. This fosters the development of a critical and pioneering perspective, allowing students to engage closely with the content learned, with a view to applying what has been learned and, as a result, transforming knowledge. The project was implemented at the Nelson Serejo de Carvalho Teaching Center and involved participant observation by the academic/researcher. The research was conducted in two first-year high school classes and was exploratory in nature, with both a qualitative and quantitative approach. Data analysis included responses to open-ended and closed-ended questionnaires, observation records, and class notes.

Keywords: Learning. Knowledge. Difficulties. Chemistry.

RESUMO

A abordagem da História da Química no Ensino Médio em sua maioria, se resume à simples caracterizações de datas, personagens e descobertas, direcionando o aluno a visões distorcidas do método científico e a ideias míticas sobre a Ciência. Neste projeto pretendeu-se verificar se uma abordagem planejada deste tema pode tornar as aulas de química mais desafiadoras e reflexivas, permitindo, deste modo, um maior envolvimento dos alunos frente

¹ Graduated in Business Administration. Universidade CEUMA do Maranhão. Maranhão, Brazil. E-mail: antoniagomes@ifma.edu.br

² Undergraduate student in Chemistry. Instituto Federal de Educação, Ciência e Tecnologia do Maranhão (IFMA). Maranhão, Brazil. E-mail: luenyoliveira.ifma@gmail.com



aos conteúdos conceituais fomentando principalmente a construção do saber, e a eficácia do processo de ensino aprendizagem. Para isso na pesquisa foi utilizado uma abordagem de ensino contextualizada e direcionada, priorizando os aspectos histórico-filosóficos da ciência no processo da aprendizagem, fomentando a construção de uma visão crítica e desbravadora, permitindo ao educando uma relação proximidade com o conteúdo aprendido, tendo em vista a aplicação do que foi aprendido e como resultado a transformação pelo conhecimento. O Projeto foi executado no Centro de Ensino Nelson Serejo de Carvalho e envolveu uma observação participante do Acadêmico/investigador, a pesquisa se deu em duas turmas de 1º ano do Ensino Médio e teve caráter exploratório, com abordagem de pesquisa qualitativa e quantitativa. A análise dos dados envolveu o conjunto de respostas aos questionários abertos e fechados, os registros de observações e as anotações sobre as aulas.

Palavras-chave: Aprendizagem. Conhecimento. Dificuldades. Química.

RESUMEN

El enfoque de la historia de la química en la secundaria suele reducirse a simples descripciones de fechas, cifras y descubrimientos, lo que lleva a los estudiantes a visiones distorsionadas del método científico e ideas míticas sobre la ciencia. Este proyecto tuvo como objetivo determinar si un enfoque planificado de este tema puede hacer que las clases de química sean más desafiantes y reflexivas, permitiendo así una mayor participación del alumnado en el contenido conceptual, fomentando la construcción del conocimiento y la eficacia del proceso de enseñanza-aprendizaje. Para lograrlo, la investigación empleó un enfoque didáctico contextualizado y específico, priorizando los aspectos histórico-filosóficos de la ciencia en el proceso de aprendizaje. Esto fomenta el desarrollo de una perspectiva crítica y pionera, permitiendo a los estudiantes involucrarse estrechamente con el contenido aprendido, con el fin de aplicar lo aprendido y, como resultado, transformar el conocimiento. El proyecto se implementó en el Centro de Enseñanza Nelson Serejo de Carvalho e implicó la observación participante por parte del académico/investigador. La investigación se llevó a cabo en dos clases de primer año de secundaria y fue de naturaleza exploratoria, con un enfoque tanto cualitativo como cuantitativo. El análisis de datos incluyó respuestas a cuestionarios abiertos y cerrados, registros de observación y apuntes de clase.

Palabras clave: Aprendizaje. Conocimiento. Dificultades. Química.



1 INTRODUCTION

The History of Chemistry, as part of socially produced knowledge, should permeate all Chemistry teaching, enabling the student to understand the process of elaboration of this knowledge, with its advances, errors and conflicts. (PCNEM, 1997) By learning Chemistry simultaneously with the History of Chemistry, the student would achieve a better understanding of the contents taught. Providing more than a view on the same topic. Show the importance of some technologies that serve or have served, throughout history, a specific community. Thus introducing students to a humanized scientific culture (SANTOS, 2002).

When it comes to the teaching of chemistry, the contents are usually taught without a correlation with the episodes that preceded or even caused that knowledge. Learning is impaired since, without a historical overview, students only have contacts with closed concepts, formulas and laws without understanding when and how these concepts were arrived at. These decontextualized contents produce aversion and disinterest in students, only memorizing them temporarily without any connection with their development and application.

The History of Science can contribute to an improvement in learning during classes, as it makes it possible to insert scientific concepts within a human reality. In addition, it values science as a human construct, not only showing the positive aspects, but also that science is not considered an absolute truth (BUZA et al. 2012).

Introducing topics about the history of Chemistry in the classes of the Chemistry discipline will introduce students to how the contents studied emerged, the way they developed, consolidated and took shape and formulas and how this knowledge interferes in our lives today. The Ministry of Education defends the historical knowledge of chemistry approached as an instrument of human formation broadens the cultural horizons and the autonomy in the exercise of citizenship of the students, in this way the chemical knowledge becomes one of the means of interpreting the world and intervening in reality, if it is presented as Science, with its own concepts, methods and languages and as a historical construction, related to technological development and to the many aspects of life (BRASIL, 2001).

The inclusion of the History of Science in teaching has reasons based on Philosophy and Epistemology and the very conception of science adopted interferes in the selection and approach of contents. It is considered that the inclusion of contents of History, Philosophy and Sociology of Science in the curricula can contribute to the humanization of scientific teaching, facilitating the change from simplistic conceptions about science to more relativistic and contextualized positions on this type of knowledge (LUFFIEGO et al., 1994; HODSON, 1985; apud OKI AND MORADILLO, 2008).



In this sense, reflecting on the concerns regarding the way we see Chemistry today, contributing to the construction of a vision of Chemistry as a human production, provides a new view on chemistry, not being a dead science reduced to formulas, concepts and calculations.

The research analyzed through an intervention the benefits of the inclusion of the History of Chemistry in the chemistry curriculum of the 1st year of High School, the significant contributions to the motivation of students during the classes of this discipline and how to use historical information to subsidize the knowledge of the various aspects necessary to understand Chemistry help in learning.

2 THE PROCESS OF LEARNING CHEMISTRY IN HIGH SCHOOL

The conception of learning permeates a much larger scope than just the transfer of content, in the teaching of chemistry this theme gains greater breadth when the National Curriculum Parameters encourage that: The appropriation of its concepts and procedures can contribute to the questioning of what is seen and heard, to the expansion of explanations about the phenomena of nature, for the understanding and valuation of the ways of intervening in nature and using its resources, for the understanding of the technological resources that carry out these mediations, for the reflection on ethical issues implicit in the relations between Science, Society and Technology. (BRAZIL, 2000).

Queiroz (2006) states that knowledge is not finished and ready, but rather continuously and historically produced in a social context. Thus, science deconstructs the view of neutrality and impartiality of its results and inferences. Understand the sciences as human constructions, understanding how they develop by accumulation, continuity or rupture of paradigms, relating scientific development with transformation in society (BRASIL, 1999).

Knowledge is not transmitted, but actively constructed by individuals; what the subject already knows influences his learning (MACHADO and MORTIMER 2007, apud BARBOZA 2013 et al.). The approach to the history of Chemistry is indispensable for understanding the development of theories; it is necessary to work during the classes on the historical contexts in which chemical concepts were built and replaced as a result of new discoveries (CEBULSKI and MATSUMOTO, 2008).

It is not possible to address everything, but history should not be reduced to the biography of scientists, because, if there is no harm in studying this, the same is not true when a student's only memory of the History of Chemistry is restricted to misunderstood names and dates (MOREIRA, 1993).



3 TEACHERS X HISTORY OF CHEMISTRY

Introducing the History of Chemistry into school curricula becomes a complicated task for a high school teacher, faced with problems essentially of two natures. The first are related to the difficulty in choosing the program to be followed, many teachers do not know which elements of the History of Chemistry to incorporate into their contents, in addition to considering it more adverse than the traditional approach (MORAES, 1999). At the bottom of these two problems is a distorted view of scientific work (PEREZ, *et al.*, 2001)

A study carried out by Correia (2003) reports that one third of the professors, although they present a course in the history of chemistry during their undergraduate studies, consider the knowledge acquired insufficient and most of the professors have never attended courses on the History of Chemistry. The study also points out that teachers also did not evaluate their students in objectives related to the History of Chemistry, demonstrating that, in addition to pronouncing the importance of incorporating the History of Chemistry into school curricula, it is necessary to have a greater direction to the access that teachers will have to this methodology.

The crisis in Science Education has affected countries all over the world, evidencing the high levels of illiteracy in science and the evasion of teachers and students from the classrooms (ARANHA, 2007). Problems like these highlight the difficulty in learning chemistry, which is shared by teachers and students. At this point, the History of Chemistry allows us to "see" the real nature of knowledge, which can thus be described, as a knowledge that is respected by recognition and not by methodology, which is subjective and provisional, through how models have been modified and adapted to new data (experimental or theoretical), discoveries and progress of other branches of knowledge, how social, economic and political aspects, and even personal belief, persistence and creativity interfere in the construction and acceptance of these models (SEQUEIRA AND LEITE, 1988).

With regard to the History of Chemistry within the classrooms, the teacher must be a conscious advisor to guide the student to success. A teacher is called for who can walk alongside and in front of the students, at an appropriate distance, serving as a mediator between the students and the new information (ALMEIDA, 1998). It is not enough just that the contents are taught, even if well taught, it is necessary that they are inseparably and meaningfully linked to human and social experience. The objective is to teach for understanding, so students must have an active role in the appropriation of their ideas (PERRONE, 2009). From this perspective, the teacher is the one who mediates and enables access to information so that the student understands and appropriates



the knowledge. Teaching is not just transmitting knowledge, but creating the possibilities for its construction and production or its construction (FREIRE, 1996).

The history of chemistry as part of the curriculum of high school classes is an important reflection, since this tool is a means of facilitating the learning process of the discipline, because "Chemistry as a science has a historically, culturally and discursively constructed field of meanings" (MACHADO, 1999) promoting the creation of materials and methods that provide this new approach is an imperative task.

4 MATERIAL AND METHOD

The research was carried out at the state public high school, Nelson Serejo de Carvalho, located in the city of Zé Doca, MA. Two morning classes of the first year of high school were chosen. The classes were chosen because they are classes that are entering high school with little or no contact with chemistry

Researches were carried out in the literature, articles, books and periodicals in order to organize a didactic unit for the application of contents related to the history of chemistry concomitant with the contents commonly studied during the period.

The didactic investigation was carried out during one quarter and the data collection instruments were applied in the classroom, during the academic period of the course.

The classes were separated into test classes and control classes. In the test class, the history of Chemistry was added to the conceptual contents, and in the control class, the conceptual contents commonly studied were continued, being worked on without the connection with the detailed history of Chemistry.

The development of the research had a quantitative and qualitative approach, with an exploratory character, involving the researchers as teachers of the classes. All students enrolled in both classes participated in the investigations, and a sample of only 40 students was used to answer the closed questionnaires. This selection was made according to the students' attendance at classes, aiming to eliminate variables.

Adapting to the specific needs of the school, the didactic unit was applied according to the contents normally taught by the teacher, making each content a historical overview and a contextualization.

History and Philosophy of Science and nature of sciences were included making a directed and contextualized teaching approach, the historical contents were articulated in a chronological perspective with the conceptual contents that are usually worked on in the first year of High School that were taught from the central theme "Constitution of matter: from the discovery of fire to Dalton's atom".



To investigate the proposed questions, the evaluation activities were the same for both classes, as well as the research, discussion and presentation activities, the objective of this procedure is to isolate the only variable to be studied in the research: the inclusion of a more detailed study of the history of Chemistry, so the difference in the results of the two classes can be attributed only to this intervention.

The historical contents organized chronologically following the school's didactic material with the conceptual contents that are usually worked on in the first year of High School through a didactic unit whose central theme is "Constitution of matter: from the discovery of fire to Dalton's atom".

The following were used as data collection instruments: questionnaires and the activities and performance evaluations of the institution where the research was carried out. Closed questionnaires were applied for a previous survey on the acceptance of the didactic unit and previous knowledge about the history of chemistry.

After the end of the quarter, in addition to the activities of evaluating the performance of the classes, open questionnaires were applied to the test class, containing problematized questions asking the students' opinion about their own performance after going through the didactic unit of in-depth content on the history of chemistry, with the objective of allowing students to reveal their experiences with the proposed knowledge.

The analysis data involved the set of answers to the questionnaires, the records of observations and the notes on the classes, especially the test class in which the contents on the history of Chemistry were applied and the performance evaluation activities provided by the institution.

5 RESULTS AND DISCUSSION

During the application of the Didactic Unit, closed questionnaires were applied in order to know the opinion of students and teachers about the more detailed approach to the History of Chemistry. Tables 1 to 7 refer to the students' opinion in relation to the discipline and the new approach, with reference to historical construction. The students answered closed questionnaires with 5 alternatives each.

In the analysis of the data obtained, it is observed that a small portion of students are not interested in knowing the History of chemistry and still some do not have a definitive position on the subject. Most students feel the desire to know the History of Chemistry, believing it to be a means of facilitating the learning of the discipline of Chemistry and certainly providing benefits. The tables are presented.

**Table 1***Difficulty in learning Chemistry*

QUESTION 1	ALTERNATIVES	ANSWERS
Do you have difficulties learning the discipline of Chemistry?	a) Yes.	58%
	b) No.	5%
	c) A lot of difficulty.	32%
	d) Sometimes.	5%
	e) Rarely.	0%

Source: The authors, 2016

It was found that most of the students, from the classes participating in the research, have some kind of difficulty with learning the discipline of Chemistry.

For Silva (2013) many students are terrified just to hear about Chemistry, this prejudice of the student community as a whole has underpinned several researches, debates and developments of new methodologies, aiming to make the learning of Chemistry and exact sciences more effective and participatory.

Table 2*Factors that hinder learning*

QUESTION 2	ALTERNATIVES	ANSWERS
Of the alternatives, which do you consider an obstacle to learning Chemistry?	a) Lack of teaching materials.	8%
	b) Teacher's methodology.	30%
	c) Uninteresting content.	42%
	d) Absence of prior knowledge that facilitates understanding.	20%
	e) None of the alternatives.	0%

Source: The authors, 2016

In this table we can see that students recognize the factors that hinder the learning of the subject, a significant part thinks that the contents covered in the course are uninteresting and that this compromises learning.

According to Matthews (1995) Chemistry is considered basic and mandatory knowledge at the high school level, however it is considered insignificant for students because it deals with formulas and concepts that are not comprehensible. Nunes and Ardoni (2010) state that the learning of chemistry should enable students to understand the chemical transformations that occur in the physical world in a comprehensive and integrated way, so that they can judge it with theoretical-practical foundations.

Table 3

Importance of the study of the History of chemistry

QUESTION 3	ALTERNATIVES	ANSWERS
Do you consider the history of chemistry something important to be studied?	a) Yes.	40%
	b) No.	7%
	c) Perhaps.	19%
	d) Very important.	29%
	e) No. These are unnecessary contents.	5%

Source: The authors, 2016

When asked about the study of the history of chemistry, the largest percentage of students consider it important knowledge, however a significant portion of students do not pay attention to this learning and others consider the content of the history of chemistry unnecessary.

According to Silva (2013), the teaching of chemistry represents a great challenge for teachers, as many students do not show interest in the contents covered in the discipline. This lack of interest in the contents presented in the chemistry discipline makes learning difficult and complex, requiring facilitating instruments for teaching and learning.

Table 4

History of chemistry as a facilitating instrument in the classroom

QUESTION 4	ALTERNATIVES	ANSWERS
Do you believe that knowing the history of chemistry in class would facilitate the learning of the chemistry discipline?	a) Yes.	62%
	b) No.	0%
	c) Perhaps.	15%
	d) Yes, it would make it easier to understand.	18%
	e) It wouldn't make much difference.	5%

Source: The authors, 2016

According to the students questioned, most of them say that the history of chemistry would facilitate the learning of the discipline by helping to understand the contents, there is also a percentage that has not taken a definitive position.

Table 5

Benefits of using the History of Chemistry in the classroom

QUESTION 5	ALTERNATIVES	ANSWERS
What benefits could the use of the History of	a) Better learning of the chemistry discipline.	45%
	b) Greater understanding of society's intervention in the production of scientific knowledge	3%
	c) Socialization of chemical knowledge	7%



Chemistry bring to the classroom?	d) Improved motivation and the possibility of learning the content in a more creative and integrated way	42%
	e) There are no benefits.	3%

Source: The authors, 2016

The students defined as the greatest benefits that can be achieved with the approach of the history of chemistry the improvement of the learning of the chemistry discipline and greater motivation in the discipline, there was a small percentage that disagreed with the majority of the students stating that there are no benefits.

Table 6

Reference made by the teacher to the History of Chemistry during classes

QUESTION 6	ALTERNATIVES	ANSWERS
In chemistry classes, does the teacher usually refer to the History of Chemistry to support the contents?	a) Yes.	0%
	b) No.	65%
	c) Rarely.	15%
	d) In all classes.	0%
	e) Never.	20%

Source: The authors, 2016

According to the students questioned, teachers do not usually refer to the history of chemistry during Chemistry classes.

Martin and Von (2008) state that the guidance of teachers, educators and specialists in the various areas of knowledge contributes to the theoretical contribution for their students to make interrelationships and build knowledge in a positive and lasting way.

Table 7

Interest in the History of Chemistry during classes

QUESTION 7	ALTERNATIVES	ANSWERS
Would you like the History of Chemistry to be addressed in the classroom during Chemistry classes?	a) Yes.	47%
	b) No.	0%
	c) If it were possible.	39%
	d) It would be nice, but it doesn't make much difference.	9%
	e) I don't see the need.	5%

Source: The authors, 2016

Table 7 shows that most students would like the history of chemistry to be addressed in the classroom, and another significant portion of students was indifferent, stating that it will not be much to have this content.



According to Schnetzler (2004), The concrete improvement of the teaching and learning process happens through the teacher's performance and knowledge, requiring a continuous process of professional improvement through continuous critical reflection and research on their pedagogical practice.

In the analysis of the data obtained, it can be observed that most students feel the desire to know the History of Chemistry, believing it to be a means of facilitating the learning of the discipline of Chemistry and certainly providing benefits. It was found that, in its majority, the students surveyed have a lot of difficulty with learning the discipline of Chemistry. and recognized that the contents covered are uninteresting and that this hinders the learning of the subject.

Tables 8 and 9 refer to the open questionnaires carried out after the application of the Didactic Unit containing a historical approach to Chemistry, the data were tabulated in the table are the 5 most recurrent answers presented by the students questioned. The most recurrent answers presented during the survey are presented in descending order.

Table 8 shows the data from the questionnaire in which the students talked about what changed during the application of the didactic unit, presenting as one of the main changes the improvement in the teaching-learning process of the discipline in question.

Table 8

Regarding the learning of the chemistry discipline during the application of the didactic unit

QUESTION 1	ALTERNATIVES
What do you consider to have changed with the inclusion of the History of Chemistry in the classes of the chemistry discipline	1. Improved knowledge acquisition
	2. Made the classes more interesting
	3. It contributed to the contextualization of the discipline with other areas of knowledge
	4. Improved performance and participation in classes
	5. There were no changes

Source: The authors, 2016

The improvement in learning and greater interest of students in the discipline of chemistry verified during the application of the research corroborates the studies of Silva (2013), when he states that the problems in learning Chemistry that are pointed out at all levels of education are not new, however, before talking about learning difficulties in Chemistry it is necessary to verify that the problem is not in the curriculum or in the methodology used.

Table 9 presents the data corresponding to the questionnaire that investigated which were the most relevant and peculiar factors observed during the application of the Didactic Unit,

Table 9

Regarding the relevant factors for the students during the application of the didactic unit

QUESTION 2	ALTERNATIVES
What did you consider most relevant in the approach to the History of Chemistry during the application of the didactic unit	1. The contextualization between the History of science and current contents.
	2. Meet the scientists who were pioneers in the construction of chemical knowledge
	3. Study theorists and scientists who contributed richly to chemistry and are little known
	4. The perception of chemistry as a historical construction of society and of knowledge as a permanent construction.
	5. That we are all scientists and builders of knowledge.

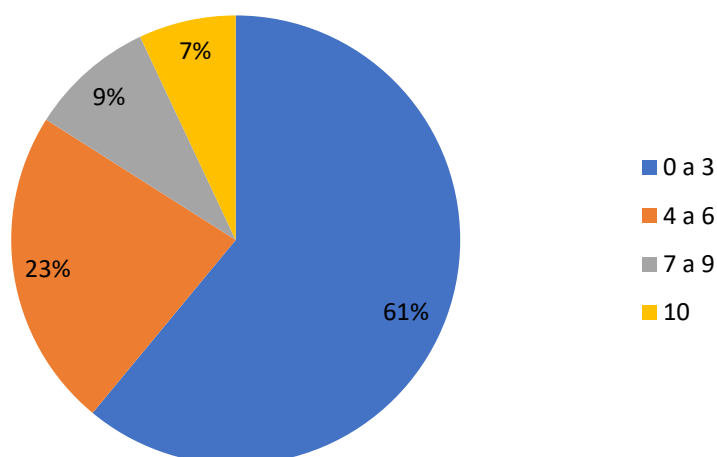
Source: The authors, 2016

At the end of the application of the Didactic Unit, there was a difference in the levels of learning of the discipline between the Control Class and the Test Class. These Figures showed the percentage of grades obtained in the two classes during the same period, and evaluations were applied and carried out using the same methodology in both classes, the same evaluations and with the same criteria, the only variant to be observed, during the application of these evaluations, is the fact that one of the classes studied in parallel with the contents normally taught contents about the history of chemistry.

From these results, it was very clear that the benefits of applying these contents were observed in corroboration with the contents already commonly used. The results obtained are represented in the Figures below:

Figure 1

Referring to the grades obtained in the Control class



Source: The authors, 2016

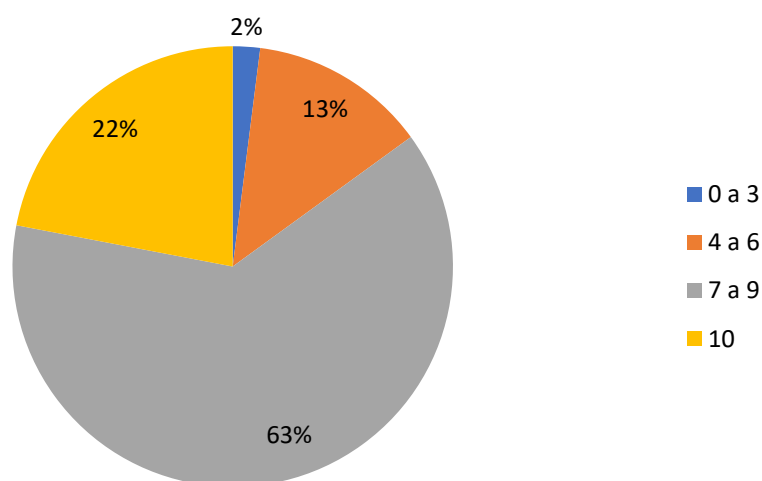
Figure 1 shows the grades of the evaluations in the control class, where the normal contents of the discipline were normally taught, without the insertion of the history of chemistry.

It can be seen that the percentage of minimum grades (from 0 to 3) leads the Figure, showing that the performance in the discipline is bad or very bad.

These results corroborate the studies of Machado and Mortimer (2007), who state that working with an excessive amount of concepts, as occurs in the usual curricula, is based on the assumption that learning chemistry is only learning the chemical content and that this makes the discipline uninteresting.

Figure 2

Referring to the grades obtained in the Test class



Source: The authors, 2016

Figure 2 presents the grades of the evaluations carried out after the application of the didactic unit in the Test class (class where the contents of the discipline were taught with the insertion of the history of chemistry). It can be seen that the percentage of minimum grades (from 0 to 3) is much lower than those of the control class and the Figure showing that the performance in the discipline of this class was excellent in relation to the control class, the percentage of good grades accounted for more than 75% of the total number of evaluations.

The Figures show results similar to those of Lima, *et al.*, (2011), pointing out that the rigid structure of the contents makes teaching fragmented and decontextualized, emphasizing only formulas and equations. Thus, for meaningful learning, it is necessary to overcome these limits, seeking new teaching methods, new alternatives and innovative



resources that enable students to create their concepts, discover new ways to reach a result and learn dynamically.

6 CONCLUSION

The results obtained in the research showed that students and teachers have difficulties regarding the discipline of chemistry, the limitations pointed out by the students compromise the teaching-learning process of the discipline, they define as the main obstacle the articulation of the contents as difficult and uninteresting.

The results showed that the history of chemistry contributes significantly to the learning of the discipline, in addition to making classes more dynamic, contextualizing the contents and fostering an investigative spirit in students.

From the results obtained, a change in the way the contents of the chemistry discipline are articulated is encouraged, the need for a more in-depth approach to the history of chemistry and its contributions to the teaching of the discipline of Chemistry, as well as a more adequate structuring of the contents taught in the discipline.

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