

Simple thematic debate and debate between groups with questions: argumentation techniques in elementary school for learning atomic models

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Abstract

In the science, the emergence of new theories initiates a series of debates and discussions, until they prove to be true, demonstrating how argumentation is linked to scientific knowledge and practice. However, science education has distanced itself from this, exposing these theories as unique truths, not subject to discussion. The objective was to develop methodologies that would bring scientific arguments closer to the classroom. They were applied to the 9th years B and C of E.E.E.F.M. Cândido Portinari, Rolim de Moura - RO, where the techniques of simple thematic debate and group debate with questions were applied. In both techniques, students showed differences in performance in the tests, compared to the previous two months, a significant index of general satisfaction and showed improvement in the criticality and abstraction of the contents. Therefore, science learning becomes effective when approached by scientific practice.

Keywords: Meaningful Learning. Science teaching. Physics teaching. Methodology.

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Introduction

Nowadays, in relation to science learning, it is possible to notice a departure from scientific practice and from Science itself. Daily in the school routine, the contents are presented in an inflexible and immutable way; the sciences and their postulates are seen as unique truths, conveying the idea that they were ready and unanimous, with no questions, counterparts or discussions being possible. Attached, yet, a reality faced by teachers, in schools, where problems of excessive workload, of nonexistent resources and determinations that must be followed and have been ignored (KRASILCHIK, 2000). Moreover, as the way this professional is formed, cause an impasse by a portion of the knowledge that would allow carrying out an analysis of reason of scientific's works, succeeding a discrepancy between their academic training and various requirements assigned (Fourez, 2016).

There is a conflict between this situation and the history of scientific practice and Science itself, since scientific theories and postulates, throughout the trajectory of science in its entirety, have been constantly criticized, discussed, exposed to trials and intensely debated, aiming to put forward understanding and subjecting recent discoveries to different situations, allowing an analysis of the whiteness of their actions, adding the reason that several theories, at a given moment, were true, are no longer today, stating that, through arguments that supported and criticized them, Science is done.

It is defined argument, as referring to the associativity components which establish a relationship with the knowledge already present in the student, performing a key role in the development of explanations, models and theories (COSTA, 2008). Based on this definition, contact is that the argument is used as an important tool in the teaching learning of science, for the reason that science education aims to help the students to get involved, from the scientific work, with elaborate speeches. Teaching should allow the acquisition of ways and means of arguing by developing activities in class and associating them with discursive practices (DRIVER et. Al., 2000). Soon, there is the urge to form responsible citizens, able to use criticism to evaluate and distinguish the information received and passed on, which are aware of the actions' consequence as their own as others and skilled in preparing reasoned argument in the moment of make decisions (CACHAPUZ et al., 2005; COSTA,



2008), as the argument makes it possible to effect the institution of a school scientific culture (SASSERON, 2015).

When talking about argumentation, its importance and relevance for the scientific evaluation of the arguments and the way they are elaborated must be emphasized. By scrutinizing and observing the structure of the argument, realizing the path of formation of the argument, it is possible to find a foundation, which can trigger the discussion in class and be directed by the teacher. It is also believed that, during the discussion, the educator believes that accompanying measures are necessary, so that he can stimulate and support the construction of the argument (SASSERON and CARVALHO, 2013). However, there is one setback related to realization of activities that enable discussions in classes, as can occur difficulties found by the teacher to organize them, it is something that needs teacher preparation and student involvement to participate effectively in this way of learning, since the complexity of constructing an argument follows not only from a practice, but also from knowledge and contexts acquired during the discussion (LOPES; GOMES, 2020).

The development of this process ranges from the gradual adaptation to the adaptive management of students, to the listening process of colleagues, to the elaboration of their questions to systematize thoughts that lead to conclusions, so the monitoring and the form of the process are important for the carrying out this type of work (CAPECCHI et al., 2000). However, it is not just about a question to aware teachers about the discussion, is a tool that promotes the construction of knowledge of students and more meaning to them. This is also related to the teachers' awareness need for follow-up steps throughout the discussion process, in order to strive to stimulate their appearance in all situations present in the classroom (SASSERON; CARVALHO, 2011).

It is common knowledge that the story concerning the composition of matter is closely connected to the history of science and developed ment of scientific thought, noting that the concepts to improve and change up constantly, in front of it to as the field progresses trial, its complexity also increases. (LOPES; GOMES, 2018), making it possible to give the idealization of science a human dimension that is easy to understand, and to interpret it as an artifact worthy of appreciation (MATTHEWS, 1995). Therefore, the importance of studying such topics in elementary education is necessary to elucidate and understand better the scientific theories and ideas, and that argumentation use is an important tool. The current work aimed to syste-

matize and develop two teaching methodologies using debates around the teaching of atomic models, having argumentation as the main tool for the learning process.

Methodology

The work is based on the elaboration and application of debate techniques and aims at teaching atomic models. To this end, we proceeded to a literature that were associated with the argument as a way of teaching science and priority was given to those who were concerned mainly content related to physics.

To understand how learning happens, we used the meaningful learning theory and the concept of subsumer, both elaborated by David Ausubel. Being applied in the ninth year of elementary school, these techniques aimed at the introduction to scientific debate, to analyze qualitative arguments developed by the students, verify the presence of a change in income in the classroom, improvement of participation in classroom and learning.

The techniques elaboration of the present work was based on the argumentation structure developed by Toulmin (2006). The main contents covered by the applied techniques were: Atomic Models by Dalton, Thomson and Rutherford-Bohr. However, they can be applied to other contents as long as satisfactory adaptations are made so that the proposals established by the teacher are fulfilled. The choice of debates as a way to develop this work, aimed to associate the student's learning with the discussions and debates that permeate the scientific environment. Aiming that, in addition to allowing the conflict of ideas between students at the same learning stage, the complexity of the theme will help to make the practice of constructing arguments viable.

Research subjects

The work was carried out at Candido Portinari State Elementary and High School, located in the municipality of Rolim de Moura - Rondônia, in Downtown, at Fortaleza Avenue, number 5550. Despite being a school located in the Center, its clientele is also formed by students who live in peripheral neighborhoods, such as Planalto, Industrial, Cidade Alta, Boa Esperança and rural students. The activities were carried out during the Science classes held in 2015.



The classes that participated in the activities of this work were all from elementary school, who attended the afternoon period from 1:00 pm to 5:15 pm, with classes lasting one hour, two classes being worked in a row in all classes, per week. 82 students participated, being the participating classes: the 9^oB which had 27 students, one of them from the rural area, with an age range varying from 14 to 17 years old and the 9^oC which has 29 students, one of them enrolled in dependency, having a 14 to 18 years old. 9^oB participated in the simple thematic debate and 9^oC developed the debate technique between groups with questions. These activities were carried out between March 16 and 27, 2015, a period that is part of the first bimonthly. The learning performance verification was performed based on the observation of the students' participation during the classes. The way like the arguments were analyzed varied according to the technique used and described below.

The simple thematic debate took into consideration: the arguments, the coherence and the participation of the student throughout the work. In the debate between groups with questions, the following were observed: the questions coherence with the contents and the relationship of the respective answers, taking into account the basis for both. The groups that performed the reports on the techniques of simple thematic debate, had the following criteria observed: the arguments' transcription presented throughout the debate, the way the technique and debates took place, and the conclusion that the group developed. The techniques were considered as a work, subject to grade, which was included in the average of the students of the two months in which they were applied.

The arguments that stood out during the application of the techniques, were recorded for later analysis, in the same way, data and arguments exposed during the activity of the reports prepared by the students were collected. There were register of observations on the students' conduct to establish a relationship with the technique's application.

To quantify the development of the work, an evaluation was established, where 0 to 4.0 points were awarded. In order to qualify the work, the unsatisfactory and satisfactory parameters were applied. When obtaining a score lower than 50% of the maximum value, they were considered unsatisfactory, those who obtained values above were considered satisfactory. In order to verify the students' learning, tests were applied, in the same bimonthly, with essay and objective questions about the work contents throughout the application of the techniques. The score was from 0

to 4.0 points, and the criteria of satisfactory and unsatisfactory, described above, were also used to analyze the tests.

The technique effectiveness was verified by making a comparison between a bimonthly that used the traditional model and the bimonthly where argumentation techniques were applied. This analysis was made from the percentage of tests that reached each of the students, in relation to the total of tests that were applied in the classes. Thus, the difference between the percentages of both bimonthly was observed to ascertain whether there was an impact on learning. The percentage values were obtained from a simple three rule.

Description of techniques applied in the classroom

Before application, the techniques were explained to students along with an introduction to the content. After this class, three weeks were given so that the students could prepare themselves for the application of the techniques, study to establish the necessary subsumer and look for the teacher, if they still had doubts.

Simple thematic debate

This kind of debate has a more direct and objective level of organization, being quite interesting for classes that have little or no experience with debates. Its proposed structure consists of dividing the students into two groups, where one of them will have to elaborate arguments to defend an idea and the other will go argue against on a previously defined and referenced theme, in this case, the content of atomic models. At the debate's time, they will not have access to any printed consultation material, only the notes they may bring and make at the debate's time.

Four classes were stipulated for the development of this technique and it was proposed that each student formulate questions (from 3 to 5 questions), being presented throughout of debate, by those who prepared them, directed to another student. It was not allowed that a student respond more than twice in a row. The students performed the replica and the rejoinder, after the previous step, with a time limit ranging from 40 seconds to 1.5 minutes, depending on the availability of time and the size of the class. The speeches were organized, so that there was no confusion to evaluate the arguments. The report was developed by a group of



2 students, which was written at the end of the debate, and which expressed a critical opinion about a conclusion. This work was the evaluation of this group in the technique. The students evaluation who debated was individual, taking into account both the questions they asked and their answers.

Debate between groups with questions

In the application of this technique, students formed 5 groups, from 4 to 6 students, and asked questions about the proposed topics. It is interesting to apply it in classes where students have little or no experience with scientific argumentation. This is justified by the simplicity of its elaboration as well as its execution and dynamics. A different theme was distributed to each group. The elaborated questions and answers given for correction, and it was suggested to the students not uses only the textbooks that used in the classroom for the elaboration of the questions, but should use other materials and resources such as internet and scientific dissemination magazines.

The questions were asked from one group to the another where the teacher directed who would answer them and each group answered only one question per stage. The students brought other reference materials to help them with the answers. The time for research and elaboration of the answer was 1 to 3 minutes and the groups that passed this time without giving an answer, lost their turn.

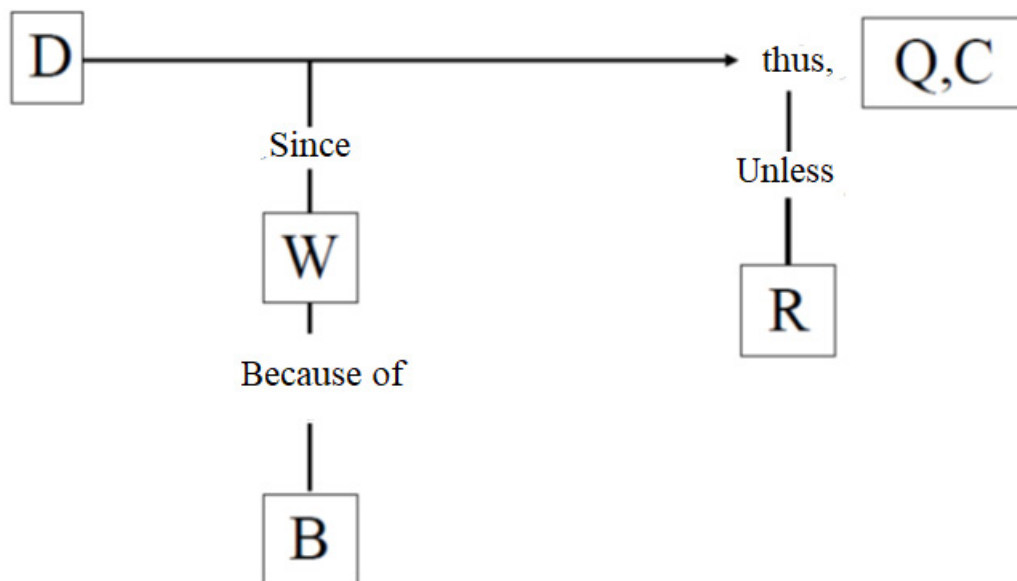
The group that answers should base its answer and explain it objectively, if it is wrong, the group that asked the question must present the answer and explaining it. Counter-argumentation was allowed. At that moment, the teacher should give time for both parties, less than the time given for the answer, and make the intervention by placing the points that each group argued and saying what would be the correct answer to the question. Throughout the debate, the teacher asked a question for all groups, where the group that found the answer first was taken into account, when it was wrong, it was considered the second group. This technique was applied in 4 classes.

Analysis of the arguments structure

In order to evaluate the student, in relation to his argumentation, it was used the way he formulated his argument, how he exposed it and its structure, based on

the steps that make up the method formulated by Toulmin (2006) (Figure 1). The layout data (D) is taken as the content previously presented to the students. The instruments subject to evaluation, being the basis for the understanding of their argument, were justifications (W) and the supports (B) used by the students. The understanding of both stages, enabled the understanding of learning and interpretation, together with the relationship established with the conclusion (C) that was proposed. The moment the student deviates from the basic concept, or if he makes a mistake as to the conclusions (C) or data (D) and this moment was perceived by the teacher or by other students, both the possibility of correction by the teacher and others would occur students to use this as support (B) at the time of their argument.

Figure 1: Complete layout of Toulmin's argument. Source: Toulmin, 2006. p.150.



It is possible to incorporate Ausubel's Meaningful Learning into the Toulmin's method. According to Lopes and Gomes (2020), to build an argument the student needs to be based on a theory or statement, as it would be the starting point of their questions and assertions, this refers to the data (D) of the argument, where they will be present in the students' subsumers, because from them the arguments will

be formed. The conclusions (C) that the student will defend, will originate from the “anchorages” made in the subsumers, because what he has learned can explain the data (D). When formulating their justifications (W), the student will make use of several subsumers, connecting them, allowing them to expand, relating knowledge which generates new knowledge.

If the student does not elaborate his argument clearly or does it in an incomplete way, having a problem in understanding the atomic models or some gap, he demonstrates the possibility that this learning may not have become significant, enabling another student to elaborate his counter-argument based on in that, allowing both to notice this mistake and restructure the concept. If this does not occur, the teacher’s interference is valid in order to clarify these errors and not to discourage or interfere in the student’s argument structure.

Report of the application in the classroom

When presenting the activities, some students had a negative reception regarding the techniques development, claiming shame or not having enough ability to speak in public. However, when explaining about the techniques, interest emerge. It was explained that one of the works objectives was to learn how to formulate an argument based on their learning, and that there is no reason for laughter, because everyone is there to learn to develop skills to build arguments, so mistakes or small mistakes are common, because of the lack of argumentative practice. It was also said that the teacher would help them to develop these skills.

Twenty-one days were given to students get prepared, after the moment that the teacher explain how the techniques works. They were instructed to study the theme, thus being able to establish subsumers, to base their arguments, and, in those requested, prepare the material they would use in the activities. Establishing a relationship between the preparation through the study, with the ideas of Ausubel, it is noted that this action would have the objective of creating necessary subsumers for the development of the work (MOREIRA, 1979) or else, to establish relations of the new knowledge, with something that they already know (OSTERMANN; CAVALCANTI, 2010). Allowing these established subsumers to function as the data (D) of your argument, generating the formulation of your justifications (W).

The grade factor also influences the students, given that some students expressed fear of stuttering or making a mistake, which could negatively affect the assessment. It was explained that the important thing was to have a well-founded argument, showing your reasoning and learning, thereby defending your conclusion (C) and presenting your justifications (W) or a refutation (R). As for the search for work guidelines, the simple thematic debate technique had little demand. Due to its simpler format, few students had doubts, the most common ones being related to the content.

In the class in which the technique of debate between groups with questions was applied, the students sought out the teacher to correct the answers of developed questions and answer questions about how they would elaborate the questions. Some students, questioned about the possibility of creating questions with multiple choice alternatives, it was not allowed, since the focus of the methodology was the elaboration of arguments as an answer and a question with alternatives would not allow this. Of the corrected answers, some had inconsistencies, distortion in relation to what the question asked and the answer content.

The use of support materials, in addition to the presentation, was restricted. This would tend to the student just reading the text, which does not match the proposal of the work, as soon as the student would not use his own words or formulate an argument, he would just reproduce the part of some work or content available on the internet.

As for the grade, it was clarified that it would be done according to the group's performance, due to the need for everyone to participate and to stimulate discussion among members. Another concern was related to the questions that the teacher would ask and what they would approach. In this question, it was explained that they would be focused on the content that each seminar would approach.

The group responsible for the report asked about the content and what they should approach in it. It was explained, that the report should contain a literal report of the facts that occurred during the works execution, containing details about what was accomplished by the groups and events that stood out the most. They were asked to draw up a final conclusion and to express their opinion on the work of the groups. Most questions were asked during the first few days, after activities were spent in the classroom. As the application date approached, the frequency with which students sought out the teacher decreased.



Techniques execution in the classroom

Simple debate on the rutherford - bohr model development

The development of this activity occurred in the 9^oB class, in 2015. Six classes were used over three weeks. The theme worked on in this activity was the Rutherford - Bohr model. At the works beginning, a problem found was the understanding of the activity, as the students came prepared with questions and answers, and when starting the work they asked questions about the content, instead of debating on the subject. As a result, work was interrupted to clarify the proposal and the functioning of a debate. It was explained how it is a debate and the importance of the argument exposed by them, after this explanation was given a week, for the students to prepare themselves and, in the following classes, the activity was resumed. Due to this problem, there was a need to extend two classes beyond the four classes that were planned.

Even though the proposal of the works was simple, some kind of problems with the students' comprehension were expected. The lack of opportunity to express themselves, whether at school works or during classes, creates this type of situation. A debate is something new for students, at that moment, it is necessary to explain that they have the right to speak, whatever they think is correct, as long as it is based in science. The evaluation structure applied in the school, based on written tests or printed research papers, does not generate any kind of stimulus for a more active student's participation.

Analyzing the arguments' structure present in this technique, according to the work of Toulmin (2006), when applying the *layout* of the argument we note that the data (D) used by the students are the statements that support the Rutherford-Bohr model as the electrosphere, the space or void between the nucleus and the electrosphere and the electron orbit.

When observing the conclusion (C), we realize that it vary according to the group's objective. The group that intends to defend the Rutherford-Bohr model, has the conclusion (C) that it explains the atom and related phenomena, while the other group has as conclusion (C), that this theory is insufficient to explain the atomic phenomena or, as some students have argued, it contradicts their experience with the real world. In this situation, the refutation (R) of a group, become the supports

(B) that another group, will use them to support their justifications (W) or become the justifications themselves (W).

The group responsible for the report, had its argument reported in writing in the conclusions of the same. When applying the *layout* to this group's proposal, the data (D) presented are the reports described throughout the body of the works, with the conclusion (C) being the final students opinion in the group, whereas the guarantees (W) presented are the reasons and personal criteria established by the group that were supported (B) by the observations made for the production of the report.

When evaluating an argument, using the Toulmin method, Sasserón and Carvalho (2013) say that the method is based on the logical structure of the argument, rather than contextual questions, not providing a standard for evaluating the argument. Therefore, the arguments presented by the students, have their evaluations based on the criteria that the teacher stipulates, according to the proposal for the group.

In the first moments of applying this technique, there was a need to clarify, that each student would have a specific time to speak and there was no need to interrupt the colleague. These interventions were necessary, because the students exceeded the established time to form their argument. As the work progressed, these situations decreased. This fact agrees with Capecchi et al. (2000), where they registered a similar difficulty in organizing a debate in the classroom. The students who had their arguments interrupted were given an extra time to complete their reasoning.

A point that was emphasized by the teacher is that all students present should exhibit their arguments, so that the assessment could be made, however there were those who were reluctant to do so, even though making it clear that the assessment would be individual. Few students were disinterested in carrying out the activity, after its beginning, they demonstrated flawed arguments, with conceptual errors, fruits of the lack of preparation, due to their lack of objectivity with the works, presenting average arguments.

The students' understanding, in relation to the Rutherford-Bohr model, was satisfactory in terms of: understanding of the basic structure of the model, position of the nucleus and the electrosphere, circular movement of electrons, the electronic levels that form the electrosphere and its sub- levels and the positioning of subatomic particles. Students who presented arguments with better satisfaction rates, between 3.5 and 4.0 points, totaled 36%, presented support (B) that supported



their guarantees in a coherent and grounded way (W) in order to prove that their conclusions (C) were correct.

However, there were mistakes in the arguments regarding the principles of the models: one related to the charges of subatomic particles, where two students in the group that questioned the Rutherford-Bohr model, said that neutrons have a negative charge and the other with the Valence layer, where a student who participated in the group that defended the model ideas, mentioned that the sub-level “Q” supported only two electrons. The argument was allowed to be exposed until the end, to wait if any other student would manifest to argue about the error. In the first case, a student from the other group identified the failure and reported it in his argument, in this situation, the students who made the mistake, justified themselves by saying that there was a confusion when speaking. In the second case, no student realized the mistake, so the teacher intervened saying that this sub-level would support up to eight electrons. The student justified himself by saying that he had studied for a very old book, which said that this layer had up to two electrons.

Situations where the student makes mistakes are shown to be important, as these errors can affect their subsumers and also harm their arguments, because according to Villani and Do Nascimento (2003) the argumentation is constituted of a specific set of directed positioning's, which can be expressed in one or more statements. If this positioning is based on erroneous knowledge, it affects the validity of its justifications (W) and its support (B), compromising the strength of its conclusion (C) before the interlocutor, which would also affect its subsumers, because the student would be “anchoring” a flawed knowledge.

In the situation shown in Chart 1, we observed that Student A used an example through a common action, relating to his learning, to support an argument that questioned a theory. Using the Toulmin (2006) *layout*, the student made use of a common act as support (B) that supported the guarantee (W), using it to ask the question as a refutation (R) for the model.

Chart 1: Excerpt from the 3rd class of the Simple Thematic Debate on the Rutherford-Bohr Model application

Debate stage	Interlocutor	Statement (Argument Stage)	Stage of the Argument
1	Student A	<i>If the atom has an empty space, why when I hit my hand on the table does it not pass through the table?</i> (R) [After doing this the student tapped the table to illustrate his question. (B)]	Question / Refutation (R) Support (B)
2	Student B	<i>There is no way for this to happen (W) , because the atoms are connected to each other by a chemical bond, as this bond is very strong there is no way for them to pass (B) .</i>	Justification (W) Support (B)

Source: Own author.

When analyzing the student's question and attitude, it is clear that he used one of the knowledge linked to the subsumer, related to Rutherford's theory, to question the existence of the empty space between the nucleus and the electrosphere. Therefore, this moment can be considered, a positive aspect of the technique's application, as it translates to a moment that could happen in a real scientific debate, where he questioned a theory, conflicting it with a real situation, demonstrating the understanding of scientifically criticizing.

Then, during the replication, the Student B tried to explain with his answer, the cohesion force that the atoms have through chemical bonds, with that he related two subunits that, at first, would not be directly associated. He listed supports (B), which were not directly linked to the original data (D), to support his guarantees (W) in a way, which was not present only within the study of Rutherford's atomic model, but related to Chemical Bonds . Establishing this connection between two different subsumers, he gave greater strength to his conclusion (C).

The group responsible for the report was positioned close to the teacher, in order to facilitate any questions they could ask. Their most frequent doubts were: what should be included in the report, its structure, whether the text should include everything literally or if they could be transcribed, with their words and their interpretation. It was clarified that the body of the report should contain the most reliable record possible and make a conclusion. The delivered report showed the detailed debate description, exposing the data (D), which supported the discussions between the teams and also the conclusions (C), which each supported with their guarantees (W) and support (B). They also included the speeches that the professor

made, in the conclusion a groups' performances and a criticism of the moments of interruption and extrapolation of time analysis was perceived, it was also reported what the group learned about the Rutherford-Bohr atomic model. Soon after the assessment, the report was returned to the group.

In Table 1, there was a drop of 11%, in relation to the two months in which traditional teaching techniques were applied, when related to the bimonthly in which the argument was applied. According to the students, they found it interesting and different to use debates as learning techniques, however they claimed that the subjects of the subsequent bimonthly were simpler to be understood, but that they would like to hold new debates.

Table 1: Evaluation of 9^oB students in relation to performance

9 ^o B 2015	School Work		Test		
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory	Did not participate
Bimonthly					
With argumentation	100%	0%	67%	33%	-
Tradicional	-	-	78%	18%	4%

Source: Own author.

It was expected that, when test's were applied, students would perform better when related to traditional teaching techniques. The interaction and participation of students with each other, as well as the exposition of learning, based on the articulation of arguments, allows us to understand that there was a better content understanding, as Costa (2008) affirms that proper skills of argumentation development it is relevant to science learning. In addition, moments like those provided by these techniques, solve the problem of the lack of opportunity to practice the argument as quoted by Driver et. al. (2000). However, it is clear that, although the performance of the activity did not reflect in the tests, the students showed interest in carrying out the technique again, showing that it becomes motivating for the science teaching-learning process, encouraging students to seek information to formulate more complex arguments and question colleagues, thus stimulating the student's criticality.

The technique proved to be satisfactory in relation to the work objectives, as shown in the job satisfaction index in Table 1. Even though it did not reflect this performance in the written evaluations, there was participation of all students in the class. After the application of the debate, there was an increase in the participation of students,

throughout the classes, asking more questions and observations in relation to the contents explained, when compared before the debate application.

Debate between groups with questions

This activity took place at 9°C, in 2015, over four classes, distributed over two weeks. The activity started after the groups were positioned in the room and the organization of their materials for consultation. Among them was his textbook, and his presence was questioned by the teacher. They justified their presence, saying it was a source of consultation that they already had available and easily accessible.

Other sources of consultation present were: printed materials from internet sites, which the ease of access and availability were the justifications for its use, however few groups stated to verify the content of this material. There were other textbooks, most of them from high school and others from elementary school, whether they belonged to someone in the family or were available in the school library.

The use of materials for consultation, is a resource where students will be able to extract their support (B), this allows their guarantees (W), to be elaborated with a better foundation. This gives greater reliability to the student, who feels more secure with the support (B) provided by his sources, to discuss possible refutations (R) that may be presented. However, materials whose sources are unreliable, such as Internet sites without origin, weaken the support (B) and the basis of a guarantee (W), when it is subjected to a refutation (R) structured in support (B) of greater credibility, such as books by renowned authors.

Applying the Toulmin method in this technique, we have the data (D) as the postulates that rule the models, which served as a basis for elaborate the questions. The conclusions (C), would be the answers elaborated for the questions, because they are being put to the test in the arguments exposed by the students. The guarantees (W) are the placements that support the answers established by the students, with the supports (B) coming from the bibliographies used. In this technique, the refutation (R) come from the disagreement about the answer presented, which is represented by the supports (B) used by the other group.

It is possible to understand the meaningful learning in this technique's stage. For the questions elaboration, it is necessary that the student resort to subsumers and analyze them to elaborate the questions, because to be able to elaborate a question



it is necessary, that the object of study is clearly understood and to be able to establish connections with other subsumers to increase its complexity. In order to formulate the answers, it is necessary that he resort to his subsumers, to be able to find the necessary supports (B), in the consultation materials, to formulate his guarantees (W), and validate his argument.

As for the beginning of activities, there were no problems, demonstrating clarity regarding understanding the technique. This, possibly, is due to the fact that the system based on questions and answers is something so much familiar to the students, because it is something that has been worked throughout of school life. However, some problems were noted during the activity. There were groups that read excerpts from the materials, instead of formulating a response based on various sources, thus evading the works' proposal. An intervention was made, clarifying that its guarantees (W) should have the bibliography as an instrument to generate support (B), because that would not be an argument, but a reading of information.

The students showed difficulty in understanding this point, since the lack of habit to using sources for elaborate and base a single answer, was not something common in their reality, as the activity was carried out, the students were able to elaborate their answers more clearly, improving the structures of their arguments. This improvement, agrees with Sasseron and Carvalho (2013) when they say that a discussion can be triggered and sent in the classroom by the teacher, stimulating and favoring the use of arguments, soon this process is noticed when then formulating an answer based on quotes, or supports (B), the other group can accept it or present a refutation (R), thus creating a debate, which originated, in common objects in a class, which are questions and answers.

After the question was asked, sometimes repeated, time was given for searching and answer's formulation. When extrapolation of time occurred, they were advised to stop the searching and respond. After a period of development of the technique, it was noticed that the groups that asked the questions, tended to interrupt the group that was answering before the end of their argument, when it proved to be correct. At that moment, the teacher intervened, explaining that there must be respect regarding the argument exposure, because the idea is that the whole argument be exposed, to see if it was satisfactory or not. Throughout the work, some groups asked questions for the teacher, related to: formulation of questions, disagreement about the idea exposition, error in the answer formulated by the group that asked

the questions and alliances and agreements between groups, to take some kind of advantage.

As for question's formulation, the most frequent questions were: about their clarity and questions interpretation, was requested to the groups were asked to repeat the questions again, in a specific case there were some questions that were not corrected as the teacher suggested, maintaining a confused and unclear feature, in this situation the group that answered the question was given an advantage, as it identified the error.

There were cases (Chart 2) that the group used different terms in an answer or based its answer on guarantees (W) and used different supports (B) than the other group that asked the question had used (Stage 2). The group that asked the question did not accept the justifications (W) presented as an answer and the support (B) linked to it (Debate stage 3).

Chart 2: Excerpt from the debate between the groups of the Rutherford-Bohr model and Dalton's model on the electrosphere

Debate Stage	Interlocutor	Statement (Argument Stage)	Stage of the Argument
1	Student A	<i>According to the Rutherford-Bohr model, where are the electrons?</i>	Question
2	Student B	<i>They are orbiting in the electrosphere layers (C).</i>	Conclusion (C)
3	Student A	<i>Wrong, they are at the electrosphere levels (R)</i>	Refutation (R)
4	Student B	<i>No, they are layers (W), because in the book it is saying that the electrons are located at the electrosphere layers (B). So that's right</i>	Justification (W) Support (B)
5	Student A	<i>But, in mine it is saying that "the levels of the electrosphere hold the electrons of the atom" (B)</i>	Support (B)
6	Teacher	<i>You can consider the correct answer, because the electrosphere levels and electrosphere layers are the same thing.</i>	Teacher interference

Source: Own author.

The groups were allowed to debate and argue present guarantees (W) that would more effectively validate the conclusion (C) that they wanted to reach, and the supports (B) that supported them (Debate Stage 4 and 5). After that, the professor explained that it is common for there to be different terms or explanations for the same idea and that the answer could be considered correct (Debate Stage 6).

Some groups, even after the correction made by the teacher, maintained errors in their feedback, in this situation the groups were allowed to debate, so that each could argue and after the discussions, the teacher clarified the error present in the group's response and, when presenting the arguments certain, gave the advantage to the group that responded.

In the cases of forming alliances between groups, to take advantage of questions in relation to others. When this situation was presented to the teacher, the students' attention was drawn through dishonesty towards the teacher and classmates. It was said that the objective of the activity was learning and discussion and if this were repeated they would have points subtracted. After that, no other problems of that order occurred again.

The questions asked by the students had several themes, such as: the Atomic Models structure, the atoms functioning in each model, formulations of theories and experiments related to them and questions focused on the historical character of the models, all of them prioritizing the data (D) that would be their arguments key points. There was an emphasis on a question that the student asked to establish a relationship between the electron evolution movement of the Thomson model in relation to the Rutherford-Bohr model, this question being considered of a somewhat high complexity, but well elaborated. When answering this question, the group used supports (B) from the structures of the two models to support their guarantees (W). The justifications (W) presented reported the difference between electron movement. The supports (B) were related to the Thomson model, where electrons were embedded in the atom surface and in the Rutherford-Bohr model, where they were organized along the electrosphere performing an orbit. Some questions asked had a scientists' biographical character who elaborated models as well as others at historical moments of the time, when asked, these questions were canceled, as they were out of context or were not discarded as suggested.

When comparing the tests results (Table 2), we see a difference of 45% in relation to one bimonthly to the other. Despite the subjects being different, the students reported that those from both quarters were of equal difficulty. The students claimed that when developing this technique, it became simpler to elaborate answers, formulate reasoning to find the correct alternatives and to interpret the questions. This agrees with Costa (2008) that the argument is relevant to the teaching-learning process.

Table 2: Evaluation of 9^oB students in relation to performance

9 ^o C 2015	School Works			Test	
Bimonthly	Satisfactory	Unsatisfactory	Did not participate	Satisfactory	Unsatisfactory
With argumentation	76%	21%	3%	69%	31%
Tradicional	-	-	-	24%	76%

Source: Own author.

Although some students have an unsatisfactory participation, and others do not participate, as shown in Table 2, the work aroused the interest of class majority and had a good level of satisfaction. The students showed animation when performing the activity, as it was seen as a game of questions and answers, which favored the participation and involvement of students with the proposal.

After applying the technique, students became more questioning. Asking more questions, throughout the classes, and also asking questions, more complex and better elaborated. Leading to the conclusion that, when formulating questions and observing the questions of colleagues, this skill was developed, reflecting in the daily life in the classroom, even after the end of the technique application.

Conclusion

Developing and applying techniques that make use of argumentation proved to be a challenge. The absence of moments where students can express their opinions and create arguments, increases the difficulty, adding to an educational system that is structured in classes, mostly expository, reducing the forms and ways of interaction of the student. Therefore, skills such as argumentation and criticality are in the background. This makes the training of students, especially aimed at taking exams and tests for future admission to colleges, passing a public exam or integrating government indexes.

The teaching and learning process must extrapolate tests, according to Costa (2008), it allows the development of a responsible citizen with critical skills, who are able to evaluate information received and passed on, having the knowledge that the actions of others and yours can cause impacts, being able to elaborate arguments based on the moment of making decisions. Therefore, agreeing with Driver et. al. (2000), teaching should, by carrying out activities throughout the classes, give access to different ways of arguing and associate them with discursive prac-



tices. Soon, the teaching that uses argumentation goes beyond the content in the classroom, aiming at the formation of critical citizens, who are able to contribute to the daily life around them and not just do tests and tests.

The application of techniques that make use of argumentation, in classes that did not have this experience yet, found this challenge, since the subsumers related to the contents of atomic models were absent and the skills and practice in formulating the argumentation were non-existent, made it necessary to preparing students with classes related to the contents and explaining the techniques so that they could be developed.

The simple thematic debate, where two groups act on a theme, applied in 9ºB, was not improved in the satisfaction indexes, having a drop of 11%. This generated a controversial one, due to the expectation of improvement with the application of the technique. However, the students' justification, saying that they found the content that came next easier, and that they would like to perform the technique again, demonstrated its validity and that, despite not showing improvement in the grade, it showed results in the classroom, where the participation of students and the number of questions increased during the classes, these questions being more critical.

The debate between groups with questions, at 9ºC, being a technique that was easy to execute, proving to be simple and easy to understand, with few doubts about its functioning because it is based on groups that elaborated questions on their topic, to be answered by another. Despite the students' difficulty in formulating questions, due to errors in the question structure itself, it proved to be satisfactory. There was an improvement of 45% in the satisfaction rates of the written evaluation notes, when compared to the two months where the classes were expository. This technique showed its benefits beyond the tests, making students more participative throughout the classes, with more elaborated and better structured questions. The students claimed that, when asking questions, understanding the questions present in tests and activities became easier.

Despite the difference between the comparison rates, the use of argumentation techniques proved to be effective, not only in terms of grades in written evaluations, but in the classroom daily. The improvement in the participation of students, in their criticality, in arguing and structuring their argument, shows that a change in pedagogical practice in the classroom brings an improvement that goes beyond

the tests, but extends in the students' attitudes towards the school and the class, revealing that addressing techniques that allow the student to participate more effectively in the class and interact with knowledge, show positive and effective results.

Debate temático simples e Debate entre grupos com perguntas: técnicas de argumentação no Ensino Fundamental para aprendizagem de modelos atômicos

Resumo

Em ciência, o aparecimento de novas teorias inicia uma série de debates e discussões, até elas se provem verdade, demonstrando como a argumentação está ligada ao conhecimento e ao fazer científico. Contudo, o ensino de ciências distanciou-se disso, expondo essas teorias como únicas verdades, não passíveis de discussões. Objetivou-se desenvolver metodologias que aproximassem as argumentações científicas da sala de aula. Foram aplicadas aos 9º anos B e C da E.E.E.F.M. Cândido Portinari, Rolim de Moura – RO, onde foram aplicadas as técnicas de Debate temático simples e Debate entre grupos com perguntas. Em ambas as técnicas, os estudantes apresentaram diferenças de rendimento nas provas, comparadas ao bimestre anterior, um índice significativo de satisfação geral e apresentaram melhora na criticidade e abstração dos conteúdos. Logo, a aprendizagem de Ciências se torna efetiva quando aproximada do fazer científico.

Palavras-chave: Aprendizagem Significativa. Ensino de Ciências. Ensino de Física. Metodologia.

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