TEACHERS’ CHANGE OF CONCEPTIONS ON ARGUMENTATION AND ITS TEACHING

Francisco Javier Ruiz O, Conxita Márquez and Oscar Eugenio Tamayo A
1,3 Department of Educatve Studies, University of Caldas, Manizales, Colombia
2 Department of Science and Mathematics Education, University Autonoma of Barcelona, Bellaterra, Barcelona, Spain

Abstract: this study shows the changes in the conceptions of the epistemological, conceptual, educational and structural aspects of five primary teachers. Those said changes occurred before and after those teachers took part of a process of critical discussion of their teaching practices on argumentation in Science class. In order to identify the changes in the four aspects, a content analysis to a questionnaire applied at the beginning and at the end of the process was done. The results showed a significant change in the components: epistemological, conceptual and educational, and not that much in the structural one. Apart from that they ratified the importance of offering spaces of participation for the teachers to discuss, evaluate and propose mechanisms to improve their practices in the classroom.

Keywords: Argumentation, teachers' conceptions, dialogic education, argumentative structure.

INTRODUCTION

Background and rationale

Many linguists and epistemologists have recognized the central role of argumentation not only in the construction of science, -since it allows substantive relations between models and evidences-, but also in the educative field because the argument is a form of discourse that needs to be appropriate for children and explicitly taught through proper instruction, structured tasks, modeling (Von Aufschnaiter, Erduran, Osborne & Simon, 2008; Erduran, Simon & Osborne, 2006), and argumentative experiences (Aleixandre & Diaz, 2003). Additionally, researches done in the field of the teaching of argumentation in Science Class, show the need, not only to teach how to do it, but also to involve teachers so that they can be conscious of their conceptions about argumentation (Driver, Newton & Osborne, 1998; Simon, Erduran & Osborne, 2006; García-Mila & Andersen, 2008).

Two more reasons that support the development of this study are: First, that with this research, although we will focus only on argumentation in Science class, we want to contribute to the development of scientific thinking in children which is one of the principal goals in the Colombian Educatve Policy. Second, we believe that with this work, we can give extra opportunities to improve teacher practices, because elementary school teachers do not have any training in argumentative processes. That is why, teachers do not emphasize on the importance of dialogical processes in their classroom.

From this perspective, this research has as general objective, to identify changes in the epistemological, conceptual, educational and structural aspects of the arguments elaborated by the teachers who take part in a process of critical reflection, on the teaching of argumentation in Science class.
Research context
This investigation was developed in a state institution called Fe y Alegría in Manizales, Colombia. This institution has approximately 2250 students and it is located in a marginal zone of the city. There, we worked with five primary teachers, in 4th and 5th grades. Four teachers are graduated from a special high school where their principal emphasis is Pedagogy; one of them is graduated of Academic High School.

METHODOLOGY
To achieve the specific goal that was presented before, the following activities were implemented:

- Initial and final questionnaire. We applied the same questionnaire at the beginning and at the end of the process (seven months after starting the critical process). The questionnaire had seven opened questions,
- Classes’ recordings. We recorded the first class before starting the critical discussion process, because it was important to know how to start with the teachers in this process.
- Meetings. There were some critical discussions about the role of argumentation as a tool to teach in class of Science. Besides, the discussions were also related to the structure and function of the argumentative components. In order to do it, teachers had three meetings. Each one lasted five hours.
- Design and application of activities. Each teacher designed and applied the first activity for the teaching of argumentation in her/his own class (the activities were video-recorded).
- Observation and analysis of the recorded classes. The participants observed the videos and then, discussed their viewpoints in groups. They also gave some proposals to change or overcome their weaknesses.
- Design and application of activities. Again, each teacher designed and applied the second activity for the teaching of argumentation in class of science (activities were video-recorded).
- Analysis of the video recordings and application of the final questionnaire seven months after the process have started.
- Interview. After each class we conducted an interview with teachers for them to reflect on their performance.

Data analysis
To characterize and identify the changes in the conceptions of teachers, a content analysis to the questionnaire applied at the beginning and at the end of the process was done. The transcription and codification of the information was done with the help of the Atlas-ti software. To do the content analysis and subsequent quantification of the codes constructed, we applied the formula: % Code = code number of citations / total citations, which allowed the construction of some frequency tables.

RESULTS AND DISCUSSION
The table shown below shows the results of the four components discussed in the initial and final questionnaire:

<table>
<thead>
<tr>
<th>Component</th>
<th>Category</th>
<th>Subcategory</th>
<th>Results questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Initial (100%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epistemological</td>
<td>Relationship</td>
<td>Yes</td>
<td>69.23</td>
</tr>
<tr>
<td></td>
<td>argumentation – science</td>
<td>No</td>
<td>30.77</td>
</tr>
<tr>
<td>Conceptual</td>
<td>Recognition of</td>
<td>Informative Process</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>argumentation as/a</td>
<td>Dialogic Process</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Learning tool</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Educational</td>
<td>Relationship teaching-</td>
<td>Yes</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>argumentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Criteria taken into</td>
<td>S</td>
<td>22.22</td>
</tr>
<tr>
<td></td>
<td>account in their teaching:</td>
<td>S-T</td>
<td>44.44</td>
</tr>
<tr>
<td></td>
<td>Student (S),</td>
<td>T-K</td>
<td>33.33</td>
</tr>
<tr>
<td></td>
<td>Teacher (T),</td>
<td>S-T-K</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Knowledge (K),</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Context (C)</td>
<td>S-T-K-C</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Classroom management -</td>
<td>Individuals</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Type of activities</td>
<td>Groupal</td>
<td>50</td>
</tr>
<tr>
<td>Structural</td>
<td>Level of arguments</td>
<td>1</td>
<td>33.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>41.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>8.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

“Table 1. Results obtained with the initial and final questionnaire”

Next, a short discussion of the findings obtained in the first three aspects: Epistemological, Conceptual and Educational, is going to be introduced. Some examples of the teachers’ answers will be included to support our discourse.

1. **Epistemological aspect:** The situation to investigate this aspect was:

   There are two general concepts of science:

   - Science is a cumulus of absolute and objective knowledge which is the result of a linear process that comes from the observation and experimentation about the real world to scientific theories.
   - Science is the result of a negotiation process among the members of scientific communities where models and theories constructed as a representation of the world are presented, discussed and validated.
Which one of the two previous concepts, do you think is the most suitable for the teaching and learning processes in the science classroom?. Support your answer.

One of the answers given by one of the teachers in the first application of the questionnaire was:

Teacher: The two processes are important for the construction of science, given the fact that in the science teaching process there should be experimentation, observation, comparison, analysis, comprehension and dialogue with other people who are performing the same experiment and investigation in order to arrive to some conclusions.

As observed in the teacher’s answer, for her, both processes are important in the construction of scientific knowledge. She justified her answer by affirming that, to arrive to a conclusion, you need some spaces to experiment, observe, understand, and interact with the scientific community. She added that the community—or “people” in her own words- have to be involved in the experiment or research experience. However, this is not always true in the process of construction of science.

In the second application, one of the answers was:

Teacher: Yes, they are. (This teacher here referred to the two processes introduced in the question. She said both of them are important). They are important because the person who belongs to the scientific community, needs to observe and experience first and then, by doing so, that person would be able to introduce, discuss and validate his/her ideas in a group.

In the answer of that teacher, she stated not only the importance of both processes, but she also recognized the importance of debate and group work to knowledge validation. That relationship she mentioned is in agreement with some authors’ ideas (Von Aufschnaiter, Erduran, Osborne & Simon, 2008). They claim that arguments that have been previously discussed, contrasted and validated in the scientific community are useful tools to the promotion and development of knowledge. Thus, the answer of that teacher shares the current theories on argumentation nowadays. According to those tendencies, argumentation is seen as a supporting mechanism to keep a qualified scientific knowledge and also as a scenario that promotes mobility from an interpsychological to an intrapsychological perspective. From that point of view then, argumentation is taken as a dialogic activity (Erduran, Simon & Osborne, 2004).

2. Conceptual aspect. The question exposed was:

If you were invited as a lecturer to an event on argumentation in the science classroom, what kind of explanation would you give of what it is supposed to be argumentation in the science classroom?

In the initial questionnaire, 80% of the texts produced by the teachers conceived argumentation as a process whose attempt is informative (perspective that tends to a structuralistic view of argumentation):

Teacher: Argumentation is to provide a set of reasons or evidence to support a conclusion or some assumptions. By means of them, people try to decide what opinions are better than the others.
Only one of the answers (20%) assumed a concept of argumentation as a dialogic process, approaching to a functional perspective of argumentation, for example:

Teacher: Argumentation is a clear and accurate concept of the issue which will deal, argumentation is to convince others to reach a conclusion.

In the final questionnaire, we found texts that demonstrated a dialogic perspective of argumentation, that is to say, they conceived argumentation as a social activity that requires the generation of a suitable atmosphere for its development. An example of this approach is found in the following extract:

Teacher: Argumentation in science classes is to express what each one understands from his own daily life, refuting concepts if needed. It also means to be able to explain why things happen, and by doing so, to create socialization settings to generate an appropriate atmosphere where everybody can discuss.

Similarly, identified in the final questionnaire, the emergence of a new conception of argumentation as a learning tool (57.1% of the answers show this trend), that evaluates knowledge, for example:

Teacher: Argumentation in science is a tool for evaluating knowledge. It is also a social process that is affected by ideas, prejudices and instances; it potentiates changes in the conceptions of individuals, leading them to rethink their knowledge about their surroundings.

3. Educational Aspect. Two question were presented to teachers:

- State two things science teacher should take into account in order to teach argumentation to his pupils?
- If one of your main objectives in your classes is to foster the argumentation process in your students, write two activities which might help. Support your choice for each of the activities.

After the first application of the questionnaire, teachers centered their criteria towards Students (22, 22%), the relation between S-T (44, 44%) and T-K (33,33%). An illustration of the first aspect is presented below:

Teacher: The children’s intellectual development and the development of their comprehension and analytic skills.

This answer shows the teacher’s tendency towards students. This sentence implies that according to that teacher, learning depends on the development of the individual. This way of thinking contradicts the Vigotsky’s sociocultural theory. According to Vigotsky, learning is a process and this process implies social interaction. Additionally, that interaction contributes to the person development. Therefore, learning is based on dialogic processes.

One of the things that emerged from the application of the questionnaire is the relationship student-teacher-knowledge and context:

Teacher: We should create a class with appropriate conditions, with the teacher’s help. We should help students to identify data and affirmations, doing group work using guided-questions; students should learn to listen, speak and justify their assumptions; They should be able to choose the best options.
An outstanding element in the previous answer has to do with the teacher’s role. It is understood here as a support or help to the construction of a class. According to this view, power relations in spite of being part of the class, they would not be so notorious because one of the characteristics of interaction are the symmetric relations between student-teacher (systemic model, Contreras, 1990, cited in Levin, Ramos & Adúriz-Bravo, 2008). Also, because in power relations, they (students and teachers) are co-participants in the creation of such interaction scenario (Wolfe & Alexander, 2008).

The second element of the answer refers to group work as a key element to develop argumentation in Science class (Osborne, Erduran & Simon, 2004b). The third element refers to choose from different options. Regarding that, it is important to mention that one of the basic processes for the evolution of science is the choice of an appropriate model theory. This selection focuses on the model that better explains the phenomena (Giere, 1999). In sum, in the answer there was a concrete intentionality: “search for the best option”. That intentionality is similar to the process followed in the construction of knowledge.

To refer to the activities, in the first application of the questionnaire, teachers talked about two kinds of activities: Individual (50%) and group activities (50%). Next, we are going to give an example of the first type of activities. With these activities we could observe learners as receptors of external stimuli and information. They do not have previous knowledge about the phenomena or theories introduced in class.

Teacher: Do some experiments with plants or living organisms. It is good for children to observe what happen at the different stages in the process.

In the second application of questionnaire, we could see changes in the kind of activities. An example is provided below:

Teacher: the most important is that the group can work with a coordinator or representative who collects concepts and writes them down. Participation and interaction are essential. As noticed, according to that teacher, it is good to work in small groups, there, students could share their ideas and later, socialize them in class. This is interesting especially because it promotes the in pupils their abilities to synthesize, listen, value ideas and get into agreement.

CONCLUSIONS AND IMPLICATIONS

The results at the end of the process show significant changes in three components:

- **Epistemological**: in the final questionnaire the teachers recognized science is affected by communicative processes, teamwork and several debates with the scientific community, to validate results.

- **Conceptual**: the most significant change here was the emerging of a new conception, argumentation in class of science as tool of learning. This conception is related to the one exposed by some authors who see in argumentation a possibility to support intentions addressed to solving some problems of learning and understanding better these processes in the classroom. (Jiménez-Aleixandre & Erduran, 2008)

- **Didactic**: a significant finding in our research refers to the criteria for teaching argumentation. This criteria is strongly related to the elements student-teacher-knowledge and student-teacher-knowledge-context. Taking those elements into consideration mean a functional perspective of argumentation, where interaction is
important but not only the one between subjects, but also where it takes place (the context) and which is the knowledge involved in this communicative process.

- For the fourth component, **Structural**, although there is an increase of texts constructed by teachers, characterized by the presence of data, denial, and some justification (Level 3, Erduran, Simon & Osborne, 2004), but we don’t see important changes in the other levels, then we consider it is necessary to continue creating environments where teachers can, critically, propose mechanisms for the improvement and development of more complex argumentative texts.

From these findings we confirmed how important the teaching of argumentation in science class is. Involving teachers in processes of critical discussion, assessment and leading them to be aware of their own views, is the first step towards the improvement of their practices in science classroom.

**Acknowledgments**

Based on work supported by the Spanish Ministry of Science and Innovation grant EDU 2009-13890-C02-02 and Catalan PRI 2009SGR1543 and Caldas University, Manizales-Colombia.

**REFERENCES**