BRAZILIAN LEARNERS' UNDERSTANDING ABOUT SCIENTIFIC INQUIRY

Mariana A. Bologna Soares de Andrade
Centro de Ciências Biológicas. Universidade Estadual de Londrina-UEL. Brazil
mariana.bologna@gmail.com

Ana Carolina Cola Levoratob
Programa de Pós-Graduação em Ensino de Ciências e Educação Matemática-Universidade Estadual de Londrina. Brazil

ABSTRACT: There is agreement among researchers that one of the main objectives of scientific literacy is that all students understand Scientific Inquiry (SI). Even with many educational proposals guided by SI, there is still a difficulty to assess learners' notions about it. From this perspective, Lederman et al. (2014) published the VASI questionnaire, which evaluates the understanding of students from different countries about SI. The results presented in this paper represent the Brazilian sample. The objective was to evaluate the notions of scientific investigation of the elementary students from private and public schools. Analyzing the responses of students, it can be considered that they can conceptualize some aspects of the nature of scientific inquiry, but cannot identify them in real situations.

KEY WORDS: Science Education, Scientific Inquiry, Elementary School

OBJECTIVE: The aim of this study was to identify the Brazilian's Elementary School understanding about Scientific Inquiry

THEORIETICAL FRAMEWORK

Currently there is an agreement among Science Education researchers that one of the main objectives of Scientific Literacy is that all students have a better understanding of Scientific Inquiry or SI (Abd-el-khalick & Lederman, 2000; Alchin, 2013; Abd-el-khalick, 2014; Crawford, 2014; Lederman, 2014). According to Schwartz et al. (2004) SI is related to the specific aspects of the process of development of scientific knowledge, including the conventions for the acceptance and utility of scientific knowledge. SI in Science Teaching is evidenced directly in pedagogical proposals that adopt research as models of teaching and learning. Quoting National Research Council and The Next Generation Science Standards, Crawford asserts that teaching sciences as inquiry

> [...] involves engaging students in using critical thinking skills, which includes asking questions, designing and carrying out investigations, interpreting data as evidence, creating arguments, building models, and communicating findings in the pursuit of deepening their understanding by using logic and evidence about the natural world (Crawford, 2014, n/p).

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Crawford (2014) suggests that, inspired by this perspective, it is possible to identify different didactic proposals such as project-based learning, problem-based learning, scientific initiation, research among citizens (which include the participation of subjects in addition to students and teachers in the Research) and model-based research. On the other hand, Munford and Lima (2007) consider it as formidable to know the real importance of teaching science through inquiry, because science taught in schools is totally different from what is practiced in universities, laboratories, and other research centers. This situation promotes the appearance of two distinct Sciences. In schools, students solve defined problems and end up constructing fixed and immutable meanings. Scientists, on the other hand, analyze problems in a less pre-determined way and consequently generate less defined meanings that can be modified. This scenario in our society highlights how important it is to bring to schools the real meaning of learning science through inquiry. Experimental science teaching began to be disseminated in schools over a hundred years ago because of the influence of the experimental work that was developed in the Universities, and the objective of this teaching was to improve the learning of the scientific content (Galiazzi et al., 2001). In Brazil, the Science Teaching was instituted in the basic education schools beginning in 1950; over the following decades, the educational objectives reinforced different conceptions about science, from a neutral vision of science, through a conception of science as a logical and critical thought to arriving at a more contextualized view that science is an activity with social implications (Krasilchik, 2000). It is considered as basic fundamental of Science Teaching that its construction should be guided by scientific knowledge. A trend that is appearing in Brazil and in different countries of the world is the emergence of proposals for disciplines of scientific initiation in basic education, or initiation projects inserted in the disciplines of Natural Sciences. These initiatives are becoming increasingly significant. Even with the many didactic proposals guided by the discussions about SI, Abd-el-Khalick (2014) shows that there is still a difficulty in relation to assessment of the notions of SI. This difficulty results in obstacles to the development of more effective didactic proposals for basic education. It is considered that understanding SI ideas can contribute to a better orientation for teachers in their practices and for students to understand the role of science in their lives.

In this perspective, Lederman et al., (2014) published a VASI questionnaire – The Views about Scientific Inquiry. In this work, the researchers presented the elaboration, development and analysis of a questionnaire that evaluates the students understanding of SI. The authors list eight aspects that Basic Education students should develop about SI. These aspects were elaborated by the reformulation of previous data collection instruments and new theoretical studies, resulting in an open questionnaire with seven questions about SI. The eight aspects are:

> (1) scientific investigation always begins with a question, and does not necessarily test a hypothesis; (2) there is no single set of steps followed in all investigations (i.e. There is no single scientific method); (3) inquiry procedures are guided by the question asked; (4) all scientists performing the same procedures may not get the same results; (5) inquiry procedures can influence results; (6) research conclusions must be consistent with the data collected; (7) scientific data are not the same as scientific evidence; and (8) explanations are developed from a combination of collected data and what is already known (Lederman et al., 2014, p. 68).

The paper published in 2014 is part of the group of research studies coordinated by Professors Norman Lederman and Judith Lederman. This group is developing international research that is using the VASI questionnaire to evaluate the understandings about scientific inquiry among elementary school students in different countries. The results presented in the present study refer to data collected in Brazil.

METHODOLOGY

This research had a qualitative approach, the instrument of data collection was the VASI questionnaire (Lederman et al, 2014) answered by 169 students from schools in the city of Londrina, Parana state, Brazil. The sample selection began with the students' grade; all were students in the seventh grade at elementary school II. We choose schools with different curriculum profiles, from schools that prioritize scientific investigation to schools where there is no activity related to it. The sample included boys and girls from public and private schools, from different social classes. Even though these students came from only five different schools, the sample collected is similar to schools from urban areas of much of Brazil, that is, regions such as the South, Southeast, Midwest and parts of the Northeast. This sample does not represent rural schools, indigenous schools, quilombolas communities' schools or rural settlements' schools.

The analysis of the questionnaire data was carried out by the Brazilian researchers, using a holistic approach (Lederman, 2014), The categorization of the answers to the questions was made according to what was presented by the subject throughout the entire questionnaire. So, if a respondent provided a consistent answer across the questionnaire that is fully congruent with the target response for a particular aspect of Scientific Inquiry, the answer was considered to be Informed. If, on the other hand, a response was either only partially explained, and therefore not fully consistent with the specific response, or there were contradictions, it was included in the Mixed category. A response that was contradictory or did not provide any evidence of congruence of the specific aspect was marked as Naïve.

RESULTS AND CONCLUSIONS

The results of the questionnaire analyzed were organized in the eight categories pre-established by Lederman et al., (2014). Each category was related to one or more questions in the questionnaire. Data analysis is presented in Table 1.

Table 1.
Learners understanding about SI

	Naïve	*Mixed*	*Informed*	*N/A Not answered*
Procedures are guided by the question asked Q.5	74,5%	6,5%	1,8%	17,1%
Data does not equal evidence Q.4	75,7%	4,7%	0,6%	18,9%
Explanations are developed from data and wwhat is already known Q.7A, Q.7B	66,3%	8,3%	-	25,5%
Begins with a question Q1A, Q.1B and Q.2	83,2%	11,2%	0,6%	4,9%
Multiple methods Q.1B and Q.1C	74,3%	10,9%	0,6%	14,2%
Same procedures may not get the same results Q.3A	82,8%	9,5%	-	7,7%
Procedures influence results Q.3B	81,1%	6,5%	0,6%	11,8%
Conclusions consistent with data collected Q.6	68,0%	17,1%	0,6%	14,2%

In an overview, the majority of students' responses were classified as naïve for all aspects of SI. Analyzing separately the aspect *Procedures are guided by the question asked*, we noted that students considered that testing the tires in more than one road would be better for finding the results. From these responses, it is clear that the students could not understand what was being asked. Students who had answers classified as mixed or informed understood the question and gave answers based on the postulated situation, that is, how to identify which tire brand is easier to get flat.

However, when analyzing the aspect that *all scientific inquiry begins with the question,* the amount of students who had their answers classified as mixed or informed was higher (12.8%). By the answers of the students, it was noted that they understand the nature of this aspect of scientific inquiry as it is identified in the answers to question 2. However, the answers to questions 5 (which refers to the aspect that research is guided by the question), 1a and 1b could not relate the question to the procedures. It can be considered that there was no direct relationship between the students claim that all scientific inquiry begins with a question and identifying this aspect in responding to situations suggested.

The aspect *Scientific Data Are Not the Same as Scientific Evidence*, showed the difficulty that students have understanding what is evidence. In the responses of the students, the vast majority indicate that there is no difference between data and evidence. Even those who claim that there is a difference consider evidence as a guess or something to be investigated. Only one student had an informed answer to this, BS-73: *Data: the person collecting the information (data) to have some conclusion. Evidence: It is with this data you end up with evidence, that's the difference*. The students performed worst on this aspect.

About the aspect *multiples methods*, again we note the discrepancy between knowing the nature of the aspect and identifying this aspect in a situation. A significant number of students responded positively to question 1c; however, they did not consider that the situation presented in the study of birds was a research method.

In the aspect *Same procedures may not get the same results*, the responses of naïve type presented as justification that if scientists follow the same procedures they will think the same way, meaning that they associate the scientific reasoning conditions with the procedures. This aspect can also lead us to consider the fact that students do not consider that the researchers themselves draw up research procedures.

As with the previous aspect, the *Procedures influence results* aspect, the responses of the students return to the idea that different procedures will change the way researchers think. Another misconception is demonstrated by the idea that there is only one type of procedure to answer a question, as in the speech of BS-060: *No, one can go wrong and the other right and do not come to the same result.*

Considering the aspect *Explanations are developed from data and what is already known*, it can be noted that students were able to explain the reasons why the dinosaur from Figure 1 is better than the one from Figure 2. The explanations cited anatomical and behavioral aspects of the animal. However, the analysis of the item 7b was almost all naïve answers because the students could not explain what knowledge allowed the conclusions.

Finally, we examine the aspect *Conclusions consistent with data collected*. Even if only one student has had the response considered informed, this aspect was the one that students were better, that is, the highest percentage of responses between mixed and informed (17.7%), that meanings, the students analyzed the table to give the answers. We noted that among the naïve responses the idea prevailed that the growth of the plant is subject to the amount of light without the students analyzing the data presented. Finally, analyzing the responses of students, it can be considered that they can conceptualize some aspects of the nature of scientific inquiry, but cannot identify them in real situations.

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