Scientific literacy in the early years: indicators evidenced by a didactic sequence*

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Abstract

The article analyzes the contributions of a didactic sequence regarding water in promoting scientific literacy in the early years. A pedagogical intervention research was developed with 24 students from Elemetary public school in Araucária/PR, during the second semester of 2016, involving the implementation of a didactic sequence based on the three pedagogical moments and the elaboration of conceptual maps. A semi-structured interview was conducted with the students, using the concept maps built as a base, so that they could explain the knowledge acquired during the didactic sequence, supporting the analysis of the presence of indicators of scientific literacy. The results showed that the implementation of the didactic sequence materialized the necessary skills to be scientifically literate, showing that the school has the important role of enabling access to scientific knowledge, being fundamental that it provide a formative process from an early age, aiming to form critical and conscious citizens. who understand scientific language and know how to use it more actively in society. We found that the didactic sequence developed skills necessary for the promotion of scientific literacy in that it provided students with the experience of situations in which they had to position themselves, putting in check their previous conceptions about the studied themes, demonstrate the appropriation of several concepts. evidencing the construction of knowledge. In order for the student to become a critical citizen, aware of society and take a stand on processes and innovations that affect him/her daily, new actions and didactic resources are needed to help increase scientific literacy.

Keywords

Scientific literacy – Conceptual maps – Elementary education.

Introduction

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According to Pozo and Crespo (1998), the inclusion of the natural sciences in the basic education curriculum provides students with a scientific culture that allows them to understand how nature works and how scientific and technological advances influence people's lives.

Science contributes to the development of citizenship (LORENZETTI, 2000; CHASSOT, 2000), which means that education allows students to participate more actively in society, thus allowing the development of the scientific literacy (SL) process. SL is the process by which the language of natural sciences acquires meanings, enabling students to understand their universe, providing access to new forms of knowledge and culture and allowing them to exercise citizenship in the society in which they live (LORENZETTI, 2000).

Therefore, science teaching in the early years should contribute not only to the student's understanding of scientific concepts, but also to their realizing that what is taught at school is part of their daily lives. We consider that the teaching of this field of knowledge contributes to the development of a critical and reflexive spirit. Such spirit should make them able to have a reading of the world, with a real understanding of the universe and an effective participation in society, characterized by decision-making when it comes to science and technology. It is necessary to offer conditions for students to increasingly develop knowledge and respect towards nature, being able to understand its phenomena and use their natural and technological resources wisely, thus enabling the development of a scientifically literate citizen.

According to Sasseron and Carvalho (2008, p. 4), scientific literacy "will not be completely achieved in elementary school classes", because "it is a process in constant construction; nonetheless, it is possible to aim for it and seek to develop certain skills among students".

Teaching aimed at promoting scientific literacy should be based on a differentiated curriculum that allows for more meaningful science teaching. There are several skills deemed necessary when aiming for scientific literacy and should be the point of support in the idealization, planning and analysis of proposals for science teaching.

In addition to different planning, it is also necessary to have a teaching practice that emphasizes critical, transformative, innovative and opinion-forming education. This challenge is not only up to the teacher to challenge, but to the educational system as a whole, which must provide educators with material, professional and intellectual conditions capable of ensuring that they have a more effective educational practice.

From this came the problem of this research, which consists in answering the following question: What are the contributions of a didactic sequence regarding water in the promotion of scientific literacy in the early years, evidenced through the explanations of the students about the scientific knowledge as represented in the construction of concept maps?

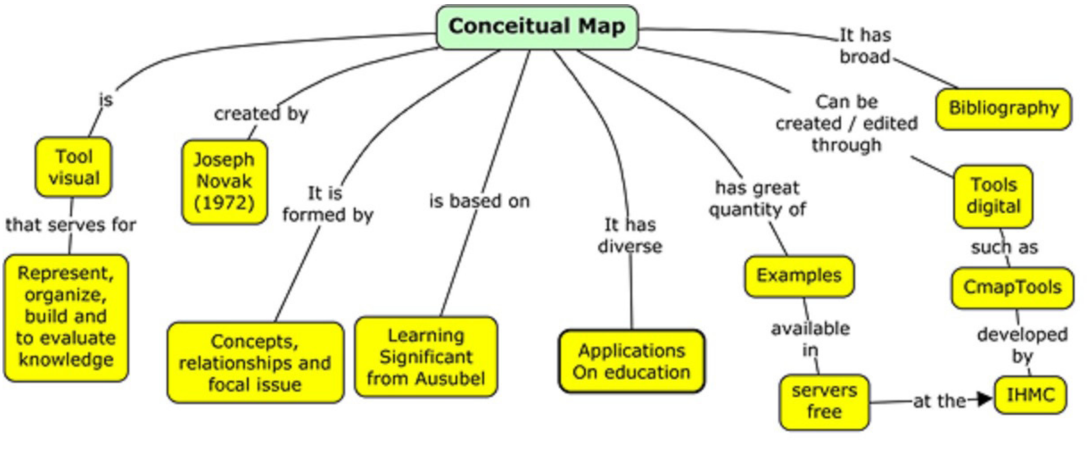
We consider that concept maps are graphic tools that allow the construction, organization, representation and assessment of knowledge in a differentiated way, and when properly used and applied, they become enhancing tools that contribute to significant learning by the students.

The concept map theory was developed by Joseph Novak in 1972, when he worked with a lot of data from Piagetian clinical interviews and needed an instrument to organize this material. The concept map is based on Ausubel's theory of significant learning, which points out that the human being organizes their knowledge using the hierarchization of concepts.

According to Novak and Cañas (2010, p. 10), concept maps (CM) "are graphic tools for the organization and representation of knowledge" and their construction process allows the exteriorization of knowledge with the visual representation that each individual elaborates. The concept map is considered a structurer of knowledge, as it allows showing how knowledge of a given subject is organized in the cognitive structure of its author, with the advantage of visualizing and analyzing its depth and extent. It can be understood as a visual representation used to share meanings, because it explains how the author understands the relationships between the stated concepts.

Concept maps can also be conceived as tools for mapping the set of ideas learned on a specific field, by students or by subjects in educational research. FIGURE 1 is an example of a concept map.

Figure 1 - Concept map of the concept map



Source: Research data.

For Tavares (2007), the concept map is a schematic structure to represent a set of concepts immersed in a network of propositions.

> When an apprentice uses the map during their process of learning a certain theme, they become aware of their difficulties in understanding that theme. An apprentice is not very aware of what the relevant concepts of a given topic are, let alone the relationships among those concepts. When they perceive these gaps clearly and specifically, they will be able to return to look for resources

> (book or other instructional material) about their doubts, and then return to the construction of their maps. This coming and going between the construction of the map and the search for answers to questions will facilitate the construction of meanings about the content under study. (TAVARES, 2007, p. 74).

Thus, the concept map is considered a knowledge structurer, as it allows showing how knowledge about a given subject is organized in the cognitive structure of its author, making it possible to visualize and analyze its depth and extent. It can be understood as a visual representation used to share meanings, because it explains how the author understands the relationships between the stated concepts.

According to Hernandez et al. (2000), educational innovation seeks to introduce a change in classroom practice, by introducing new teaching processes, products, materials and ideas. Thus, the inclusion of diversified strategies, such as the use of concept maps in science classes, can renew the teaching of content and even change the teachers' pedagogical practice. In addition, they can contribute to the promotion of students' scientific literacy.

Scientific literacy in the early years

One of the objectives of science education is to promote scientific literacy through teaching practices that insert students in a world of new meanings, in order to familiarize them with a language different from the one used in everyday life - the scientific language - which has its own characteristics, so that students are able to: attribute meanings to the world in which they live, based on this language; b) understand what science is, so that the language of sciences becomes meaningful; c) apply the knowledge acquired in new situations; d) know and interpret the natural phenomena around them; e) increase the ability to make decisions in their daily life; and f) acquire skills and attitudes that will assist their education as a more critical individual, participant and active in the community in which they live (LORENZETTI, 2000).

However, for SL to become effective, schools need to be the bridge that connects the student to scientific knowledge in an appropriate way, approaching science as part of the student's life and not as an isolated content, dissociated from their context.

For Lorenzetti and Delizoicov (2001, p. 8-9) the process of scientific literacy "can and should be developed from the initial schooling phase", even before the acquisition of reading and writing. The reason is it contributes to the insertion of the student into the scientific culture, by means of an interdisciplinary and contextualized pedagogical practice. Carvalho et al. (2010, p. 13) emphasize the importance of science education in the early years as it allows students to "discuss and propose solutions compatible with their development and their worldview, but in a sense that will lead them to the eventual scientific knowledge".

It is essential to teach science based on the relationship among science, technology, society and the environment, which can develop scientific skills that allow students to build a learning process capable of relating knowledge from various fields, identifying their social, cultural, political, economic and technological implications. Thus, teaching processes based on the development of a scientific culture, through scientific literacy, contributes to the development of more active citizens and participants in the society in which they live.

Therefore, according to Sasseron (2014, p. 51), SL can be understood as "the objective of teaching science for the development of people who know and recognize scientific concepts and ideas, aspects of the nature of science and relations among the sciences, technologies, society and the environment".

Making scientific content endowed with meaning to discuss the role of scientific and technological development and its implications for social dynamics presents itself as an important issue for science education.

There is an urgent need to educate citizens with the understanding of the interactions between science, technology, society and environment (STSE) and its implications. People need to understand science and technology as human activities and not simply neutral activities apart from social problems.

According to Reis (2004, p. 31) "people learn science from a variety of sources, for a variety of reasons and in different ways". However, schools have a very important role in enabling the student's access to scientific knowledge through the teaching of sciences. It is essential to provide a formative process from an early age, aiming to form critical and conscious citizens who understand the scientific language, who know how to use it more actively in society and, as said elsewhere, who are able to comprehend that the production and use of science can both contribute to the improvement of life and have negative implications and consequences for humans and the environment.

The concept of scientific literacy should include the development of students' capacity and involvement in taking appropriate, responsible and effective actions on issues of social, economic, environmental and moral-ethical interest, which according to Hodson (2003) must be based on seven areas of concern: human health; food and agriculture; land, water and mineral resources; resources and energy consumption; industry; the transfer and transport of information; ethics; and social responsibility.

As a result, it is understood that the role of the teacher is essential in the search for the desired scientific literacy, and it is up to them to plan and organize activities and teaching strategies that arouse the interest of students, contemplating different spaces and means to achieve the learning objectives.

School activities should not be restricted to the basic understanding of scientific terms, knowledge and concepts, being limited to linguistic-conceptual appropriation. There is a need to go further and work on other activities to develop skills that lead the student to realize the relationships between the systematized knowledge at school and the subjects present in everyday life.

Therefore, they will be allowed to raise hypotheses, test them, question them, seek explanations and build arguments for the theme worked, in addition to perceiving the existing relationships between science, technology, society and the environment and the implications that this represents for society and for the planet.

The STSE teaching approach with a focus on science teaching seeks to prepare students for the exercise of citizenship, assisting them in the process of making responsible decisions, as well as being able to perform a critical reading of reality. Thus, science classes should enable students to problematize and investigate phenomena linked to their daily lives, so that they are able to master and use the knowledge built in different spheres of their lives, seeking practical benefits for people, society and the environment. For this reason, the definition of scientific literacy is centered on the meanings, senses and applicability of scientific knowledge, going beyond the simple reproduction of concepts in science classes.

Sasseron and Carvalho (2011b) defend the need for science education that goes beyond the provision of scientific notions and concepts. According to them, it is important that students are faced with authentic problems in which research is a condition to solve them. For this, they support the inevitability of carrying out activities that promote discussion, in order to create a more complex argumentative environment. Therefore, this environment goes beyond the presentation of data and conclusions only, it shows the acquisition of some skills specific to science, named Indicators of scientific literacy.

Structuring axes and SL indicators

Sasseron and Carvalho (2008) highlight that there are some requirements to consider a citizen as scientifically literate. The authors identified three relevant points when thinking about the promotion of SL, calling them “structuring axes of scientific literacy”, as they are the ones that support the idealization, planning and analysis of teaching proposals that aim at scientific literacy.

The first axis is configured in the “basic understanding of fundamental scientific terms, knowledge and concepts”; the second refers to “understanding the nature of science and the ethical and political factors that surround its practice”; and the third “understands the existing relationships between science, technology, society and the environment” (SASSERON; CARVALHO, 2008, p. 3).

Based on these axes, scientific literacy indicators were established, which consider the skills used by scientists during their investigations and that serve as parameters to identify that scientific literacy is in process.

These indicators refer to skills specific to science and scientific practice, and common skills developed and used for the resolution, discussion and dissemination of problems in any area of science. There is a search for relationships between what is seen in the investigated problem and mental constructions that lead to the understanding of it (SASSERON; CARVALHO, 2008).

The indicators serve to reveal some skills that must be worked on when it is desired to implement SL in the process of knowledge construction. The teacher has, by means of the indicators, clues on how to improve their teaching practice so that it effectively reaches the student.

The indicators are divided into three groups: the first group of indicators is related to obtaining data; the second group is related to the structuring of thought; and the third group is related to finding relationships. Each of these groups represents a block of actions that are put into practice when there is a problem to be solved.

According to Sasseron and Carvalho (2008, p. 6) the first group involves the indicators that are specifically related to the work with the data obtained in an investigation. They are classified into information ranking, information organization and information classification. These three indicators are important in investigating a problem, as it is “through them that it becomes possible to know the variables involved in the phenomenon, even though, at this moment, the work with them is not yet centered on finding relationships between them and the reason why the phenomenon occurred as observed” (SASSERON; CARVALHO, 2008, p. 6).

The second group of indicators involves dimensions related to the structuring of thought that shapes the statements made and the speeches expressed during science classes, in addition to demonstrating ways of organizing thought, “indispensable when the premise is to construct a logical and objective idea for the relations that regulate the behavior of natural phenomena” (SASSERON; CARVALHO, 2008, p. 6). There are two indicators in this group: logical reasoning and proportional reasoning.

Finally, in the third group are the indicators most directly linked to finding relationships. The following indicators are part of this group: hypothesis raising, hypothesis test, justification, prediction, explanation. They must appear in the final stages of the discussions, as they are characterized by working with the variables involved in the phenomenon and the search for relationships capable of describing the situations either for that context or similar ones.

Chart1 presents the indicators of scientific literacy, which Sasseron and Carvalho (2008) describe as important to assess the level of SL of students.

Chart 1- indicators of scientific literacy

Group	Indicator	Description
FIRST	Information Ranking	It is linked to the establishment of bases for investigative action.
	Information organization	It appears when trying to prepare the existing data on the investigated problem.
	Information classification	It appears when trying to establish characteristics for the data obtained.
SECOND	Logical reasoning	It understands how ideas are developed and presented.
	Proportional reasoning	Like logical reasoning, it is what shows the way in which thought is structured.
THIRD	Hypothesis raising	It points out moments when assumptions about a certain topic are raised.
	Hypothesis testing	These are the steps in which the assumptions previously raised are put to the test.
	Justification	It appears when, in any statement made, a guarantee is given to what is proposed.
	Forecast	This indicator is made explicit when an action and/or phenomenon that happens associated with certain events is stated.
	Explanation	It appears when seeking to relate information and hypotheses that were already raised.

Source: Sasseron; Carvalho (2008, p. 68).

It should be noted that the “presence of one indicator does not prevent the manifestation of another”. Quite the contrary, because during “classroom argumentations, in which students try to explain or justify an idea, it is likely that the indicators show support for the explanation that is being made” (SASSERON; CARVALHO, 2008, p. 7).

According to Sasseron (2008), in order to achieve scientific literacy, it is important to consider what efforts should be made from the beginning of students’ schooling. Thus, even in elementary education, the elaboration of proposals that take into account the structuring axes can achieve good results, developing students’ skills that can be used in different contexts, not only in science classes. In this article we argue that a didactic sequence, based on the structuring axes of scientific literacy and on the three pedagogical moments, can contribute to the promotion of SL, which will be evidenced in the indicators obtained in the interviews with students, when they explained the scientific knowledge represented in the concept maps constructed at the end of the sequence.

Methodology

The present research can be considered of qualitative, exploratory nature, with a pedagogical intervention type design, since the reality is not static and an intervention research must have the context as an object of analysis, seeking to elucidate issues related to learning problems. For Damiani et al. (2013, p. 58), they are “investigations that involve the planning and implementation of interferences, aimed to produce advances or improvements in the learning processes of the subjects who participate in them and the subsequent evaluation of the effects of such interferences”.

The proposed activities were developed in nine meetings, the first three of which were aimed to train the teacher who developed the didactic sequence and to discuss the sequence. The other six aimed for the implementation of the didactic sequence, each meeting lasting two hours.

The didactic sequence was implemented between October and December 2016 in a public school in Araucária, state of Paraná, with 24 students from the 4th grade of elementary school I. Those responsible for the students signed the Term of Free and Informed Consent, after approval by the Ethics Committee of Institution X, and will be identified as A1 to A24 in the analyzes.

Concept maps were prepared in the six classes, and in the first five classes the maps were built with the help of the teacher, in order to understand its construction process. The last map was created in pairs or trios and without the help of the teacher, in order to assess the construction of the map, the understanding of the content and the SL indicators.

The development of the classes used the three pedagogical moments (3PM) by Delizoicov, Angotti and Pernambuco (2011) as a didactic strategy. Initial questioning aims to awaken the student’s interest in acquiring knowledge that they do not have yet, by presenting significant situations in which the student manifests previous knowledge. Knowledge organization is the stage in which the rupture of knowledge based on common sense must occur, building more critical views that are related to the phenomenon studied, insofar as the identified and planned scientific knowledge is studied mediated by the teacher, enabling the situations discussed in the initial problematization to be understood. In application of knowledge there is a resumption and analysis of the issues listed initially, contributing to the systematization of knowledge that has been understood and incorporated by students. The knowledge acquired in this stage can contribute to the understanding of other issues, in addition to those addressed in the initial problematization (DELIZOICOV; ANGOTTI; PERNAMBUCO, 2011). 3PM can guide the structuring of the curriculum, as well as contribute to its implementation in the classroom. In this article, we defend that a didactic sequence, structured based on the three pedagogical moments, can contribute to the promotion of the scientific literacy indicators of students.

It is important to emphasize that the 3PM establish a different perspective for the teaching practice. In addition to valuing the students' previous knowledge, it instigates curiosity to seek solutions to the problems presented and to actively participate in the classes.

The sequence was called Water: where does it come from, where does it go?[3], which in summarized in Chart 2.

Chart 2 - Structure of the didactic sequence

Class	Content	Didactic resources	Learning objectives
1	The importance of the presence of water in the soil, in the air and in living organisms.	Different images with or without water; Terrestrial globe; Plant; Poster; CM.	To perceive the presence of water on the entire planet: in living beings, in the soil, in the air and in living organisms.
2	Water pollution and contamination in Araucária and other cities.	Student's tour itinerary; Several images; Comparative board; CM.	To perceive the action of man in pollution and contamination of water and its consequences to health.
3	Water pollution and contamination in Araucária and other cities.	Text: "Petrobrás is ordered to pay around 1.4 billion for spilling oil in the Birigui and Iguaçu Rivers"; Images of industries in Paraná; Question board; CM	To identify water pollution and contamination in Araucária and other cities and their main polluting sources.
4	Diseases caused by poor hygiene and basic sanitation.	Documentary on pollution; Text: "Not so pure"; Factsheets on diseases caused by poor hygiene and basic sanitation; CM.	To perceive the action of man in pollution and contamination of water and its consequences to health.
5	Notions of basic sanitation and Water Treatment Station (WTS), pollution and water contamination by humans.	Images; Computer animation; Printed activities on basic sanitation; CM.	To understand what basic sanitation is and its importance for people's health.
6	Notions of basic sanitation and Water Treatment Station (WTS).	Images; printed texts; Animated video; MC.	To understand what basic sanitation is and its importance for people's health.

Source: Research Data.

For the analysis of the data constituted during the investigation context, we decided to use the discursive textual analysis (MORAES; GALIAZZI, 2011), due to the qualitative and exploratory nature of the research. According to Moraes and Galiazzi (2011, p. 13-14) "the discursive textual analysis operates with meanings constructed from a set of

3- A detailed analysis of the didactic sequence can be seen in Silva, Maestrelli and Lorenzetti (2019).

texts. Textual materials are significant to which the analyst needs to attribute senses and meanings", emphasizing that the intention is "to build understandings from a set of texts, analyze them and express from this investigation some of the senses and meanings that would make it possible to read".

In the analysis stage, the students' explanations about the construction of the eight concept maps prepared in pairs or trios in the last class were examined and they should express what the students had learned in the didactic sequence classes. In the interview, students were asked to explain the concept map prepared by the group, and several questions were asked involving the knowledge shown by students in the concept maps.

The analysis was as much of the structural characteristics (form/structure) as in the semantics (content) in order to verify the developed scientific knowledge, as well as the understanding of the technique of construction of concept maps.[4] In this phase, the students' speeches were assessed. They had been obtained by means of a semi-structured interview after having constructed the concept maps. The students' speeches were categorized according to the definitions of the literacy indicators present in Figure 1.

The evidenced indicators of scientific literacy

The students' speeches, obtained during the interviews, showed the knowledge acquired during the implementation of the didactic sequence, enabling the identification of the scientific literacy indicators based on the reference by Sasseron and Carvalho (2008), with the following indicators: information ranking, organization and classification, logical and proportional reasoning, hypothesis raising, justification, prediction and explanation.

These indicators serve to show some of the skills that must be worked on when it is desired to put the SL in process with the students. The teacher can, by means of the indicators, assess whether the student has appropriated scientific knowledge, thus managing to improve their teaching practice. In this sense, the students' oral explanations regarding the construction of their concept map greatly facilitate the task of analysis.

Seeking to analyze the indicators of scientific literacy present in the explanations of the concept maps constructed by the students in the last class, from the application of a didactic sequence that addresses the water theme, it was considered the way students argue and the characteristics expressed in these arguments. They shed light on how the process is taking place, based on the semi-structured interview.

Table 1 shows the number of units of analysis for each indicator in the eight maps analyzed.

4- The analysis and discussion of concept maps in relation to structural and semantic characteristics can be verified in the article published by Lorenzetti e Silva (2018), since it is not our objective in this article.

Table 1 - Scientific literacy indicators

Indicator	CM1	CM2	CM3	CM4	CM5	CM6	CM7	CM8	Total
Ranking	0	6	0	3	0	1	0	0	**10**
Organization	5	9	2	8	15	3	12	1	**55**
Classification	4	12	0	7	0	0	0	0	**23**
Logical reasoning	0	0	0	1	1	0	5	0	**7**
Proportional reasoning	0	0	0	0	0	0	0	0	**0**
Hypothesis raising	22	22	3	27	34	1	17	1	**127**
Hypothesis testing	1	5	0	9	0	0	4	0	**19**
Justification	12	7	0	18	7	0	11	0	**55**
Forecast	6	6	0	3	4	0	9	0	**28**
Explanation	7	4	0	4	6	0	14	0	**35**
Total	**57**	**71**	**5**	**80**	**67**	**5**	**72**	**2**	**359**

Source: Research Data.

The SL indicators were obtained from the interviews and the results indicated the predominance of the hypothesis raising indicator, with 127 occurrences. Followed by the organization and justification indicator, with 55 each. The intermediate SL indicators were: explanation, with 35 occurrences; forecast, with 28 occurrences; and classification, with 23. Hypothesis testing, with 19 occurrences; ranking, with 10 occurrences; and logical reasoning, with 7 occurrences were the least evident. The proportional reasoning indicator was not evidenced in the interviews with the students.

From the interviews, it was possible to analyze the students' statements, thus being able to classify according to the corresponding CA indicators.

The lower occurrence of the information ranking indicator may point to a limitation in the students' training process, since this indicator requires greater mastery and interpretation of the observed data, different from the information classification indicator that refers to a more elementary level of SL.

As for the lower occurrence of indicators of logical and proportional reasoning, this fact may happen because children of the early years of elementary school are in the stage of concrete operations, which is marked by the acquisition of the notion of reversibility of actions. Thus, they have difficulty relating abstract concepts and reasoning about hypotheses, that is, having complete mastery of logical and deductive thinking. What predominates is logic in mental processes and the ability to discriminate objects by similarity and differences.

The *information organization* indicator is related to the arrangement of new information with what the student already knows, with a resumption of the contents worked (SASSERON, 2008). The *hypothesis raising* indicator, in the school environment, acquires an important pedagogical character in the construction of scientific knowledge, as it is by its means that students expose their previous knowledge to later make a decision, making it possible to test and trace a meaningful explanation considering the hypotheses (confirmation, denial or doubt), and so, later, build new knowledge.

In this sense, raising hypotheses in science classes can be an important milestone for the appropriation of language and skills that evidence the occurrence of scientific literacy. Note that it is with the constructed hypotheses that opportunities arise for the construction of relationships that, in turn, cause the emergence of explanations linked to the presented hypotheses.

The indicators related to justification, explanation and prediction correspond to the search for connections and relationships between variables that emerge, in order to describe and explain the phenomenon and its consequences, attributing causes and effects. The explanation reveals the relationships built up during a placement. The main functions of the elements that appear associated with it, within the argument, are to ensure greater validity and authenticity to the proposition, such as the SL indicators, the justification and the forecast (SASSERON, 2008).

Thus, as children justify, predict and explain, even though they still have an argument of little consistency and coherence, it is a possibility for them to build ideas and explanations, which gradually become more complex and coherent.

The presence of these indicators can be identified in the excerpts that will be analyzed below, based on the purposes that were intended to be achieved with this work.

In the first group are the indicators of information ranking, information organization and information classification.

The information ranking indicator can be observed when students answer the teacher's question according to their previous experiences. Below are some examples

> A6: I knew that the watermelon had water because it has a little liquid;
> A17: the rain is there in the sky;
> A6 and A17: the water reaches the houses through the pipes.

This indicator aims to list data already worked and/or previous experiences of students, establishing bases for the problem investigated. In this way, the speeches listed in the excerpt are linked to a list of data related to the theme with which the teacher intends to work and to the student's daily events.

In this group, it is also possible to observe the *information organization indicator* that seeks an ordering of new or already worked information in order to remember them. Its occurrence can be observed when the student refers back to the information worked in the classroom. In this case, the reading of each concept map contributed to the resumption of the information discussed during the classes.

> A19: We use water to bathe, drink and do chores at home and for that we need to treat it. Some diseases caused by contaminated water: swimmer bacteria, hepatitis A and E, diarrhea, leptospirosis, ascariasis, cholera and giardiasis. Basic sanitation is a set of measures that work to make our lives healthier. Water is in rivers, living things and soils. The polluting sources are industries, sewage, foam, pesticides, waste and oil".

> A7: The water is sucked into the river, goes to the WTS (water treatment station), there in the WTS they wash and clean the water, removing the dirt. After that, they go (inaudible) and get into a huge water box, which after that box will distribute throughout the city.

The first group contains *information classification* that also takes up the ideas already discussed and seeks to relate them. The dialogue between researcher (R) and students on the theme of water worked in the didactic sequence shows the indicator:

> R: do you know how water gets to your house?
> A19: First it is treated at the WTS and then it goes through the pipe and arrives at my house, then it goes through the sewer and then the sewage is treated at the STS (sewage treatment station) and is taken to the river".
> R: Do you know how water is treated?
> A17: First it sucks the water from the river, it passes to remove the thick things, leaves and things like that. Then go on to put chlorine and things, fill the box and go to the houses.

In the examples above, there is the ordering of the elements worked, seeking a better understanding of the information.

The second group of indicators includes elements related to the structuring of thought in order to articulate ideas and explanations about the natural world. *Logical reasoning* comprises the way ideas are developed and presented and are directly related to the way thought is exposed. *Proportional reasoning*, on the other hand, refers to the way the variables are related to each other, showing the interdependence they may hold.

It can be seen in the following excerpt, through the dialogue between researcher and the student (A7), an example of *logical reasoning*, as this speech demonstrates understanding in relation to the proposed problem about polluting sources and brings a hypothetical proposal for solving the problem.

> R: What do you have to do to keep people from polluting?
> A7: Invent a law and you have to put a camera, a lot of cameras around the city. And you have to put a fine, because if someone throws trash on the floor, then you can see and pay a certain fine.

In the next section, the child relates the information and hypotheses raised to a new explanation and helps the classmate to reach a conclusion about the existence of water in the air.

> A7: Like those serums, for inhalation, when you breathe, what you breathe is vapor ...

In another fragment there is also an example of logical reasoning, as this speech demonstrates the awareness, understanding in relation to the proposed problem about polluting sources in the city of Araucária and the attempt to solve the issue by proposing alternatives for the excess of consumption.

> R: What actions should we take to prevent this pollution? Or what solutions?

A11: if we already have something and we don't use it anymore and throw it in the trash and sometimes the trash goes there to the river and contaminates the whole river ... because of the things we buy and don't need and so then throw away. So we need to buy fewer things.

The proportional reasoning indicator was not identified in the analyzes, as there was no extrapolation of the representation of the structure of thought that covered the interdependence relationships between the variables worked.

The last group of analyzed indicators is related to the search for relationships, that is, understanding of the scenario. The *hypothesis raising* is an indicator that aims to point out the assumptions that students make to the researcher's question:

R: Is there water in the fruits?
Students: Yes.
R: In watermelon?
Students: Yes.
R: What about in the banana?
A20: No.
A11: There is in the watermelon, because it is a liquid.
A20: And there isn't in the banana, because it is dry.
R: Does the banana have no water because it is dry? Is that it?
A11: yes, it's kind of dry.
R: But does watermelon have it?
Students: Yes.
R: But isn't a banana a fruit?
A11: Yes ... so the banana has it because it is a fruit.
R: Does it have water or does it not?
Students: yes.
R: Do all fruits have water?
Students: yes.
R: So does the banana have water? Or does it not?
Students: yes.
R: Are you certain?
A11: Yes. It's a fruit.

In the passage above there is a raising of hypotheses and confrontation of ideas, creating a valuable dialogue and reassessment of concepts.

According to Capecchi and Carvalho (2000) learning science involves expressing oneself in a new social language. In this perspective, it is necessary to provide students with situations that make it possible to expose what they think and create conditions for them to have access to other points of view, listen to other arguments and visualize other ways of analyzing a phenomenon.

R: Does Banana have water?
A19: I don't think so.

R: And watermelon?
A19: Yes.
R: Does the dog have water?
A19: I think so.
R: What about us?
A19: Yes.
R: Why does the banana have no water?
A19: I don't think so. Because ... I think I changed my mind, because if the banana has no water it can stay, it will not live I think, it will be totally wilted I think and we will not be able to eat.

In the transcript above the child is raising the hypothesis about whether or not banana fruit has water "I think I changed my mind". However, the student presents other indicators of this same group at the same time: the *forecast* present in the fragment "it will be totally wilted" and the *explanation* when saying "we will not be able to eat", in addition to appearing traces of *logical reasoning*. The child established a relationship between bananas and fruits having water. Since the banana is a fruit, it also has water.

The same fact can be verified in the dialogue between researcher and student, transcribed below:

A19: We can use the water to bathe, to drink and do the housework, because without water we cannot make food and without food we cannot live and without water we cannot also bathe and imagine if we didn't take a shower, we will start to rot.
R: These people who walk on the street, are homeless ... they don't bathe, are they rotting?
A19: I don't think so, but if you are like, for example, a year without taking a shower, I don't know if that is possible, but if you are a very poor person ... you can't have good water to clean yourself, you stay a year without taking a bath, the flesh may become gray...

In this passage, the child is *raising hypotheses* regarding the lack of bathing "imagine if we didn't take a shower" and then *justifies* his hypothesis by saying "we are going to start to rot". In the fragment, the student presents other indicators of the same group, such as the *hypothesis test* with the words "a year without taking a shower, I don't know if that is possible", testing her previous assumption and the *forecast* that appears in the fragment "is a year without taking a bath, the flesh can start to get a little gray".

In the next two excerpts, it is also possible to verify the presence of *justification* and *explanation* indicators for a situation raised by the researcher and the hypotheses elaborated by the students.

R: What are the attitudes that we have to take then? What actions are important not to pollute water?
A10: Reuse water, do not throw garbage on the street and recycle.
A1: They could learn to pollute a little less than they pollute.
A1: They should reuse water, simple as that.
A13: I think we shouldn't throw garbage in places that we can't.
A7: we have to recycle.

> R: What attitudes do we have to have at home to reuse water?
> A10: get the shower water, use the shower water to wash things.
> A11: We can't throw garbage in the rivers, we have to throw it in the trash so as not to pollute the planet.

In response to the question raised by the researcher, the children evidence the *hypothesis-raising* indicator about what should be done not to pollute the water "I think we shouldn't throw garbage in places that we can't". To *justify* the responses "we have to recycle", "reuse water, don't throw garbage on the street and recycle". They list some attitudes that can contribute to avoid pollution of both water and the planet: "get the water from the shower, use the shower water to wash things", "we have to throw it in the trash so as not to pollute the planet", "They could learn to pollute a little less than they pollute" and "they should reuse water, simple as that".

In the second section, the children justify their statements that allow the construction of an explanation for their answers.

> R: How is the water from the Iguaçu River being used?
> A20: They only use it to throw garbage [...].
> A11: We can't throw garbage in the rivers, we have to throw it in the trash so as not to pollute the planet.
> R: What attitudes should we have to avoid this pollution? Or what solutions?
> A11: We shouldn't throw garbage around, don't buy many things that we don't need.
> R: What do you mean A11?
> A11: Like this, if we already have something and we don't use it anymore and throw it in the trash and sometimes the trash goes there to the river and contaminates the whole river ... because of the things we buy and don't need and then throw away. So we need to buy fewer things.
> R: How did rainwater end up in the clouds?
> A17: The water evaporates from the rivers and rises to the clouds, which gets too heavy and rains.

As an example, the child presents his/her explanation for the question asked by the researcher about how it rains: "The water evaporates from the rivers and rises to the clouds, which gets too heavy and rains". Providing assurance to what was said, giving certainty based on what she/he believes to be and inserts a justification in her/his speech stating that "the clouds are too heavy and it rains".

It is possible to notice that student A17, after *organizing the information* obtained and starting from it, proposes a solution to the researcher's question about how rainwater ended up in the clouds and in her/his argument *justifies* and *explains*, evidencing the development of indicators.

However, in the speech the structuring of the child's thinking appears to attribute a certain coherence to her/his argument, seeming to perceive that there is a relationship between the events, indicating the dependence between the variables. These indications demonstrate that she/he made use of the logical reasoning indicator.

It is also possible to check in student A11's excerpt the argument and a proposition of alternatives, albeit genuine, for the question "if we already have something and we don't use it anymore and throw it in the trash and sometimes the trash goes there to the river and contaminates the whole river, because of the things we buy and don't need and then throw away. So we need to buy fewer things." The child justifies, explains and proposes a behavior change, which are important for the SL process.

In the analyzed sections, we were able to perceive the explanation of practically all the SL indicators: from the ranking, organization and classification to the obtaining of data, being the indicators that mark the construction of the argumentative process. Moreover, we verified the structuring of thought by means of logical reasoning, which provided a certain cohesion and coherence to the arguments presented in the children's speeches and arriving at the search for relationships by raising, testing and justifying hypotheses, in their prediction and explanation of the facts.

As Sasseron and Carvalho (2008) point out, the presence of one indicator does not preclude the manifestation of another. During argumentation students try to explain or justify an idea, and it is likely that many indicators will appear to support the explanation being made.

Final considerations

The present study aimed to analyze the contributions of a didactic sequence regarding water in the promotion of scientific literacy in the early years, evidenced through the explanations of students about the scientific knowledge represented in the construction of concept maps, based on the assumption that scientific literacy is a lifelong construction process and that its development in science classes is fundamental, since the first years of schooling. Thus, children are building from an early age the values and skills necessary for a conscious, autonomous subject, capable of judging, making decisions in the face of scientific and technological advances, understanding the world and interpreting the actions and phenomena they observe and experience in their daily lives.

Thus, with this theoretical assumption in mind it was possible to verify that the implementation of a didactic sequence, based on the three pedagogical moments, which uses the concept maps as a teaching strategy, proved to be effective in promoting the indicators of scientific literacy, being necessary that the teachers have knowledge both of the content to be taught and of scientific literacy, concept maps and pedagogical moments.

Regarding the objective of analyzing the scientific literacy indicators present in the explanations of the concept maps, in order to highlight the need to understand the applications of the knowledge constructed by the students, it can be verified that there was contextualization, by some students, of the problems involving the theme and its possible repercussions. Some proposals for improvement and alternatives to the problems raised during the interview can also be verified.

It is noteworthy that the proposed didactic sequence materialized some of the skills necessary to be scientifically literate, because by providing students with situations in which they needed to position themselves and put their previous and/or constructed conceptions in check on some of the themes, they demonstrated, through the construction of the concept map and the interview carried out, the appropriation of several scientific concepts and they realized that it is possible to give an opinion, take a position and even propose solutions for everyday situations.

We agree with Sasseron and Carvalho (2008) on the importance of putting students in contact with "doing science", that is, providing students with not only scientific notions and concepts, but also providing opportunities, from an early age, for a development that contributes to becoming a citizen. This development inevitably passes through the school and finds a privileged space to happen in science classes in the early years of elementary school.

Thus, science classes need to enable students to problematize and investigate phenomena linked to their daily lives, so that they are able to master and use the knowledge built in the different spheres of their lives, seeking practical benefits for people, society and the environment, going beyond simple reproduction and provision of scientific notions and concepts. When considering themselves an integral part of the environment and suggesting solutions to problems, the children see themselves as citizens who make decisions, discuss with arguments and propose alternatives.

It is important for the teacher to keep in mind that Concept Maps within the didactic sequence can represent the content worked on, as they are capable of graphically representing the significant learning relationships established by students, assisting the teacher in conducting the teaching process.

However, it will only be meaningful for the students, if the map can internalize their learning, when it is explained it can be expanded and consequently add knowledge and a higher level of awareness, questioning and positioning. For the teacher, it will be important to diagnose and relate the student's knowledge to the corresponding SL indicator, and so be able to help overcome it at the various levels, through interventions and questions.

For this, it is necessary to carry out activities that promote discussions, which go beyond the presentation of data and conclusions, but that show the acquisition of skills specific to science and scientific practice. We believe that the didactic sequence implemented contributes to the promotion of scientific literacy, considering those specified in science teaching for a 4th grade class of elementary school.

Based on the results presented, the present research shows that the work with sciences in the early years makes it possible to promote scientific literacy, in an articulated way to the use of concept maps so that they become an instrument for verifying the acquisition of knowledge and finding out occurrence of SL indicators. As already explained, there are some limitations that must be taken into account, as they can interfere with the intended result, such as the short time to develop the themes worked and the lack of time to exercise the mapping technique in the construction of concept maps.

In order to implement such pedagogical actions in schools, it is necessary to introduce and/or expand knowledge about didactic sequences, concept maps and scientific literacy in the initial training of teachers. In addition, it is essential to offer continuing education courses for teachers in order to expand knowledge about the mapping technique.

In order to work with concept maps and scientific literacy in elementary school, it is necessary to modify the perception of how to act in the classroom. In order for these differentiated methodological practices and approaches to be incorporated into the teaching practice, changes are necessary, in order to make science teaching more attractive, meaningful and capable of promoting students' criticality, decision making and intellectual autonomy.

It is hoped that this work contributes to expand the dissemination of studies on scientific literacy and concept maps and also to encourage the development of new investigations focused on this field, offering greater contribution to students and teachers of sciences.

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