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Dimensions of scientific literacy in the teaching practice of a teachers' group

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ABSTRACT

This current paper explores the teachers' reflections and ideas of the early years of an elementary school in Paraná state about their pedagogical practices in science teaching. The considerations here intend to describe and analyze scientific literacy (SL) aspects that are currently introduced in elementary school teachers' reports about teaching work and the relationship with science teaching. The data were acquired from semi-structured interviews in which constituted a report for each interviewed teacher. The reports were analyzed based on Lauren Bardin's Content Analysis, in particular the thematic analysis. Our results allowed us to reveal specific aspects from the pedagogical practices of the social actors involved, and also to analyze the school and the teachers understanding regarding the Natural Science area, besides demonstrating that the teachers show difficulties with scientific mediation turned to the area of the science, and consequently in the principles of understanding SL. Finally, we believe that the analysis of teachers' representations allows us to know the school needs within science education.

KEYWORDS: Scientific Literacy. Science Teaching. Elementary School.

INTRODUCTION

The teaching of scientific subjects in elementary school permeates the construction of a bridge between students and the world in which they live to understand natural phenomena, theories, and scientific laws. Accordingly, science is a way of understanding natural phenomena and analyzing what has been built over time by different scholars. Therefore, science education deserves special attention to the social, cultural, and economic aspects of scientific practices, turning the thinking back to how science can impact the world in which we live (SASSERON; MACHADO, 2017).

Thus, teachers need to think about teaching-learning geared to the specificities of Natural Science, building bridges so that students can see the world through scientific optics. However, the most common approach presents the teacher as a provider of the knowledge already established, favoring the construction of distorted, empirical, theory-distant, and rigid visions concerning the scientific method (SASSERON; MACHADO, 2017; POZO; CRESPO, 2009).

In order to develop this critical sense and a constructive view of science, teachers should promote and enhance Scientific Literacy (SL), which has the objective of contributing to transforming students into more critical individuals in the face of everyday situations, learning how to position themselves in these situations (CHASSOT, 2011). In this work, the theoretical assumptions of SL, defined by Sasseron and Carvalho (2011) and defended by Leite (2015), are the basis that relates SL and teacher training. For the first authors, the idea of literacy "should develop in any person the ability to organize their thinking logically, in addition to helping to build a more critical awareness about the world around them" (SASSERON; CARVALHO, 2011, p. 61, our translation).

Concerning the identification characteristics of SL aimed at citizen formation, Leite (2015) proposes three dimensions that highlight the essential ideas. For the author, SL involves the following: a) understanding of the nature of science and scientific knowledge; b) identification and recognition of the importance of concepts and scientific theories in daily processes; c) clarity of the socio-scientific aspects involved in diverse situations of life (LEITE, 2015). In order to explain these dimensions better:

a) Understanding of the nature of science and scientific knowledge:

Understanding the nature of the sciences is essential for individuals to interact with the historical, social, economic, and philosophical implications and understand science as a human activity, which involves scientific activity processes (LEITE, 2015; SANTOS, 2007). Also, they should develop a complementary vision between scientific work and scientists, turning to the conceptions of science construction close to individuals (CARVALHO; GIL-PÉREZ, 2011).

The importance of reflecting on teaching science's characteristics with a provisional and uncertain character, subject to change and investigation, must be emphasized, allowing students to accept the possibility of building several alternatives (hypotheses) for solving a problem. Besides, the teaching work in the classroom reflects the understanding of science by teachers, who commonly present an inadequate representation of scientific work and scientific knowledge (LEITE, 2015; SANTOS, 2007).

Therefore, this first dimension seeks to understand science construction processes through scientific knowledge and demonstrate the importance of science's provisional characteristics, enabling a conversation between students and teachers. It is worth mentioning that this work addresses the early years of elementary school, and themes about science's nature should not be worked on explicitly. However, aspects of scientific culture may be inserted in the teacher's daily work with students, allowing them to participate in scientific investigations that enable them to reflect on science processes (BRICCIA, 2013).

b) Identification and recognition of the importance of concepts and scientific theories in daily processes:

This dimension is reserved for understanding science teaching in its specificities so that one can question teaching practice within the "for what" and "why" and teach scientific knowledge directed to a daily perspective. Therefore, the teaching work in the classroom needs to emphasize the importance of building scientific knowledge to be used in daily situations and interpreting everyday information (POZO; CRESPO, 2007; SASSERON; MACHADO, 2017).

Hence, individuals need to be able to use scientific knowledge in making daily decisions and integrate values of recognition of the importance of this knowledge in their lives. Still, it is the teacher's responsibility to teach science meaningfully and reflect on the goals through science education (LEITE, 2015).

c) Clarity of the socio-scientific aspects involved in diverse situations of life:

This dimension addresses the relationship of science, technology, society, and the environment (STSE), discussing environmental, economic, and political aspects related to science and technology. The concepts need to address not only environmental and ecological issues, which are the most common in the classroom, but also content through an interrelation between scientific, technological, and social education, in addition to historical, ethical, political, and economic discussions. Furthermore, it is expected through this dimension that the citizen will be able to participate in decision-making related to science and technology and learn to deal with technological tools (SANTOS, 2007).

By basing the school curriculum and the development of teaching and learning according to the three dimensions described above, it is believed that students will be prepared to live and act in society, offering active participation. However, teachers with initial and continuing education, based on epistemological and socio-scientific assumptions, are expected to happen.

The dimensions presented make it possible to investigate whether there is a promotion of SL through science teaching mediation in the classroom. However, an influential factor within the pedagogical practice of these teachers is related to training aimed at the pedagogical area, which demonstrates a fragmentation in the teaching of Natural Science, disseminating a limited idea of practical work as a view of scientific work, thus constituting a distorted image and contributing for the transmission of concepts previously elaborated (CARVALHO; GIL-PÉREZ, 2011).

It is essential to mention that gaps in teacher training can be overcome when teaching and research are not dissociated and, still, if there is a collective work of innovation, research, and permanent training of the pedagogical team. Thus,

Carvalho and Gil-Pérez (2011) present a path for the development of science education directed to SL, whereby it is understood that "knowledge is the answer to questions, which implies proposing learning from problematic situations of interest for students" (CARVALHO; GIL-PÉREZ, 2011, p. 34, our translation). Addressing the assumptions of more investigative teaching can promote SL in the classroom.

This research aimed to identify the representations[1] and reflections on the development of science teaching in a private school in the early years of elementary school through interviews with teachers who currently teach or taught the science subject at school. It should be noted that this work is part of more extensive research at the master's level (in progress), which seeks to investigate how a school science club at school can assist in developing children's SL.

RESEARCH METHODOLOGY

In this section, the course of the work carried out, and the theoretical foundations that served as the basis for collecting and analyzing the data are presented. The qualitative nature characterizes this research, as it comprises an investigation in the school environment to analyze the behavior and the experience of a specific social group: the teachers. The qualitative approach is intended for the verb "to understand," which in this research goes through all the paths taken because it is necessary to consider the individual uniqueness and specificities to reach the idea of understanding. After it, there is a continuous act of interpreting, determining the possibilities of what is understood (MINAYO, 2012).

The analysis *corpus* is constituted in the narratives constructed from the semi-structured interview with the teachers who currently teach or taught science as a subject. The school has a team of teachers and assistants (teacher-trainees who assist the conducting teacher). For the early years of elementary school, the team has ten teachers and four assistants. For this research, the teachers were consulted, of which seven had already taught or still teach science. Therefore, the seven teachers were invited to be part of the research, and they all accepted.

Table 01 – Profile of the group of teachers surveyed

Teacher Interviewed	Degree	Post-graduation	Teaching Experience
P01	Pedagogy 2008	Specialization in Management and Psychopedagogy	13 years
P02	Pedagogy 2004	Specialization in Social Sciences	6 years
P03	Pedagogy 2013	---	8 years
P04	Pedagogy 2004	Specialization in Institutional Psychopedagogy and Art Teaching Methodology	22 years

Teacher Interviewed	Degree	Post-graduation	Teaching Experience
P05	Pedagogy 2009	Specialization in Institutional Psychopedagogy and Ludo-pedagogy	10 years
P06	Bachelor of Biological Sciences 2010	---	6 years
P07	Pedagogy 2008	---	15 years

Source: Own authorship (2020).

Thus, the social actors involved are seven female teachers. Two (P2 and P4) do not currently work with science teaching but have already taught the subject during their teaching career. The other five teachers are part of the elementary school team, each working with a class from the 1st to the 5th grade. One of the teachers (P1) on the shift, contrary to classes, is a pedagogical supervisor of Early Childhood Education at this same school.

This research was submitted to the ethics committee of human beings of the Western Paraná State University, with the certificate of presentation of ethical appreciation (CAAE) no. 16617519.1.0000.0107, approved in August 2019.

Data Analysis

The research data treatment was carried out through Content Analysis by Laurence Bardin (1977), particularly the thematic analysis, which is described as a set of communication analysis techniques, which uses systematic procedures and objective description content of messages. The method consists of five stages: the organization of the analysis, the coding of results, the categorization, and the inferences:

a) Analysis organization: it is configured around three chronological poles: pre-analysis; exploration of the material; and the treatment of results, inference and interpretation. In this stage, the *corpus* is defined, and the treatment of the results obtained through interpretation occurs;

b) coding: it corresponds to a transformation of the raw data of the text. This organization comprises three choices: the cut, in which the units of meaning are defined; enumeration; and classification and aggregation, in which categories are defined;

c) categorization: it is an operation to classify the constituent elements of a set, called in this research of themes. Categories are rubrics or classes, which bring together a group of elements under a generic title;

d) inference: producing inferences in the content analysis means basing them on theoretical assumptions of different world conceptions (BARDIN, 1977).

From the analysis, four categories were built with their respective subcategories that describe the teachers' ideas related to the SL dimensions defended here.

RESULT ANALYSIS AND DISCUSSION

The *corpus* analysis constituted four categories, composed by their due subcategories; the presentation of these categories occurs by discussing theoretical references about the dimensions of SL (LEITE, 2015) and science teaching (POZO; CRESPO, 2009). Thus, the categories are discussed as unfolding considerations that guide the discussion, as follows:

Table 2 - Dimensions and categories that formed the *corpus*

Dimension	Categories
a) Understanding of the nature of science and scientific knowledge	Representations of sciences and scientific work
	Experiments in science teaching
b) Identification and recognition of the importance of concepts and scientific theories in daily processes	Relationship between scientific knowledge and everyday knowledge
c) Clarity of the socio-scientific aspects involved in diverse situations of life	Identification of the relationship among science, technology, society, and the environment

Source: Own authorship (2020).

Table 03 represents the three themes, the four categories, and their respective subcategories that will be addressed to improve visualization and understand the structure adopted for carrying out the analyses. It is worth mentioning that the subcategories were constituted from the units of meaning obtained from the narrative constructed based on the transcripts of the recorded interviews.

Table 3 - Summary of themes, categories, and subcategories obtained in the analysis of the interviews

Theme	Category	Subcategory
Understanding of the nature of science and scientific knowledge	Representations of sciences and scientific work	1: Development of beings and the environment
		2: Observation of nature and its components
		3: Discovery and discerning study
		4: Research and daily experience with science
		1: Theory and practice

Theme	Category	Subcategory
	Experiments in science teaching	2: Everyday experience
Identification and recognition of the importance of concepts and scientific theories in daily processes	Relationship between scientific knowledge and everyday knowledge	1: Use of teaching resources
		2: Problematization
		3: Intervention through scientific knowledge
Clarity of the socio-scientific aspects involved in diverse situations of life	Identification of the relationship among science, technology, society, and the environment	1: Awareness and preservation of the environment
		2: Waste of water and waste separation
		3: Principle of stewardship

Source: Own authorship (2020).

The option was for a discussion structure based on the integration between theory and results since these are complementary. The analysis will be organized based on the three points listed above and their respective categories, aiming that this structure allows a better understanding of the objective of this research.

Table 4 - Approach in which category 1 and its subcategories were divided

Category	Subcategory
Representations of sciences and scientific work	1. 1: Development of beings and the environment
	1. 2: Observation of nature and its components
	1. 3: Discovery and discerning study
	1. 4: Research and daily experience with science

Source: Own authorship (2020).

A unit of meaning will be used to discuss the subcategories since some teachers may be cited more than once as more than one specificity of aspects of science or scientific work was mentioned. For this category, the interviewees answered two questions. From the answers, four subcategories of analysis that will be discussed below emerged individually.

The first subcategory listed - 1.1 Development of beings and the environment - concerns "interpretive realism," presented by Pozo and Crespo (2009), describing that it is through science that the nature and reality of the world become known. We agree with realism, but the mentioned authors, when investigating this concept, approach that teachers in this subcategory understand that students only need to reproduce that knowledge already developed by scientists, developing the idea of absolute scientific knowledge, based primarily on the concepts covered in the textbook and contrary to the idea of knowledge construction.

Thus, the speech of teacher P5 demonstrates the understanding of science:

> [...] is related to life, to discoveries, to the study of everything that exists on the planet. Besides, through professional experience, I understand science through scientific theories, such as evolutionary, creationist, and

> microorganisms' parts and functions, believing that science is related to school content (P5, our translation).

Through the description of the teacher's report, one comprehends that her understanding of science is focused on the universe evolution, based on the representation of the school syllabus through the explanation of the "discoveries" cataloged.

In addition, this representation of sciences is guided by the syllabus-based school experience. However, even though one of the areas of science understands the development of the universe and the characteristics that compose it, it is believed that building an image of science requires, in addition to knowing the facts, concepts, and principles, how to show attitudes and values of construction interest in science as a way of getting to know the world around us (POZO; CRESPO, 2009).

The second subcategory - 1.2 Observation of nature and its components - concerns the process of observing nature in which it refers to a still-disseminated idea that a scientific method based on observing the facts is necessary to extract the principles and laws for the development of scientific knowledge (POZO; CRESPO, 2009). The teacher P1 reports that:

> the students were doing science through observation in nature with magnifying glasses, identifying the shape, the structure of the plants, the ferns, the pores; they were not aware of the names, but the textbook provides that (P1, our translation).

Based on the teacher's description, observation is understood as part of a process within the planning of Science classes. Therefore, the importance of observation as a process within the study of science's nature is emphasized. However, the observation process needs to embody an objective, that is, a problem to be observed. Observation cannot comprise just one scientific method stage but be part of scientific knowledge construction (CARVALHO, 2013).

It is essential to clarify that scientific knowledge is not just the product of mere observation or transmission of information, but it involves a historical approach, a process of coming and going within scientific methods (CASTRO, 2004). Furthermore, the acts of observing and interpreting are implicitly influenced by previous ideas already established as truths (GIL-PÉREZ; MONTORO; ALÍS; CACHAPUZ; PRAIA, 2001).

The third subcategory - 1.3 Discovery and discerning study - concerns a simplistic and empirical idea of scientific work, in which it delimits the objective of the scientist's work to discover laws and truths (HARRES, 1999). Moreover, this view of science is characterized in research as individualistic and elitist, considering science as neutral, ignoring scientific processes throughout history (CACHAPUZ; GIL-PÉREZ; CARVALHO; PRAIA; VILCHES, 2011). Regarding this matter, the teacher P3 claims that:

> [...] the word "science" means what is out of our view, what is out of our natural reach; I think that we have to discover science, we need to study it, discover it, science is a study, a careful study of things, also of what is science but has not been studied yet (P3, our translation).

In the teacher's description, one can perceive science as a discovery that needs time to study what appears new to society. For Harres (1999), this idea of science/scientific work is part of inadequate science representations.

The fourth subcategory - 1.4 Research and daily experience with science - concerns the construction of knowledge. Teaching as an investigative process enhances aspects of the nature of science, such as dealing with a problem, reflecting on the relevance of the activity, elaborating hypotheses as a way of solving, analyzing results, and refuting hypotheses, highlighting the role of communication and debate in the construction, and highlight the collective dimension of scientific work (AZEVEDO, 2004).

Concerning this view on science, the teacher P6 declares:

> [...] when I hear that word, I immediately think of investigation, mystery and something that may be hidden and needs to be unraveled. I like to treat science like that with students to instigate them that science will always answer a question through this investigation and research. In addition, in general, I believe that science refers to the erudition of deep work on some content because sometimes people know some concept in a practical way, but science has a depth about that subject (P6, our translation).

Based on the description, the teacher addresses the importance of problematization, a pillar of teaching by research. Thus, it is clear that the use of investigative teaching processes in the classroom is an excellent potential for SL's promotion (CARVALHO, 2013).

Table 5 – Approach in which category 2 and its subcategories were divided

Category	Subcategory
Experiments in science teaching	2.1: Theory and practice
	2.2: Everyday experience

Source: Own authorship (2020).

The first subcategory - 2.1 Theory and practice - concerns the construction of scientific knowledge and theoretical content in science, which involves presenting the possibility of investigating that concept through activities aimed at experimentation. Science education needs to happen really in several spaces in addition to solving exercises and memorizing concepts, enabling students to investigate phenomena studied in the classroom (POZO; CRESPO, 2009). Thus, teacher P4 highlights this idea because:

> [...] when I hear the word "science," I think of experimenting, practicing, getting my hands dirty, providing a time to experiment and discover. I believe that science is like that, to seek more practical knowledge or to combine theory with practice. Some content cannot be worked only in theory in science, and you need to experiment (P4, our translation).

This experimental characteristic widely described by teacher P4 has the empiricist and proving character attributed to science (HARRES, 1999). However, experimental activities are perceived as of great importance within science teaching due to an investigative bias that relates social, economic, and political aspects. Furthermore, this approach considers the student as an active being

within the teaching-learning process and the teacher as a mediator of this process (CARVALHO, 2013).

Consequently, it is necessary to disseminate the understanding of experimentation as a "source that generates questions and answers to the investigated problems, as well as to form explanatory hypotheses" (SANTOS; SARTORI; ODY, 2016, p. 42, our translation), that is, the planning of an experimental class has the objective of investigating the studied processes and the training exercise in the argumentation of the theme. Nonetheless, it is worth emphasizing the importance of the teacher being clear about the use of experimental activities, since the objective with this activity needs to be the north so that school knowledge is built, and not just a motivation and fun strategy (SANTOS; SARTORI; ODY, 2016).

The subcategory - 2.2 Everyday experiences - concerns the relationship between scientific knowledge and everyday knowledge through experimentation. The teacher needs to start from the problematization of the students' daily experiences so that the experiments' performance is meaningful and productive of meanings (POZO; CRESPO, 2009). According to this, the speech of teacher P3 reports:

> [...] I relate this knowledge through experiences that enable students to relate to their daily lives [...] I try to bring stories from the students' daily lives and relate them to experiences, to later enter into scientific knowledge, as I understand that it is easier for them to assimilate knowledge through what they already know, to transform it into an experience and then come up with scientific knowledge. It is a more effective relationship in the students' minds; due to the age group, it is necessary to use the practice to reach scientific knowledge (P3, our translation).

Thus, in her pedagogical practice, the teacher demonstrates that she provides students to build a path for teaching and learning in which everyday knowledge is the starting point and scientific knowledge the endpoint. With experiments, this path is often evidenced by the scientists related to school syllabus studied or even in the early years of elementary school, through the experiments that led those scientists to conceive a law or theory. Nevertheless, in order to form laws or theories, researchers need to consider the construction of hypotheses and the historical processes of the existing theories, together with their pre-existing theories, that is, the teacher's practice of relating the daily experience, the hypotheses, and existing knowledge. Gil-Pérez et al. (2001) emphasize that it is not just a fact, such as Newton's apple, that a theory is built, but, instead, a construction process based on previous studies (GIL-PÉREZ; MONTORO; ALÍS; CACHAPUZ; PRAIA, 2001).

Table 6 – Approach in which category 3 and its subcategories were divided

Category	Subcategory
Relationship between scientific knowledge and everyday knowledge	1: Use of teaching resources
	2: Problematization
	3: Intervention through scientific knowledge

Source: Own authorship (2020).

Based on the theoretical framework described on the second dimension of SL, the subcategories listed for this category will be analyzed below, considering the units of meaning, that is, the interviewees' reports. Hence, according to the first category for the analysis description, a unit of meaning will be used.

The subcategory - 3.1 Use of teaching resources - refers to a critical role within science education, since the use of resources (image, video, games, among others) allows more meaningful teaching to students; however, its application needs to be conducted and produce a sense of the concepts covered. The speech of teacher P2 relates knowledge:

> [...] through something that they can visualize [...], I need to bring something significant, mainly because it is a second-grade class, it should not be based on just readings, so they can realize the relationship between the theoretical and what they experience. When the content addresses something more complex, one way is to bring videos, pictures, and images to the classroom (P2, our translation).

Based on the teacher's report, it is understood that, for proper development of teaching and learning, the use of various didactic resources brings students closer to the content to be learned, that is, demystifies the abstract character of science, because from them the development of various skills with students is granted. For this, the teacher must analyze the task in question, as it is also necessary to address the students' previous knowledge and use these resources as promoters of a didactic approach to science teaching. (POZO; CRESPO, 2009; SANTOS; SARTORI; ODY, 2016).

The subcategory - 3.2 Problematization - concerns a vital process within the historical construction of scientific knowledge, as the problems motivated/enabled humanity to investigate and build knowledge over the years. Thus, science is built through problems (BRICCA, 2013). The speech of teacher P5 approaches the contents through questions:

> [...] everyday knowledge is related to the students' daily lives, as when I was working, for example, the respiratory and digestive systems, I started the content by asking some questions: How does food enter the body? It shows that they already have some knowledge, but a very superficial knowledge, which they learn when they have a question and ask their father or their mother, and the explanation happens in a more popular language. With the initial questions, the students get more interested, and through the questions, I can work better with the scientific names because they knew that the food goes in and out, but they did not understand the explanation of science (P5, our translation).

Still, the problem needs to be a well-planned issue; it needs to be contained in the students' social culture so that, from questions about everyday situations, it is possible to introduce scientific knowledge. As Carvalho (2013, p. 22, our translation) states, "problematizing is overcoming the view based on common sense;" in other words, the question needs to be something that involves them searching for a solution, allowing previous knowledge to be exposed. Based on it and manipulating the material to be studied, students can raise hypotheses and test them to solve the problem (CARVALHO, 2013). Consequently, the problem becomes a manner of making students think and reflect on actions already experienced to relate them to the new concepts learned.

The subcategory - 3.3 Intervention through scientific knowledge - refers to pedagogical referrals in the classroom, by which empirical knowledge, acquired in daily experience, requires the teacher to intervene when exposed to the discussion, addressing the bias of scientific knowledge. It is believed that a concept needs to be changed when it does not match what science describes (POZO; CRESPO, 2009). The teacher P6 describes:

> [...] I like to intervene whenever there is empirical knowledge that is generally not certain; sometimes it is a legend, and I like to shed light on what science tells us [...] I like to intervene when I am sure about the content, but without discarding what they (students) know. I usually say that when I studied, that was not how I learned in books, in articles. The scholars who researched this subject did it another way (P6, our translation).

The teacher reports that she believes that when there is empirical knowledge that is "wrong," it needs to be worked on through intervention. Therefore, through science teaching, students' previous knowledge must be brought closer to scientific knowledge (POZO; CRESPO, 2009). Based on the interviewee's speech description, it is possible to realize that she understands the importance of scientific knowledge and that everyday knowledge should always be the starting point. However, what a teacher is expected to achieve is that students assimilate scientific knowledge without abandoning their previous knowledge so that they coexist, and students learn to use them at the right time, depending on the context (POZO; CRESPO, 2009). In addition, scientific knowledge will always be influenced by historical and contextual contexts, and this must be taken into account when transposing it into school planning (HARRES, 1999).

Table 7 – Approach in which category 4 and its subcategories were divided

Category	Subcategory
Identification of the relationship among science, technology, society, and the environment	1: Awareness and preservation of the environment
	2: Waste of water and waste separation
	3: Principle of stewardship

Source: Own authorship (2020).

The subcategory - 4.1 Awareness and preservation of the environment - is the subcategory with the most significant number of units of meaning, which concerns a theme well emphasized within school planning by an ecological awareness bias, being spread throughout the world through social media because of the occurrence of damage to the environment on a global scale (CHAVES; FARIAS, 2005). The teacher P6 approaches this topic:

> [...] I believe in the importance of bringing awareness into the classroom, the idea that if everyone performs a small action, it becomes great. I really like working on the environment, landfill, recycling [...] so I really like teaching about the environment, always thinking about care and preservation (P6, our translation).

The importance of the approach through environmental education in the early years of elementary school is emphasized in the teacher's speech since it is a relevant moment for this topic, and the school has an essential role in the face of

the challenges that humanity has been facing. Nevertheless, teachers report a lack of training in the environmental area, which is why concepts related to the environment often appear only on commemorative dates. Additionally, awareness will only be effective if individuals are exposed to a critical and global conception of the environment to develop social and scientific attitudes and values, along with a daily and routine awareness process (VIANA; OLIVEIRA JÚNIOR; SOBRAL; SOBRAL; LIMA, 2019).

In the subcategory - 4.2 Water waste and waste separation - the factors related to waste disposal and water consumption are the most common within the school environment, leading the student to reflect on the environmental impacts caused today, which will be harmful in the future. The speech of teacher P2 focuses on this point:

> [...] inside the school, the main environmental concepts covered are related to garbage and water waste, as students usually leave the taps in the bathrooms open and change the water in the water bottle even when it is full because it is at room temperature. The school also has individual fabric towels for each student; first, the school cannot afford to buy paper towels, which are of vegetable origin and involve preservation. The use of the bottle too, if they were to use disposable cups, how many cups would be consumed per day? (P2, our translation).

Based on the teacher's interview description, it is clear that water and garbage are treated through daily awareness. Also, by adopting water bottles and fabric towels, the school's organizational policy proposes environmental principles. Therefore, according to Sorrentino (2005, p. 289, our translation), one of the main objectives of the study of environmental education needs to lead students to "socio-environmental sustainability, to recover the concept and meaning of eco-development (sustainable development), as a possibility of transforming the natural environment," promoting classroom practices to lead them to an experience in a society that emphasizes sustainable development.

The subcategory - 4.3 Principle of Stewardship - concerns the methodology of the school's Christian network[2], by which the concepts related to science, technology, society, and the environment are approached through biblical principles. According to teacher P7, it means that:

> [...] the approach used in the school is education by principles and presents as an example the work on the principle of stewardship, that is, learning to take care of what God has given us [...], thus being good stewards at school, caring about the real need to sharpen the pencils, the production of garbage, the use of rubber, the devastation of the environment and the need to plant trees, addressing sustainability through the planting of new flowers at school (P7, our translation).

The principle of stewardship means "care, zeal, managing both external and internal properties" (BRITO, 2011, p. 41). This principle is treated when they address "[...] the care for school materials, with the environment, as these are things that God has given us to take care of and we will be accountable to" (BRITO, 2011, p. 42, our translation).

The religious character given to science education in the early years, especially in this school participating in a network of Christian schools, was also observed by Castro (2013) when stating that teachers carry not only religious references but

also artistic and political references in their statements, although they present little scientific reference. Also, he addresses that "the science idea that these teachers have is informed by an almost mythical rationality, with features of a pre-scientific science vision" (CASTRO, 2013, p. 109, our translation).

Although the school has a characteristic of biblical principles, teachers must build school planning based on scientific references, based on a historical and philosophical approach, and a religious understanding. It is crucial that even following the school's specific guidelines, the concepts and descriptions present in the official documents, such as the National Common Curricular Base (BNCC), are not abandoned. In this document, the STSE relationship is described based on the specific competencies of Nature Sciences for Elementary Education, which seeks to:

> Analyze, understand and explain characteristics, phenomena, and processes related to the natural, social and technological world (including the digital), as well as the relationships that are established between them, exercising curiosity to ask questions, seek answers, and create solutions (including technological) based on the knowledge of the Natural Science (MEC, 2017, p. 324, our translation).

A (re)adaptation of the school curricula is essential, and it should be based on theoretical assumptions aimed at SL and its dimensions, expressed in official documents such as the BNCC. The analyses made based on the transcripts of the interviews conducted with the teachers enabled us to understand the relationship between SL's dimensions and the teaching and learning proposed by the investigated school. Thus, a table was organized to exemplify supposed relations between the teachers' actions and the dimensions addressed in this article.

Table 8 – SL dimensions identified in the teachers' speeches

Teacher	SL Dimensions		
	D1	D2	D3
P1	Understands science through the observation of nature, but she does not relate to the construction of scientific knowledge.	Addresses the relationship of knowledge through experimentation but still understands science as abstract.	Understands environmental issues through sustainability, but still without a critical view of the environment.
P2	Believes that science happens in a practical way uniting theory with practice, but still perceives science through empirical discoveries.	Approaches concepts based on teaching resources and through problematization but also relates them to Christian beliefs.	Addresses environmental issues as a daily awareness process based on changes in student habits and behavior.
P3	Understands science as a careful study but believes in scientific proof and its difficulty to be accessed.	Relates scientific knowledge to students' daily lives, through experimentation.	Addresses environmental issues in an interdisciplinary way, involving socio-scientific aspects.

Teacher	SL Dimensions		
	D1	D2	D3
P4	Understands science through experimentation but still believes in science by discovery.	Lists knowledge based on students' everyday issues.	Believes in environmental issues through the Christian approach to stewardship and care.
P5	Understands the ideas of research but still believes in science through discoveries.	Addresses scientific knowledge through problematization with difficulties in scientific language.	Addresses environmental issues of sustainability and recycling superficially.
P6	Understands science through investigative bias and approaches scientific knowledge through problematization.	Understands the importance of scientific knowledge for students but believes in abandoning everyday knowledge.	Addresses concepts that involve environmental awareness but still relates it to Christian beliefs.
P7	Understands science as an investigation but related to Christian beliefs.	Relates knowledge through problematization and teaching resources but presents scientific knowledge superficially.	Presents environmental issues through care and zeal for small things but with a Christian perspective.

Source: Own authorship (2020).

The teachers present in their narratives principles that demonstrate some characteristics of the SL dimensions. However, difficulties in understanding scientific concepts and the actual representation of sciences for society can be seen since most teachers have training in pedagogy and teacher training. Their curricula discriminate fragmentations in areas focused on Natural Science. This statement is justified when analyzing the relation of teacher P6's speech dimensions, also trained in Biological Sciences, who shows SL characteristics through the investigative approach.

According to table 8 and the teachers in their speeches, possible relationships between teachers and each SL dimension can be established. In dimension 1 of the SL, it was observed that, even though all the teachers' ideas are listed there, teachers P6 and P7 present descriptions related to the nature of science. On the other hand, the ideas of P1, P3, and P4 can be evidenced in three subcategories, following broader thinking, even though the assumptions of this dimension are guided by difficulties with scientific knowledge, science through discovery, and Christian beliefs.

For dimension 2 of the SL, only one category can be organized since, of the seven teachers interviewed, four of them presented characteristic descriptions of the relationship between scientific concepts and their theories. Besides, the teachers highlight the importance of the relationship between everyday knowledge and scientific knowledge through their speeches. However, they need

to abandon erroneous science ideas, such as the abandonment of common sense knowledge, abstraction of science, difficulties with scientific language, and Christian beliefs.

For dimension 3 of the SL, the statements of teachers P4 and P6 demonstrated greater emphasis in this dimension since they superficially understand the environmental aspects, addressing these during the contents of the Natural Science and the daily process of awareness. However, according to the other dimensions, the school's characteristic focuses on its principles behind scientific concepts and the teaching of science learning.

FINAL CONSIDERATIONS

This research sought to focus on science teaching in the early years of elementary school, investigating the protagonists of teaching-learning development. The idea of teachers and school identity, related to science teaching, influences the representations directed to Natural Science. Part of the problems caused within the teaching of Science in schools occurs through the initial and continuing training of teachers, especially in the initial years, as reported by the interviewees.

In the analysis of the interviews, the emphatic relation of the scientific bias representations was focused on experimentation or practical activities. During the analysis process, the importance of allocating a specific category was evident to give special attention to this work's specifics. From this reflection, it is possible to understand that teachers present an empirical representation of sciences based on observing and obtaining results through experiments, thus deviating from the idea of investigative teaching as a promoter of SL.

Hence, other subcategories, such as teaching resources and problematization, are part of theoretical assumptions focused on teaching through investigation, which is characterized as a didactic approach, related to practices carried out by the teacher, but still establishing freedom for students to investigate a problem, being active in this process (CARVALHO, 2013). Thus, if these specificities permeate the stagnant representation of sciences and turn to teaching and learning as a joint construction of social actors, education that promotes SL in a small but possible way may occur.

In the category for the investigation of the relationship of STSE, the approach on awareness and environmental preservation was reported by the interviewees with emphasis on a bias similar to that described by Leite and Rodrigues (2018), "quite tied to the romantic idea of awareness, as if the fact of being aware of what is or is not correct to do characterizes some modification" (LEITE; RODRIGUES, 2018, p. 48, our translation). An action aimed at aspects of environmental awareness described by the school's interviewees was implementing actions such as the use of water bottles and individual towels. However, the implementation of means to reduce waste production is not enough; there is a need for it to be related to the daily experience of "why" and "what for." These actions are relevant as awareness beyond school time. Therefore, the work directed to this dimension is guaranteed when addressing "the desire for a sustainable future for society and the planet, and its achievement is linked to bridges built by the professor so that

scientific themes are analyzed globally, outside the microcosm constituted by the classroom" (SASSERON; MACHADO, 2017, p. 23, our translation).

Nonetheless, this work shows the importance of investigating the nature of science, socio-scientific processes, pedagogical and scientific referrals, and the processes that involve the daily development of science in teachers of the early years of Elementary School. Through the analysis of the interviews, it is notorious, by the six teachers with a degree in Pedagogy, a focus on the assumptions of traditional teaching associated with the appropriation of finished academic meanings, guided by the empiricist ideas produced through a scientific method. As for the teacher with a degree in Biological Sciences obtained before the Pedagogy one, when approaching investigative teaching, of construction, of knowledge together with the students, she shows an approach to constructivism, relating science to the understanding of the world.

Finally, the science teaching and learning process of the early years of elementary school should be investigated regarding the teachers. Through them, a more significant concern with science teaching can be developed to understand the relationship between daily processes and scientific knowledge. Furthermore, it is proposed that, based on this investigation, the school may present a more expressive concern in providing teachers with continuing education focused on Natural Science, especially when addressing an investigative pedagogical practice that can enhance SL, and teachers can perceive the need for the teaching profession to be always in the process of (re)construction and learning.

Dimensões da alfabetização científica na prática docente de um grupo de professores

RESUMO

O presente artigo tem como objetivo explorar as reflexões e ideias dos professores dos anos iniciais do Ensino Fundamental em uma escola do estado do Paraná, acerca de suas práticas pedagógicas no ensino de ciências. Nossas considerações buscam descrever e analisar os aspectos da Alfabetização Científica (AC), presentes nas narrativas de professoras de ensino fundamental sobre o trabalho docente e a relação com o ensino de ciências. Os dados foram obtidos por meio de entrevistas semiestruturadas que se constituíram em narrativas individuais. As narrativas foram analisadas com base na Análise de Conteúdo de Laurence Bardin, em especial a análise temática. Nossos resultados nos permitiram revelar aspectos específicos das práticas pedagógicas dos atores sociais envolvidos, e também analisar a compreensão da escola e dos docentes referente à área das Ciências Naturais. Além de observar que as professoras apresentam dificuldades com a mediação dos conhecimentos científicos voltados a área das ciências, e consequentemente em compreender os princípios da AC. Por fim, acreditamos que a análise das representações dos professores nos permite conhecer as necessidades escolares dentro do ensino de ciências.

PALAVRAS-CHAVE: Alfabetização Científica. Ensino de Ciências. Ensino Fundamental.

NOTES

1. In this work, we use the term "representation" based on Leite (2015), when addressing "all ideas or concepts of those investigated concepts" (LEITE, 2015, p. 91).

2. Principle Approach, defined as "a historic Christian method of biblical reasoning, which makes the truths of the Word of God the basis of each subject in the school curriculum" (Association of Christian Schools of Education by Principles – AECEP -, our translation).

3. Translation by Henrique Farias, professorhenriquefarias@gmail.com, Western Paraná State University (UNIOESTE), Cascavel, Paraná, Brazil.

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