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Research Article

Elaboration of A Didactic Sequence in Astrobiology for Elementary School 2

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Abstract

This work aims at the elaboration and analysis of a proposal to discuss topics of Astrobiology with Elementary School students 2, particularly with eighth grade students from a municipal school in the city of São Paulo, named the João Guimarães Rosa Municipal Elementary School. We sought to understand how they construct their conceptions about the possibility of existence of extraterrestrial life from concepts of Astronomy and Sciences addressed in the classroom. A didactic sequence was applied, materialized in a plan of five classes, where the conceptual evolution of the students was observed through indicators of scientific literacy. Based on an exploration of students 'spontaneous conceptions, using the student notebook and teacher support notebook, we observed the students' positioning in the face of situations of cognitive conflict, as well as the role of mediators in the construction of knowledge, according to the Vygotsky's socio-interactionist theory. The result of this work derived from the application of a didactic sequence is the student's notebook and the observation of the evolution of the students' scientific literacy in the course of the application of the activities.

Keywords: Astrobiology; Didactic sequence; Interdisciplinarity

Introduction

In response to the need for improvements in the teaching of Science and Mathematics as a form of social inclusion and increased interest of students in careers in the fields of Technology and Engineering, STEM-acronym for Science, Technology, Engineering and Mathematics (English: Science, Technology, Engineering and Mathematics), was presented by the National Academy of Sciences, Engineering and Medicine of the United States as a globalizing teaching proposal.

Based on projects and, through the proposition of problems, STEM seeks to articulate and apply the knowledge of school disciplines so that, integrated into the knowledge structure of the individual, they can be meaningful in a concrete situation, which led to a later development of STEM in STEAM by including art (Science, Technology, Engineering, Arts and Mathematics)) within its scope (SOUSA e PILECKI, 2013) [1].

The consideration of Astrobiology within basic education aligns with the goals of STEM Education, by integrating in a natural way the great fields of thought: Physics, Chemistry, Biology, Astronomy, Geology, History and Philosophy.

Astrobiology is the study of the origins, evolution, distribution, and future of life in the universe. It requires fundamental concepts of life and habitable environments that help us recognize biospheres that may be quite different from our own. Astrobiology encompasses the search for potentially inhabited planets beyond

our Solar System, the exploration of Mars and the outer planets, laboratory and field research on the origins and early evolution of life, and studies of the potential of life to adapt to future challenges, both on Earth and in space.

Interdisciplinary research combining Molecular Biology, Ecology, Planetary Science, Astronomy, Information Science, Space Exploration Technologies and related disciplines is required.

The National Curricular Parameters (PCNs) and the National Curricular Parameters More (PCN+) emphasize contextualization, along with interdisciplinarity, as one of the central assumptions to implement a teaching by competencies. But what happens is that there is no consensus regarding what is a teaching by competencies in the scope of the Sciences. This interpretation of contextualization ends up being reinforced by the National Curriculum Guidelines for High School (DCNEM), which state "that it is possible to generalize contextualization as a resource to make learning meaningful by associating it with experiences of daily life or with knowledge acquired spontaneously" (BRASIL, 1998a, p.94) [2]. This is clear in PCNs and PCN+.

Copernicus and Newton, as well as their contributions to the development of Astronomy should be seen not as systems of right and wrong, but of complementarity, where science is grounded, building systems that are closer to reality. The observations with instruments and the analysis of photos of the stars observed by Galileo are revealing and also allow us to discuss the role of technology in the development of new knowledge.

Based on the Russian school of psychology that refers to the social, historical and cultural dimensions of the formation of individuals and their relations with the other and with the world, the Activity Theory is an interdisciplinary framework that allows a complex reading of phenomena from the dialectical materialist perspective. By this reference, the focus of analysis is the development of the subjects in their activities and the systematization of these allows us to locate contradictions and tensions, fundamental elements for the emergence of Expansive Learning Cycles and new activities.

A very interesting and intriguing topic, which is the scope of the current work, is for students to investigate a topic to be problematized-"Is there life out there?"-, using appropriate tooling produced by the continuous discovery of exoplanets in different solar systems, which have a proximity to a star, atmosphere of gases and presence of water in various states, to infer whether there is incipient life on these exoplanets or not, making the investigation facilitated by the mediating role of the professor in conducting the research of life forms that adapt to extreme situations, extremophiles (BRASIL, 1998b) [3].

The astronomical distances should be worked with the students, because they are associated with the respective models of the Universe, as well as the notion of apparent movement of the Sun, in which the Heliocentric system is drawn. The mediation of the teacher will be beneficial when he helps the student himself to imagine and explain what he observes of the Sun, the Moon, the stars and planets, making them make the respective notes and confront with the existing models of the Universe, arising from this cognitive conflict a system of teaching learning.

During the professional master's course in Astronomy teaching, it was developed, under the guidance of prof. Amâncio, the theme of Astrobiology or the emergence of life in a cosmic context, in which it was applied in the classroom, at first, with high school students and later with students of Elementary School 2.

It was noted that the curricular grids of both high school and science for Elementary School 2, despite contemplating the content Astronomy, did not mention at any time the issue of Astrobiology or even curricular factors that would lead to a discussion on the subject.

The theme began to be applied, initially in high school, particularly in the curriculum of the first year of high school, in which the components Astronomy, Newton's laws, Kepler's laws and theories of formation of the Universe are part of the repertoire of the PCNs. Within this context, Astrobiology proved to be a motivator of students in the sense of understanding its interdisciplinarity and consequent ease to deal with a theme that is so much in the media. But in Fundamental 2, when the theme was presented to the children of the fifth, sixth and seventh grade, it caused charm and generated a flood of questions, research came from the students, and in this process of knowledge construction, everyone participated, gave opinions and walked to a scientific view of the process, deconstructing, from reflections produced in the classroom, the figures of green, Martian or anthropoid extraterrestrials as depicted in fictional films.

In this sense, by applying in a systematic and planned way a didactic sequence on the subject in a class of the eighth grade of Elementary School 2 of a municipal school in the city of São Paulo, starting from spontaneous conceptions of the students and using the method of scientific literacy, in which a problem raised in class-"Is there life out there?"-promoted a broad participation of the students, materialized in the student's notebook and support to the teacher.

The theme of Astrobiology is justified in view of promoting interdisciplinarity in school, as well as the discussion of concepts such as exoplanets and extremophiles.

As part of the objectives, the following were discussed:

About the interdisciplinarity that the theme provides when relating to science subjects, particularly, Physics, Chemistry, Biology and Mathematics. The assumptions of Piagetian constructivism and Vygotsky's socio-interactionist approach, as well as the structuring axes of scientific literacy (SASSERON, 2008) [4] and pedagogical moments (DELIZOICOV AND ANGOTTI, 1994) [5] are detailed because they are fundamental for the analysis and elaboration of the intervention.

Methodological Procedures

The methodological procedure, a data collection of research involving students of the Municipal School of Elementary Education "João Guimarães Rosa", located at Praça Haroldo Daltro S/N, city of

São Paulo-Capital, with eighth-grade class, composed of 25 students and classes of 45 minutes duration. The present work was carried out during five classes provided by the Science teacher who also collaborated for the application of the activities.

It should be noted that the group of students is not uniform in terms of class attendance, since many are absent for various reasons, and others have recently entered the school unit via transfer.

The lesson plan, attached, consists of five lessons and begins with the first class in which the students' previous knowledge regarding the theme Astronomy is explored, where they are invited to recognize, in the student's notebook, the Solar System, the Galaxy, the Milky Way, the planet Earth and the aqueous surface of the planet.

The following is the music by Guilherme Arantes, Planeta Água, in which he contextualizes the need to preserve water, its importance for the community. Students are invited to answer, in the student's notebook, about their understandings of the importance of water, highlighted in the music.

Following the activity, the mediator introduces the students to the water molecule (H2O) emphasizing the two hydrogen atoms and the oxygen atom in their molecular constitution. The illustration in the notebook shows the set of hydrogen, carbon, oxygen, and nitrogen atoms, in which students are invited to recognize the hydrogen atom as being the most abundant in the universe. An analogy with the song Planet Water leads them to realize that the chemical element hydrogen is present in places where there is a possibility of life.

In the second class, students observe in the notebook the model of a homemade spectroscope and its construction, referencing it as an element of observation of the astronomer to discover chemical elements in other stars, planets or exoplanets.

The students begin the construction of the spectroscope and at its completion point it to a light source, observing the colors that appear on the display and relating them to the specific colors of each chemical element, leading them to answer, in the student notebook, the importance of the spectroscope for the work of the astronomer, as well as the signature, color of each chemical element that exists in the universe. This activity was done inside the computer room, in which the students researched on the internet the importance of the spectroscope as well as its importance in the work of the astronomer.

In the third lesson, the students, in possession of the student's notebook, observe the Solar System, as well as the distance of each planet from the Sun comparing with the habitable zone of the Solar System to that of exoplanets, with their respective distances from the Sun and the central star, and based on a supporting text regarding exoplanets and the possibility of the existence of microscopic life, answer a questionnaire in which they compare the relative distances from the Earth to the Sun as well as the relative distances of exoplanets from their star, inferring the possibility of a habitability zone, configured in the third class.

In the fourth lesson, students are introduced to two moons of planets in the Solar System, Europa, one of Jupiter's four Galilean moons, whose observations by the Galileo spacecraft revealed an inner ocean beneath its crust, and Titan, Saturn's largest moon that must also contain liquid water in its interior. Next, the students were asked to mark in the notebook the appropriate comparisons between these moons and our Moon, the Earth's natural satellite, and to discuss the possibility of the existence of microscopic life because there is a large amount of water on these moons.

In the fifth class, the students were invited, in groups, to synthesize their learning in the form of a dissertation about the application of the didactic sequence and to answer the initial problematizing question: "Is there life out there"? The student's notebook, his elaborations as well as the answers of some students are presented in the attachments.

Development

Within the curricular component Astronomy for Elementary School, Astrobiology is a transversal theme that covers several disciplines, helping the constitution of an interdisciplinary environment and coming from meeting fundamental questions formulated by humanity: Is there life in other parts of the universe? What is the future of life on Earth and beyond? What is life? These are central questions of Astrobiology, but they are not recent, being present throughout the evolution of humanity.

Although Astrobiology is an emerging and developing field, the question of life elsewhere in the Universe is a verifiable hypothesis, and is therefore amenable to scientific investigation, that is: there is a problem to be solved, and by extension, one of the objectives of this work is that students in possession of materials and scientific parameters can elaborate hypotheses and work to solve the problem of whether there is life outside the Earth. Astrobiology addresses three basic questions: How life begins and evolves; life exists elsewhere in the universe and what is the future of life on Earth and beyond? (DES MARAIS, et al. 2008) [6].

Given that Astrobiology is the study of life in the universe it, by principles, two objects, the Universe and Life broad enough to define a transdisciplinary space within which it operates.

Thus, Astrobiology already promotes in a natural way the integration of fields of knowledge, such as Physics, Chemistry, Biology, Astronomy, Geology, History and Philosophy. More specifically, it improves the educational foundation in STEAM, favoring navigation in a world increasingly immersed in science and technology.

Finally, it is an aid to guide ethical attitudes taking into account scientific knowledge. In contrast to interdisciplinary research, which involves its object before various points of view, the transdisciplinary approach allows the expansion of its object into an enveloping space, in such a way that there is an interdisciplinary object and a transdisciplinary space.

The transdisciplinary space adds a third dimension to the domain, where multidisciplinarity and interdisciplinarity operate.

Astrobiology has its transdisciplinary aspect attended by the fact that it includes the biological dimension to astronomical studies. The question "What is life?" allows areas apparently not contiguous to Astrobiology to penetrate its transdisciplinary space. Such is the case, for example, of psychology, when one investigates subjectivity in the recognition of alien life (FRIAÇA, 2010) [7].

Astrochemistry is a multidisciplinary field of astronomy that studies the evolution of the molecular content of the Universe from the abundances of chemical elements, their reactions, mechanisms of formation of molecules and their interaction with radiation. Within this context, it also studies the origin and formation of molecules in the interstellar medium, prebiotic molecules (amino acids, for example) as the basis of the origin of life on Earth. Isolated atoms such as H, hydrogen, C, carbon, and molecular species such as H2, CO and H2O are studied.

Thanks to the resources of radio astronomy, infrared astronomy and, more recently, millimeter and submillimeter astronomy, our knowledge of the molecular species of the Universe has undergone a revolution. They are present in Solar System bodies, exoplanets, stars, star-forming regions, and the interstellar medium of both our galaxy and other galaxies. To get a more accurate idea of the molecular content of the Universe, one needs to refer to the question of the origin of the chemical elements. The formation of the chemical elements involves three major classes of processes: primordial nucleosynthesis, stellar nucleosynthesis, and interstellar nucleosynthesis.

The didactic sequence, henceforth called SD, in a simple and direct way is a way for the teacher to organize teaching activities according to thematic, conceptual and procedural nuclei. For Dolz, Noverraz and Scheneuwly (p. 97, 2004) [8] the "didactic sequence is a set of school activities organized, in a systematic way, around an oral or written textual genre."

For this, the basic structure of a sequence, according to the authors, contains an opening section, with the presentation of the study situation in which the task of oral or written exposition that the students must perform is described in detail. According to these authors, there should be an initial or diagnostic production, from which the teacher evaluates the skills already acquired and adjusts the activities and exercises foreseen in the sequence to the possibilities and real difficulties of a class.

After this stage, the work focuses on the modules (also called workshops by other authors who follow these same principles) consisting of various systematic and progressive activities or exercises that allow students to apprehend the thematic, stylistic and compositional characteristics of the target genre of study. The didactic sequence is a method for the development of teaching activities and, depending on how it is organized, can thus contribute to learning, whether in elementary school or at any level.

According to Zabala:

The way the sequences of activities are configured is what will determine the "differential characteristics" of the teacher's practice. According to the author, if we analyze the sequences trying to find the elements that constitute them, we will see that "they are a set of orderly, structured and articulated activities for the achievement of certain educational objectives, which have a beginning and an end known to both teachers and students (ZABALA, 1998, p.18) [9].

Particularly, in the didactic sequence to be applied in science teaching, the teacher plays a fundamental role in the elaboration of teaching activities, because it is through this mediation instrument that the student will establish a relationship between the phenomena and the processes of the sciences.

For this, it is necessary to adopt a problematizing perspective for teaching and learning, in such a way that an authentic dialogue is built in the classroom. In this sense, the teacher is the agent that establishes the dialogue between the scientific concepts in his students, and consequently can promote their active participation in the process of appropriation of knowledge mediated by sociocultural interactions.

In this context, we aim to present a process of Elaboration, Application and Reelaboration (EAR) of Didactic Sequences (SD). This process is consolidated through systematized analyses and consecutive evaluations of each of its phases.

As a consequence, DS are validated in a process that promotes the professional development of the teacher, since the definition of contents, identification of teaching conditions and the selection of dynamics and methodologies materialize according to a teaching object. The product of this professional performance of the teacher is the mediating instrument (a SD in this case) of the teaching-learning process that one wishes to consolidate.

It is considered that didactic sequences are also instruments that trigger the actions and operations of teaching practice in the classroom. Consequently, the structure and dynamics of DS are determinants of the planning of activities through which students will interact with each other and with the elements of culture.

In the elaboration or planning of a DS, several mediated actions are structured, each through specific cultural tools. In this perspective, the focus of the teacher's attention when elaborating the DS needs to be in the process and not in the product of learning.

The EAR process consists of a method of elaboration and validation of didactic sequences according to systematized analysis and consecutive evaluations of each of the elements that constitute the DS, its context of application, its results and its relationship with the school's teaching plan.

It is structured according to a sociocultural approach (VYGOTSKY, 2008) [10], from the perspective of the third generation of activity theory.

The process begins with the elaboration phase, which consists of planning and organizing the SD according to the elements: title; target audience; problematization; general objective; specific objectives; Content; dynamics; References; bibliography used.

In the EAR process, the elaboration of DS needs to be conducted according to a theoretical foundation that guides the action of the teacher and his action strategies. In this sociocultural approach

(GIORDAN AND GUIMARÃES, 2012) [11] the student assimilates knowledge according to his social interaction and with the elements of culture, mediated by cultural tools.

In the application of DS, this in the EAR process is composed of four phases, being three specific validation stages and one stage in which the SD is developed in the classroom. The latter constitutes the experimentation of the validation process. In each of the stages, DS can and should be reviewed by the teacher as a way of validating itself.

In the reelaboration, the teacher, in possession of the previous information, can confront his perceptions and objectives regarding the elaboration of the DS, the analysis and the data of the experimentation. The confrontation of the results represents the closure of the cyclical validation process. It is the space of the teacher, armed with experiences and information, can improve the SD and its teaching action.

Another relevant factor in the application of DS is the construction of indicators of scientific literacy that comes in the midst of the dialogues with the cultural tools developed during the process of application of DS. Thus, the application of DS is still a permanent research forum and its use in the classroom enriches the praxis of the teacher, as well as makes teaching-learning extremely interesting, being able to build elements that indicate the empowerment of these students in relation to knowledge, as well as to be situated at the frontier of society, where technology induces to increasingly constant questioning, motivating the student to start and become literate in a scientific way, in order to have the understanding of the modern issues proposed.

Considering the classroom as a social organism with its own culture and identity, where actions are carried out between people with different worldviews, the theory of mediated action comes to be a structuring axis so that the teacher can organize and plan his classes, as well as the continuity of these organizing units in the space-time of the classroom and with regard to the theoretical construction and coherence between the various units of planning Curriculum.

Thus, the topological model of teaching proposes the activity, the concept and the theme as three organizing axes of the classroom. Since the topological model of teaching is based on the theory of mediated action, it is necessary to consider that in the organization of teaching some properties of mediated action must be observed, among which stand out situationality, historicity, materiality and mediation.

An example of a combination of narrative "voices" occurs in the passage between the demarcation of an experimental problem by the teacher, through his speech, and the realization of the experiment, which is conducted by a written script.

In the delimitation of the problem, the teacher conducts the activity and the students follow in their mental plane their propositions. Already in the realization of the essay, the students read the script and come across the laboratory materials. It is desirable that, in possession of the written script, students establish reference relations between the teacher's previous speech, when demarcating the problem, and the stages of the experiment, and even more, when the experiment is carried out, this movement of reference skill is maintained even with other narrative voices, for example, the textbook.

The narrative within the classroom in the question about the resolution of a problem is given by a sequence of dialogues between the students and the teacher, which has peculiar characteristics in relation to the interventions of the agents in the classroom. One can classify this dialogue according to the narrative of the classroom in which the progress of a teaching-learning relationship is configured, in such a way that when there is intense speech between students and teacher, it is said that the situation is interactive. When only the teacher speaks, for example, in an expository sequence of activities, it is said that the situation is of the non-interactive type.

Another example of a combination of narrative voices can be observed, for example, when the teacher and student jointly interpret a temperature graph as a function of the time present in a textbook.

Therefore, the narrative of the teaching sequence is formed by the temporal arrangement of various means of representation and dissemination of ideas, each with its singularities and functions in the process of construction of meanings. If learning science concerns the appropriation of these cultural tools to solve problems or to dialogue with a community that interprets the world through these tools, then the organization of activities to teach science depends on the interaction and dialogues between teachers and students.

Within the interactive and discussional process of the activities developed in the classroom, there is, at some point, the materiality of this mediated action, initially by the verbalization of the word spoken by the mediator, which is a cultural tool, or other cultural tools that can be used as meters, textbook, etc.

In this work, we tried to execute and understand a diagnostic questionnaire of the students of the eighth grade of elementary school, cycle 2, of a municipal school in the east of São Paulo, the Municipal School of Elementary Education João Guimarães Rosa, about Astrobiology, seeking to know, from the spontaneous and alternative conceptions of the students and their knowledge and knowledge about the existence or not of life within a cosmic context, and work them towards a procedural dynamic of scientific literacy to a refinement of the understanding of extraterrestrial life, as well as its origin and evolution.

The student's notebook uses a questionnaire composed of objective, discursive and drawing questions as a methodology to evaluate their conceptions about knowledge of Astronomy, Biology, Chemistry.

Most students have knowledge of Astronomy due to the curriculum, and the conceptions about Astrobiology in Elementary School come from the media and science fiction.

In this sense, measuring the spontaneous conceptions of students and referring them to a treatment of nature of scientific vision, scientific literacy, is part of this work that aims at a transformative modeling of reality in such a way that the student

can appropriate this tool and use it in their analyses resulting from their insertion as a citizen participant in a society that evolves and that is always at a level of technological advancement.

This process of scientific literacy will be based on a didactic sequence, previously prepared, together with the science teacher who will make the classes available for the application of the project and the didactic sequence, making the articulation of knowledge and pedagogical actions evident together with the students, leading them to a reflection on Astronomy, Sciences and, More than that, to an appropriation of the tools used in sciences, such as graphs, tables, expressions of proportion and magnitudes, leading them to the path of scientific literacy and their empowerment, in which the knowable object becomes a present action transforming reality.

Within the context of scientific literacy that can occur in different ways and, certainly, the way it occurs is linked to the conditions made available and the specificities of what is investigated, it is possible to say that all scientific research involves a problem, the work with data, information and knowledge already existing, the survey and testing of hypotheses, the recognition of variables and their control, the establishment of relationships between information and the construction of an explanation.

Thus, in the classroom, in order to scientifically literate students, we must be aware of skills that can be grouped into three blocks. This set was called Structuring Axes of Scientific Literacy, because these three axes are able to provide sufficient and necessary bases to be considered at the time of elaboration and planning of proposals for classes aimed at scientific literacy Starting from a survey in the literature, Sasseron and Carvalho (2008) [12], group the skills classified as necessary for the scientifically literate, and present the structuring axes of scientific literacy.

The first is configured in the "basic understanding of fundamental scientific terms, knowledge and concepts"; the second refers to the "understanding of the nature of the sciences and the ethical and political factors that surround their practice"; and the third "comprises the understanding of the existing relations between Sciences, Technology, Society and Environment".

In order to analyze, in different situations, how these skills are being worked on in science classes since the first grades of elementary school, the authors propose indicators of the process of development of Scientific Literacy: the serialization of information serves to establish the basis for investigation. The organization of information organizes the data related to the problem investigated.

The classification of information sorts the data according to their characteristics. Logical reasoning is the exposition of thought according to how ideas develop. Proportional reasoning extrapolates the demonstration of the structure of thought encompassing the relations of interdependence between variables.

The survey of hypotheses points to assumptions about a problematizing factor. Hypothesis testing refers to the steps in which assumptions are proved.

The justification is presented in the guarantee of a statement made. Prediction indicates the succession of an action or phenomenon associated with an event. The explanation deals with the relationship between information and hypotheses raised.

At the beginning of the application of SD the student is asked about his previous knowledge of Astronomy and Astrobiology.

Table 1 below quantifies this knowledge relationship, as well as relates it to the indicators of scientific literacy, which are in process during the application of the activity.

Table 1: Indicators of previous knowledge.

Issues	Answers: Students 8th A	Scientific Literacy Indicators observed
Have you heard of Astrobiology?	No: 14 Yes: 03	Explanation, hypotheses and justifications.
If so, where?	School: 01 Internet: TV: 02	Explanation, hypotheses and justifications.
Why do you think there is life on one planet and not on another?	04 Did not respond 12 Because there is water and oxygen 01 It has oxygen 02 Good temperatures	Explanation, hypotheses and justifications.
Regarding the Figures in the student's notebook: solar system with the planets, galaxy and life:	06 Did not respond 13 recognized the figures.	Classification and serialization of information.
Regarding the central theme of Guilherme Arantes' song "Planeta água":	05 did not respond 14 recognized water as the main theme of the song	Classification and organization of information.
With respect to the most abundant chemical element in the universe.	07 responded hydrogen 02 responded oxygen 10 did not respond	Classification and organization of information.

If there are living things on other planets, what do you imagine they would look like? Use the space below to draw them.	14 answered anthropomorphic images 05 did not respond	Logical reasoning.
In your opinion, what elements would these beings use for their survival?	01: Technology 13: water, food and oxygen. 05: Did not answer	Logical reasoning.

Source: elaboration of the authors.

Construction of spectroscopes in the classroom: In this activity, the students organized themselves into groups.

In possession of black cardboard, scissors, crepe tape, adhesive tape and old CDs, they produced, according to the drawing of the students' notebook, a spectroscope. This, when facing the continuous spectrum lamp, projected several colors on the inside of the straw.

This result provided the understanding of the students in the sense of making an analogy with the spectral line that each chemical element has and, mainly, to make the correlation with the spectral line of the chemical element hydrogen, the most abundant in the universe, which would denote regions of water and the possibility of the existence of some kind of life.

Next, the students answered the questionnaire in the student's notebook. Table 2, Spectroscopes and indicators, can be observed, where the students' answers can be observed:

Table 2: Spectroscopes and indicators.

Issues	Answers: Students 8th A	Scientific Literacy Indicators observed
What instrument does the astronomer use to check the spectrum of chemical elements?	14 answered spectroscope 05 did not respond	Organization of information and serialization
In your opinion does each chemical element have a spectrum?	14 answered yes 05 did not answer	Serialization and organization of information
Is the spectroscope an instrument used by the astronomer?	14 answered yes 05 did not answer	Serialization and organization of information

Source: elaboration of the authors.

Research in the computer room: Research topic: spectrum of chemical elements and potentially habitable zones and their characteristics.

Next, the students looked at figures of potentially habitable zones on Google, relating them to the spectroscope and its usefulness.

A dynamic was carried out among the students, divided into groups, after observing the websites on the Internet, to socialize with the other colleagues what they found most important in their observations.

Consensus of all groups on the question: What are the main working instruments of the astronomer?

All groups answered (attachments): telescopes and the spectroscope Indicators of Scientific Literacy (IAC) organization and serialization of information.

Potentially habitable zones. In this activity, the students received the student's notebook and began to answer questions about potentially habitable zones, interpreting the figures of the Solar System and comparing it to the habitable zone of Gliese 581, followed by a media text about the discovery of a new system with seven planets about the size of Earth, about 40 light-years away, and orbiting a red dwarf star.

Table 3, Indicators and habitability zone is then observed, where it is observed about the questions asked and the answers of the students and the indicators of scientific literacy that can be observed according to the quantification of answers:

Table 3: Indicators and habitability zone

Issues	Answers: Students 8th A	Scientific Literacy Indicators observed
Locate Earth and the largest planet, the solar system	-14 Located Earth and Jupiter 05 did not respond	Serialization of information;
With respect to Figure 2, look at Earth-like exoplanets and see their location relative to the distance from their Sun.	-13 Found the blue band as potential/ habitable 06 did not respond	Organization of information.

Review the 2 Figures as well as the NASA report and explain why life can develop in a potentially habitable region.	05 did not respond 11responded to water and favorable climate 03 responded due to the heat	Prediction and explanation.
Look at Figure 3 (Europa, Jupiter's moon) and answer: how could you explain the emergence of life on this moon?	04did not respond 15accounted for the amount of water	Explanation and justification.
See Figure 4 (Saturn's moon Titan) Answer: Is there a possibility of evolution of life on this moon?	01maybe 04did not respond 10answered yes 04answered no	Explanation and justification.
Name differences between these moons and our planet's Moon	16 Our Moon Has No Water 03 did not respond	Serialization and organization of information.
In Figure 3 and 4, can it be said that they are potentially habitable for life?	13 answered yes 01 answered no 01 answered maybe 04 did not respond	Logical reasoning, explanation and prediction

Source: elaboration of the authors.

Synthesizing the activity: In this final activity, according to Table 4, the students socialize among themselves the discussion of the final text and each one writes what they understood from the applied activity. With "A" standing for student, where the answers to the final question of the text were numbered from one to nineteen, involving and referencing the central problematizing question "Is there life out there?".

Table 4: Indicators and problematizing question.

Issues	Answers: Students 8th A	Scientific Literacy Indicators observed
A1	There are indeed lives on other planets, but not developed.	Forecast and explanation
A2	I learned that there can be life outside of Earth etc.	No IAC index
A3	Where there is water, we can survive.	No IAC index
A4	I learned that there may be life on other planets, but microscopic.	Forecast and explanation
A5	Loved where there is water, we can survive.	No IAC
A6	There is life on other planets because of water oxygen. 10 did not respond.	Prediction, explanation and justification
A7	There is life on other planets because there is water, but not developed.	Prediction and explanation.
A8	I understood that astronomers use various machines to discover life outside of Earth.	Logical reasoning, explanation and prediction
A9	Life is on the planets.	No IAC index
A10	Perhaps, because there is no proof that there is a condition of life, there is no possibility of having life in a place that has a very high or low temperature, because it is a matter of having patience for scientists to research.	Explanation and justification
A11	I think it is possible to have microbial life mainly can be forming in water, as our evolution, I learned that it is possible that there is life on another planet if the temperature is favorable, and what scientists discover the planets with the spectroscopes, because with them can detect and presence of hydrogen.	Prediction, explanation and justification.
A12 to A19	They didn't answer.	No IAC.

Source: elaboration of the authors.

Within the context of the activity, since its inception, I observed that the students answered in the student's notebook the questions formulated within a bias of construction of their meanings about the problem raised-"is there life out there?"-in which the construction of knowledge was gradually taking place, revealing, in the process, the indicators of scientific literacy listed in the tables above. In this sense, the activity was developed in the classroom in a discussional environment, where the mediation was in charge of the teacher who applied the activity. Particularly, in the second class was applied the rewriting of the student's notebook, in which

they went to the computer room and made the spectroscopes, as well as observed the potentially habitable zones in figures and sites of exoplanets.

This activity proved to be fundamental for the basis of solving the problem in which most of the students participated in its elaboration and answered the question of how the astronomer works to discover chemical elements on other planets. The students' initial hypotheses, element of IAC, about probable extraterrestrial inhabitants, with their drawings representing anthropomorphic forms, were replaced by their understandings that there may be microscopic life on exoplanets due to the question of the existence of water, as well as their understanding that the chemical element hydrogen is the most abundant in the universe. Table 5, configured below, systematizes the temporal evolution of the indicators worked in the classroom.

Table 5: Time evolution of the indicators.

IAC	Lesson 1	Lesson 2	Classroom 3	Lesson 4	Classroom 5
Organization	X	X	X	X	X
Serialization	X	X	X	X	X
Chance	X	X	X	X	X
Hypothesis Testing	0	X	X	0	0
Logical Reasoning	X	X	X	X	X
Proportional Reasoning	0	X	X	X	X
Justification	0	0	0	X	X
Forecast	X	X	X	X	X

Source: elaboration of the authors.

Final Considerations

It was planned and applied in a school, where together with the science teacher Maria Helena Pereira, who made her classes available and collaborated in the proposed activities of the student's notebook. After the application of the activities of the student's notebook and in the process of reflection and reelaboration of the activities, it was remodeled to a final version due to the progress and dynamics of the classroom. This new notebook is located in the annexes.

In this sense, as a qualitative result of the application of the didactic sequence there is the student's notebook, final version, as well as enables the product so that the teacher, at some point, can apply or even reelaborate it.

The application of this didactic sequence at the educational institution led us to realize that elementary school students were involved with the proposed investigations and discussions. The arguments established during the classroom activities proved to be quite satisfactory, since they were not restricted only to simple statements, but often appeared linked to logically constructed justifications and judgments. Making a temporal analysis of the evolution of student learning during the application of the activities, gathered in five classes, it was observed within the scope of categories of indicators of scientific literacy, a gradual evolution on the part of the students in relation to a better understanding of the content and the proposal taught by the student's notebook.

It is worth noting that the discussions led the students to use the skills of "scientific doing", which here is called IAC. This fact demonstrates that the students participating in these discussions are in the process of becoming scientifically literate and, therefore, the classes analyzed here were able to insert them into discussions specific to the sciences. Another observation that deserves to be highlighted in our work is the fact that the proposed activities raised discussions in which it was possible for the students to build relationships between the knowledge of the sciences in the computer room, the construction of the spectroscope, the technologies associated with this knowledge and the consequences of these for society and the environment.

The analysis of the conceptions about the students involved in the development of a proposal for the organization of the student's notebook for the classes of Astrobiology for Elementary School 2, revealed, in the dialectical relationship and based on the dialogue between the subjects, the movement and the transformations of the individual and collective conceptions. The structure on specific and fragmented content, the teaching of this area, from the perspective of STEAM, began to be considered and understood by the integration between the disciplines so that, through more active practices, it aims at the integral formation of the student.

Through the analysis of the results, it was noticed the great repertoire of indicators of scientific literacy that was used by the students. In the first class of the didactic sequence, it was noted the formulation of hypotheses by all students, without exception, when they drew anthropomorphic forms of possible inhabitants of other planets.

In the course of the activities and with the closing of the classes, the majority, using the prediction and the justification, already placed as inhabitants of another planet those of microscopic category due to the question of the existence of water for their habitability. This is an important fact, because it deconstructs the idea of beings similar to humans, so made possible by the media and media. That is: from the point of view of doing science and trying to understand the world of science, most students came to this conclusion as a result of the discussions and technological contributions made possible during the activities.

During the application of the activity, it was seen the use of organization and grading by students as an important cultural tool for data collection to solve the problem. In this sense, the application of the didactic sequence, materialized in the student's notebook and the support to the teacher, constitutes an important cultural tool of teaching-learning with regard to the students, and a reflection on the pedagogical activity of the teacher, in which he can, in the application of the activity, make a reflection on the performance of his school practice.

Particularly, this practice of discovering lives outside our solar system engenders a technological discussion, in which students engage in the cultural and technological issues of advances in society, allowing them a scientific literacy in the sense of following the news of the communication media and detecting their errors and inaccuracies. This character of the activity reinforces what the National Curricular Parameters imply about the formation of the student inserted in a technological society.

The didactic sequence now applied with the students was substantiated in an appropriation of the cultural tools presented, thus contributing to the understanding of the proposal and the set of activities. The present activity can be applied in Elementary School 2, in High School and also in undergraduate courses of Biological Sciences, Sciences or Physics, Geology or Chemistry, respecting the contents at each level of education, however, maintaining interdisciplinarity in its approach in line with technological advances and their applications and implications to society.

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Conflicts of Interest

No conflict of interest.

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