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EXPLORING POSSIBILITIES IN STELLARIUM FOR ASTRONOMY EDUCATION IN THE EARLY YEARS OF ELEMENTARY SCHOOL

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ABSTRACT

Astronomy is considered one of the oldest sciences of humanity. His themes have always fascinated human beings. In this concept, the present work proposes to analyze the possibilities of using a Learning Object, the Stellarium software, in the classroom in the early years of Elementary School. The study is part of the qualitative research and, to examine the Learning Object, descriptive analysis will be used, as it is the one that best suits the purpose of this work. The theoretical bases are based on Meaningful Learning, which values previous knowledge, considered as the foundation for new knowledge. In this context, since the Learning Objects can help the teacher in his practice, Stellarium stands out as a potential to provide opportunities for learning this science, as well as bringing technologies closer to the classroom. The results obtained demonstrate that this software can be used to work with Astronomy in the different years of Elementary School, in line with what the BNCC proposes, with a strong aspect for innovation. The didactic sequences proposed in this work aim to stimulate the insertion of technologies in the teaching-learning process.

Keywords: Astronomy. Stellarium. Learning Object. Elementary School.

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INTRODUCTION

Throughout history, human beings have raised several questions when looking at the sky. Some of them boosted and served to further increase his curiosity, as well as to give him the opportunity to understand many phenomena, among which the phases of the Moon, the apparent movement of the Sun, the formation of the tides and many others can be highlighted.

For Ridpath (2007, p. 16), "since the dawn of civilization, man has struggled to understand the complex movements of celestial bodies, and countless ancient monuments and artifacts reflect his fascination". The desire to understand these phenomena gave rise to Astronomy, which is considered, according to Longhini and Mora (2010, p. 87), "one of the oldest sciences, perhaps because its object of study - the sky - has been part of human life since its beginnings". This intense relationship with Astronomy is old, and Caniato (2010, p. 13) points out that:

> Our relations with the stars began long before we realized it. Long before the first forms of life. In addition to the constituent elements of the Earth, its temperature, determined mainly by the distance from the Sun, the inclination of its axis and its rotation, were conditioning factors of the forms of life that developed. Even the Moon played an important role in this process.

The relevance of this science for the human being and its influence on different discoveries to which it contributed a lot, such as the knowledge of the heavens, which was so important in the process of navigation, is great.

However, even with great relevance in the area of Education, the teaching and learning of Astronomy continue to need attention, since the insertion of the theme in Basic Education is still far from ideal, for several reasons, as highlighted by Pinto, Silva & Silva (2018). Barrio (2003) points out that teachers who teach Astronomy do not always have training in the area, a fact that is confirmed by Leite (2006, p. 11):

> Most of the teachers we surveyed felt insecure to work on this topic in the classroom, not only because of the students' high expectations, but also because of the little or no academic training of these teachers in content in this area.

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This lack of training to work with Astronomy is even more serious in the first stage of Elementary School, since the teachers who work with children from the 1st to the 5th grade are trained in Pedagogy, and most of the time they do not have any training in that area. This fact was demonstrated by Bretones (2006), who highlighted that there were few courses that offered disciplines in the area of Astronomy in the initial training of teachers. In this perspective, several questions emerge, such as: What materials can be used to help the teacher to insert Astronomy in the classroom in the early years of Elementary School? Can technologies help in this work? What technologies can be used?

In this context, the work with the *Stellarium*, a Learning Object (LO), can help the teacher in his practice in the classroom. The use of technologies becomes increasingly necessary, since their different forms are increasingly popularized and their insertion in the classroom presents positive results, as pointed out by Freitas *Et. Al* (2021), which highlight that this LO acts as a facilitator for learning.

WHAT IS THE IMPORTANCE OF ASTRONOMY IN THE EARLY YEARS OF ELEMENTARY SCHOOL?

Astronomy is considered one of the oldest sciences and the contemplation of the stars and the sky and the phenomena observed have always fascinated human beings. This work aims to analyze the possibilities of using *Stellarium software* in the classroom in the early years of Elementary School.

Astronomy began to be strongly suggested in the National Common Curriculum Base (BNCC) (BRASIL, 2017), which guides Brazilian Basic Education. Chart 1 presents the synthesis of the first five years of Elementary School with regard to their recommendation for the discipline of Science. In the first column appears the year proposed for the theme; in the second, the Thematic Unit \u2012 title for the subdivision of the proposed contents \u2012; and the third column brings the contents, called Objects of Knowledge.

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Table 1: Astronomy for the early years

Year	Thematic Unit	Objects of Knowledge
First	Earth and Universe	Time scales
Second	Earth and Universe	Apparent movement of the Sun in the sky The Sun as a source of light and heat
Third	Earth and Universe	Earth Characteristics Sky Watching Land uses
Room	Earth and Universe	Cardinal points Calendars, cyclical phenomena and culture
Fifth	Earth and Universe	Constellations and Sky Maps Earth's rotational motion Periodicity of the phases of the Moon Optical Instruments

Source: Brazil (2017) - adapted

With the investigation of this *software*, it is expected to offer facilitating aspects to teachers, so that they can, based on the results of the research, optimize their planning, since the exploration of this LO seeks to help the teacher in the teaching-learning process of Astronomy, in the insertion of this important theme in the classroom.

LITERATURE REVIEW

THE INSERTION OF LEARNING OBJECTS IN THE CLASSROOM

The use of different LOs for the teaching of different themes has been increasingly common. However, this use and its insertion in the classroom still lack significant commitment. Two important issues that need to be rethought stand out here: teacher training and the availability of these LOs for all schools.

SO is defined in a larger group, called Digital Information and Communication Technologies (DICT). They have entered the different spaces with increasing intensity, however, the appropriation of the real meanings of this for teaching still seems to be a little far from what was expected, as Leão and Teixeira (2020, p. 128) underline:

> if the studies related to the uses of DICTs point to barriers to the development of the great technological potential, inside and outside schools, especially with regard to teacher training, inequalities in access to technologies between populations of different contexts, the same faces education in Astronomy, which needs continuing education for educators and minimal investment in infrastructure in educational spaces.

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It is observed the need to break down barriers and understand that the use of different technologies can be a facilitating agent of the learning process, and more, that these technologies are allies of the teacher who develops different themes. In this context, if the teacher has a certain LO and is able to explore it, the resource can be a great ally in promoting true learning, so that it is truly meaningful.

One of the OA for working with Astronomy in the classroom is *Stellarium*, a *software* that reproduces, using technology, the sky and the movement of the stars, through basic concepts, such as cardinal points, and more advanced ones, such as the recognition of constellations. Freitas *et al.* (2021, p. 9) highlight that:

> considering that many schools do not have the resources and space to carry out Astronomy classes, with the possibility of light pollution in some cities, the use of Virtual Learning Objects (OVA) is considered an excellent alternative in the teaching and learning process. Thus, a study was carried out on the potential of the Stellarium virtual observatory in formal education, in which works on the subject were found.

It is observed that technologies can, if well used and with the knowledge of those who will use them, help to reproduce the real world in the classroom, as this *software* does. Santos *et al.* (2019, p. 8-9) reinforce the aspect of the importance of technologies in the classroom for the work of different themes, and emphasize that:

> The use of technologies incorporated into the pedagogical process in a pertinent way can favor the teaching and learning processes, since the use of these (technological) contributions in the educational process sensitizes students and teachers to new subjects, promotes the search for new information, reduces routines, brings the student closer to different realities of the world, increases interaction and the development of critical thinking, fostering the construction of knowledge. Therefore, incorporating technologies into pedagogical practice can make a difference.

This perception demonstrates the importance and need to bring the real world closer to the technological world and to make sure that the walls that still exist between them can be overcome – so that technology is seen as an ally and not an enemy – as well as to make

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an important investment to equip schools with more up-to-date machinery and with fast and quality internet access.

The 2020 ICT Education survey (JULIÃO, 2021) points to complex data for Brazil: 18% of Brazilian schools, public and private, still do not have an internet connection, and when it comes to schools farther from large centers, such as rural ones, this rate reaches 48%. However, even with a coverage of 82%, only 40% have access by fiber optics, that is, the quality of service is still a problem, among many others. These data make up the survey carried out by the Cetic.br and NIC.br.

Based on the data presented above and the relevance of the insertion of technologies in Education, we understand that they can be facilitating agents for the teaching of different themes and can certainly help in the learning of Astronomy in the early years of Elementary School.

THE INSERTION OF ASTRONOMY IN THE EARLY YEARS OF ELEMENTARY SCHOOL: CHALLENGES

In addition to the aspects related as complicating factors to insert DICT in the classroom, there are almost historical obstacles to inserting Astronomy in teacher training, as already pointed out by Bretones (2006), who highlights how scarce initial training courses that offered mandatory Astronomy subjects were at the time he carried out his work. In his research, he observed that, of the Physics courses responsible for this training, only seven had mandatory Astronomy subjects.

If in the training of Physics teachers there are few related disciplines, in the training of teachers in the early years, which is in Pedagogy, these disciplines may appear as optional, and not mandatory (ALBRECHT, 2012). As there are no options, teachers need to seek continuing education to understand Astronomy a little.

Pinto, Silva & Silva (2018, p. 73) highlighted in their research with teachers in the early years that they "reveal that they feel difficulties in some content or to answer students' questions about astronomy". In many cases, the only material available to the teacher is the textbook, and then he is often faced with another problem, which is conceptual errors, as pointed out by Langhi and Nardi (2007). These errors happen in illustrations, scales, and terminologies.

In line with what was observed by Pinto, Silva & Silva (2018), Leite (2006, p. 11) had already pointed out years earlier, after a survey of teachers, that "most of the teachers we

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surveyed felt insecure to work on this topic in the classroom, not only because of the great expectations of the students, but also because of the little or no academic training of these teachers in content in this area."

In this context, it is observed that there are still many challenges for the insertion of Astronomy in teacher training and work with technologies. *Stellarium* can be an important LO, since it can bring technologies closer to the teacher and assist teaching practice.

THE CONSTRUCTION OF THE BNCC AND THE PATH TO THE CONSTRUCTION OF THE CURRICULUM

For Astronomy to be present in the documents that guide Basic Education, such as the BNCC (BRASIL, 2017), a long way has been traveled. In this context, it is necessary to understand what the curriculum is. It is closely linked to the processes associated with Education and the classroom. The first ideas point to the curriculum as an instrument of domination, linked to political issues, since it is thought of in a vertical and imposing way. Libâneo (2006, p. 75) justifies that:

> Education and teaching continue to lend themselves much more to clientelism, to the exchange of electoral favors, to the game of interests than to effective social and cultural development. At the same time, an elitist educational culture predominates in the political-party environment, with minimal interest in popular public education and with almost total ignorance of the properly operational issues of teaching, such as curricula, teaching methodologies, the effectiveness of learning, the evaluation of processes and results.

Over time, the curriculum becomes the target of important studies and several changes occur, and new conceptions of curriculum are constructed, such as those highlighted by Silva (1998, p. 200-201):

> The curriculum is one of the privileged places where knowledge and power, representation and domination, discourse and regulation intersect. It is also in the curriculum that power relations that are crucial for the process of formation of social subjectivities are condensed. In short, curriculum, power, and social identities are mutually implicated. The curriculum embodies social relations.

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It is perceived that the curriculum is also understood as an instrument to establish and build different relationships, both in society and in the school. Silva (1998, p. 184) points out that it goes beyond the conception of a list of contents or prescriptive document, it goes beyond the limits of the school, because "the curriculum constitutes the core of the institutionalized process of education. The intimate and close link between education and social identity, between schooling and subjectivity, is ensured precisely by the cognitive and affective experiences embodied in the curriculum."

We can highlight that throughout history, curriculum ideas have not always considered those who were actually in the classroom. Goodson (2007, p. 242) highlights the established models of power relations that sustain the curricular prescriptions when he says that "perhaps the most relevant thing is that the people intimately linked to the daily social construction of the curriculum and schooling, the teachers, are therefore effectively excluded from the discourse of schooling".

This aspect directly affects the full development of citizenship and suggests the need to rethink the ideas of curriculum, which for a long time was understood only as a "recipe" of content. For Goodson (2007, p. 242):

> More than writing new prescriptions for schools, a new curriculum, or new guidelines for reforms, they need to question the true validity of predetermined prescriptions in a changing world. In short, we need to shift from a prescriptive curriculum to a curriculum as a narrative identity; from a prescribed cognitive learning to a narrative learning of life management.

This would be, initially, the perspective to rethink and build a common base of contents, to provide the opportunity for the most distant places in Brazil to have a single basic structure, but also a varied part, so that the cultural diversity present in this country of continental dimensions would be respected.

However, structuring a common basis in the perspectives of what is defended by Goodson (2007) would be to go beyond the aspects of bureaucracy, it would be to structure clear, objective proposals – beyond a content-based education – that would value the subjects of interest to the student, in this case, the contents of Astronomy. A prescriptive curriculum, which deals only with content and concepts, is outdated and needs to be adapted to the needs of a flexible and constantly changing world.

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In view of the above, the idea of building the BNCC (BRASIL, 2017) initially tried, through public consultations, to value the knowledge and propositions of teachers from various Brazilian states. And Astronomy became part of this document prepared for the different years of Elementary School. However, it seems that teacher training has not followed this insertion, even though the theme arouses interest in students and can promote Meaningful Learning, in line with what the literature recommends.

MEANINGFUL LEARNING FOR THE TEACHING OF ASTRONOMY

Meaningful Learning is presented by David P. Ausubel and its insertion begins to be proposed in 1963. It is a cognitivist theory, which values the previous knowledge of the student or learner and defines it as subsumers, in which new concepts are structured. Ausubel (2003, p. VI, emphasis in the original) points out that:

> Knowledge is meaningful by definition. It is the significant product of a cognitive psychological process ("knowing") that involves the interaction between "logically" (culturally) meaningful ideas, previous ("anchored") ideas relevant to the learner's particular cognitive structure (or knowledge structure) and the learner's mental "mechanism" for learning meaningfully or for acquiring and retaining knowledge.

In the words of Moreira (1999, p. 11):

> Meaningful learning occurs when new information is anchored in specifically relevant knowledge (subsumers) preexisting in the cognitive structure. That is, new ideas, concepts, propositions can be learned significantly (and retained) to the extent that other relevant and inclusive ideas, concepts, propositions are adequately clear and available in the individual's cognitive structure and thus function as an anchorage for the former.

In this context, Astronomy has great significant potential, in the words of Aususbel (2003, p. 79) it is "potentially significant". This aspect can be explained by the fact that it itself arouses the curiosity of students, and that historically it has contributed to different technological advances. However, for the processes of assimilation of Meaningful Learning to occur, it is necessary, according to Ausubel (2003, p. 8), that there is:

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> (1) selective anchoring of the learning material to the relevant ideas existing in the cognitive structure; (2) interaction between the newly introduced ideas and the existing relevant (anchored) ideas, the meaning of the former emerging as the product of this interaction; and (3) the connection of the new emerging meanings with the corresponding anchored ideas in the memory interval (retention).

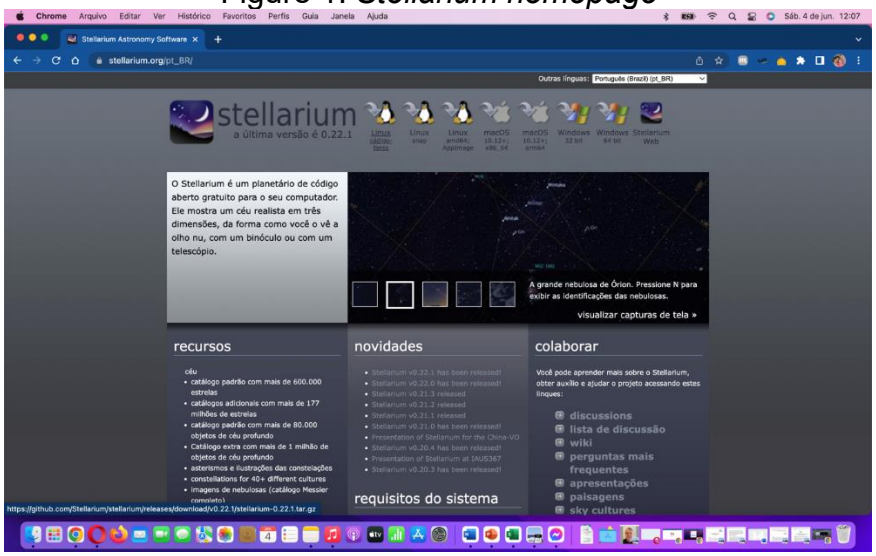
The interaction between old and new knowledge is continuous throughout the entire process of Meaningful Learning, and results in new knowledge. Initially, new knowledge and existing knowledge can be dissociated, however, after the assimilation process, new knowledge is generated, which will be incorporated into the student's cognitive structure. In this aspect, it is expected, with the analysis of *Stellarium*, to help the teaching practice by offering subsidies so that the learning of Astronomy is in fact meaningful.

O STELLARIUM

Stellarium is an important OA, available for different operating systems, especially Linux, IOS and Windows. It is a planetarium, an open-source digital structure for computers. It simulates a realistic sky in three dimensions, with a great resemblance to what can be seen with the naked eye or using instruments such as binoculars or a telescope.

Stellarium is accessed at the address https://stellarium.org/pt/, and the entire program is available in Portuguese, with Brazilian Portuguese \u2012 which can be changed in the tab in the "other languages" icon. The home page of OA can be seen in Figure 1.

Figure 1: *Stellarium homepage*



Fonte: *Stellarium* (https://stellarium.org/pt/)

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On the home page, shown in Figure 1, you can see the definition of what this LO is, the resources available in it, the news of each version, the history, the necessary requirements and other information about the *software*, as well as all its applications, system compatibilities and other aspects. This work will analyze how this LO can contribute to the process of Meaningful Learning in the classroom and help teachers of the early years of Elementary School with regard to Astronomy, as shown in Chart 1.

METHODOLOGY

What materials can be used to help the teacher insert Astronomy in the classroom in the early years of Elementary School? Can technologies help in this work? What technologies can be used? To try to answer these questions, which guide this work, it is inserted in the molds of qualitative research, which brings with it an important characteristic: it allows the researcher to understand the proposed problem, by analyzing multiple realities in a subjective way (CRESWELL, 2007; MINAYO, 2006).

In this context, it is highlighted that qualitative research is based on the construction of an interpretation, "this also means that the researcher filters the data through a personal lens situated in a specific sociopolitical and historical moment" (CRESWELL, 2007, p. 186) and the idea of linearity and of only one way to find answers is not part of this process, but rather the diversity of contexts and ways of seeing and conceiving.

To achieve the proposed objective \u2012 to analyze the possibilities of using *the Stellarium software* in the classroom for the early years of Elementary School \u2012, we will use the descriptive method, in which the researcher does not interfere, but analyzes, records and correlates different aspects that involve facts or phenomena (BARROS; LEHFELD, 2007). It details and structures the data found, but does not intervene at any time.

Based on these explicit precepts, it is observed that to proceed with the analysis of the *Stellarium software,* this is the methodology that offers adequate support. Descriptive research can be of different types: documents, surveys, analyses, among others. For the analysis of the LO target of this research, some steps were established: the first of them will be the appropriation of the *software* with the exploration of its different functionalities; then, the construction of a framework that presents these functions analyzed; the third step will be the elaboration of a comparative table between the contents for work in the early years of Elementary School presented in the BNCC (BRASIL, 2017), as seen in Chart 1, and the

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contents present in the LO; the fourth step will be through the exploration of the images shown by the OA; and the fifth step will be the analysis of the depth of the themes presented by the LO and their suitability for use in the classroom by the teacher.

Based on the data collected at the different moments of the research, an analysis will be structured based on the different theoretical references proposed in this work. The theme of Astronomy is innovative because it presents itself as naturally stimulating and with different themes in Education and for Education. Some obstacles that appear in initial training are present for teachers in the early years of Elementary School, and building an analysis of a LO that can help the work on the theme is undoubtedly an innovative fact, of great relevance and that provides opportunities for Meaningful Learning.

For the analysis of the OA, some steps (script) will be followed to structure this verification:

1) Initial reading of the opening page of the OA;
2) Highlight in this reading of the main themes of Astronomy presented;
3) Exploration of the OA with a view to investigating what Astronomy content it presents;
4) Investigation of the usability aspects of *the software* for working with Astronomy in the early years;
5) Elaboration of a comparative table between the contents presented in the LO and what is recommended in the BNCC (Chart 1);
6) Suggestion of a didactic sequence, combined with the guidelines of the BNCC, for each of the initial years of Elementary School, in order to assist the teaching work;
7) Construction of an analysis in order to answer the question initially proposed, guiding this work.

RESULTS AND DISCUSSIONS

When analyzing OA *Stellarium,* one can observe, on its home page, the guidelines that optimize its use. It presents, as seen in Figure 1, a summary of everything that can be found in OA. This initial presentation helps the teacher in the construction of his planning for working with Astronomy. Also on the homepage, there is also an indication that this *software* is open source, as well as information about the available version and compatibility. An

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aspect that can facilitate the teacher's work is the existence of a *web version*, which does not require a *download* or any specific program for it to work.

On the opening page of the program, the list of contents present in this OA is exposed, with emphasis on the observation of the sky, with more than 600 thousand stars and 80 thousand objects from deep space and the presentation of the different constellations, in line with what the International Astronomy Association proposes, and also from other cultures, as recommended by Ethnoastronomy. It also exhibits the Milky Way and its different bodies, as well as the Solar System and its planets and other details.

The *software* makes it possible to work with the local sky in real time, to identify the stars present. It is also possible to change the date, to make the observation at different times and events, such as the passage of epoch-making comets or artificial satellites that are in Earth's orbit.

Regarding the usability aspects, this *software* is suitable for insertion in the early years of Elementary School, and can support the teaching work, by introducing aspects of Scientific Literacy from the early years, which can help in the development of scientists and, of course, provide opportunities for Meaningful Learning, as Ausubel (2003) emphasizes, since Astronomy is a theme that arouses the interest of the student.

All the themes presented in the BNCC (BRASIL, 2017) for the early years of Elementary School regarding Astronomy (see Chart 1) are present in this *software*, which gives the teacher the opportunity to work with this science and use technologies as an important tool in the construction of knowledge, to assist the teaching and learning process.

Next, the didactic sequences will be presented as an initial proposal for teachers in the early years who want to improve them or insert and use them in the work with Astronomy.

DIDACTIC SEQUENCE FOR THE FIRST YEAR OF ELEMENTARY SCHOOL

Subject: Science

Theme: Time Scales

Contents worked:

- The day \u2012 morning, afternoon and night; The periods of the day – day-clear and night; The week, the month and the year; My birthday; Does the Earth rotate?

Skills according to the BNCC (BRASIL, 2017):

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- \u2012 (EF01CI05) Identify and name different time scales: the daily periods (morning, afternoon, evening) and the succession of days, weeks, months and years.
- \u2012 (EF01CI06) Select examples of how the succession of days and nights guides the rhythm of daily activities of human beings and other living beings.

Number of lessons: 6 lessons

Materials for the didactic sequence:

- Slate; Chalk; Calendar; *Stellarium;* Scrap materials (newspaper or wrapping paper, barbecue stick, gouache paint, string, lantern); Notebook; Writing pencils and coloring pencils; Sheets of paper.

Classes 01 and 02

In the first class, the teacher will conduct a conversation circle, to raise with the students their previous knowledge about the "day", in order to build a map of concepts on the board, with the main terms and explanations presented by them; after that, they will make illustrations with the activities they develop throughout the periods of the day \u2012 morning, afternoon and night. Then, the teacher questions the students about the light and dark period throughout the day, so that they report what they do in each of them and how they imagine it occurs; then the teacher, with the help of *Stellarium*, explains to the students how the day occurs and its light and dark period. As an assignment for the weekend, he asks students to draw what appears in the sky during the day-clear and night, and asks them to bring a calendar from home, highlighting the month and day of their birthday.

Lessons 03 and 04

In these classes, the teacher begins by resuming the theme developed in the previous class and in the presentation of the homework forwarded. He promotes a conversation circle for students to explain what they found and what they saw at each moment and organizes the concepts on the board; Then, he asks them to take the calendars they brought (and provides others for those who forgot) – at this point, the teacher rescues topics that have already been addressed previously and asks each student to say when they would have their birthday. This is the first moment in which each student sees what changes from one birthday to another, they are instigated to perceive the days, weeks and months as human constructions. At the end, the professor raises the following

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questions: "What do you think happens for us to have clear day and night? How do you think the year goes?"

Classes 05 and 06

The teacher begins by rescuing the contents previously worked on and leads the students to manipulate the *Stellarium software* so that they can, under the guidance of the teacher, observe how the phenomenon of the "day" occurs, the sky and the stars present at different times, as well as examine the Earth and the Sun with the help of OA. After that, with the use of scrap materials (newspaper or wrapping paper, barbecue stick, gouache paint, string, flashlight), they build, in pairs, paper balls that represent the Earth and the Moon, without much concern at this time with sizes and proportions. The teacher uses the flashlight so that students can perceive the rotation of the Earth, observe the clear day and night and recognize the year as the period of "rotation" of the Earth around the Sun that marks the anniversary, which stimulates the association of the phenomenon with the calendar and its identification as a human construction.

Evaluation

The evaluation will be made in an observational way of the participation of the students and the development of the proposed activities.

DIDACTIC SEQUENCE FOR THE SECOND YEAR OF ELEMENTARY SCHOOL

Subject: Science

Theme: The sky

Contents worked:

- Does the Sun move in the sky?; The sunrise and sunset; The rotation and translation of the Earth; Day-light and night; Where does the heat that warms us come from?; The Sun as a source of energy.

Skills according to the BNCC (BRASIL, 2017):

- \u2012 (EF02CI07) Describe the positions of the Sun at different times of the day and associate them with the size of the shadow cast.
- \u2012 (EF02CI08) Compare the effect of solar radiation (heating and reflection) on different types of surfaces (water, sand, soil, dark, light and metallic surfaces, etc.).

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Number of lessons: 6 lessons

Materials for the didactic sequence:

- Slate; Chalk; *Stellarium;* Scrap materials (newspaper or wrapping paper, barbecue stick, gouache paint, string, flashlight, yellow birthday balloons, Styrofoam spheres); Notebook; Writing pencils and coloring pencils; Sheets of paper.

Classes 01 and 02

In the first class, the teacher will conduct a conversation circle, to raise with the students their previous knowledge about the movement of the Sun. Then, with the students, in the schoolyard, he places some stakes in the ground, taking care to choose sunny places. Then students should measure the shadows at least three times, throughout the morning or afternoon, and write down the projection of the shadow from each stake (Gnomon). On that same occasion, the teacher asks them, as a task, to observe at home if the Sun always rises in the same position, with the use of a marking that helps in the investigation. This activity aims to lead students to observe the change in position of the Sun throughout the daylight (it can also be used to observe the sunrise and sunset throughout the year \u2012 in this case, the Astronomy worked will be used with an investigative character, and will mainly show the particularities of the periods close to the changes of seasons).

Lessons 03 and 04

In these classes, the teacher begins by resuming the theme developed in the previous class and takes the students to work with *Stellarium* so that they change the movement of the Sun in the sky throughout the year, and observe the change in the birth and sunset of the Sun throughout each month of the year. The teacher asks students to build a paper ball to represent planet Earth and fill their balloons to represent the Sun, even out of scale. After that, using OA, they observe how the Earth and the Sun move, in order to investigate how rotation and day occur, and translation and the year. The teacher must provide students with the opportunity to develop propositions, hypotheses, and mediate learning. As a task, they are asked to draw the Sun and Earth, as well as the occurrence of daylight and night. The professor requests research on what is responsible for the heat and life on Earth.

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Lessons 05 and 06

At the beginning of these classes, the teacher asks the students to present their tasks and expose their work, in a conversation circle to observe the learning about the theme. Then he asks: Where do you believe the heat that warms us and maintains the temperature and life on Earth comes from? In these discussions, the professor resumes the requested research and, in the role of mediator, encourages students to try to explain or build hypotheses about how the Earth warms and the maintenance of life on the planet occurs. After that, he explains the energy process, how it comes from the Sun, and uses the episode "The Big Star" from the cartoon series *The Luna Show* to reinforce the theme. As a complement, the teacher asks students to bring beans from home and plant them in two pots, one exposed to sunlight and the other placed in the dark, without light, and observe what happens to each one, in order to build hypotheses about it. At the end, the teacher asks them to draw what they believe happened and exposes the work in the classroom.

Evaluation

The evaluation will be done continuously and with individual monitoring of participation. The observational aspect will also be important in the analysis of the activities developed by the students.

DIDACTIC SEQUENCE FOR THE THIRD YEAR OF ELEMENTARY SCHOOL

Subject: Science

Themes: Characteristics of the Earth; Sky Watching

Contents worked:

- Is the Earth round?; Day-light and night; Terrestrial rotation.

Skills according to the BNCC (BRASIL, 2017):

- \u2012 (EF03CI07) Identify characteristics of the Earth (such as its spherical shape, the presence of water, soil, etc.) based on the observation, manipulation and comparison of different forms of representation of the planet (maps, globes, photographs, etc.).
- \u2012 (EF03CI08) Observe, identify and record the daily periods (day and night) in which the Sun, the other stars, the Moon and the planets are visible in the sky.

Number of lessons: 4 lessons

Materials for the didactic sequence:

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- Slate; Chalk; *Stellarium;* Scrap materials (newspaper or wrapping paper, barbecue stick, gouache paint, string, lantern); Notebook; Writing pencils and coloring pencils; Sheets of paper.

Lessons 01 and 02

To begin the class, the teacher probes students about what they believe the Earth to be like. In this context, he acts as a mediator, stimulates discussions and takes students out of the classroom, in order to make observations on aspects that confirm the sphericity of the Earth; after that, the teacher returns to the class and encourages socialization by asking students to expose what forms they believe the Earth has. Then, he leads students to manipulate *Stellarium* so that they can, with the help of OA, observe from space the shape of planet Earth and its main characteristics – such as the presence of water (and its essentiality for life as we know it) – the relief, the elevations on the surface and, of course, the mountains, among others. As a task for the next class, students will research and show, in written and drawn form, how they believe the phenomena of clear day and night occur.

Classes 03 and 04

The teacher begins the class by asking students to present and comment on the task, and socialize with classmates. After socialization, the teacher stimulates discussions so that students perceive and build hypotheses about what leads to the occurrence of the light period and the dark period on Earth, which is called day and divided into clear day and night. Then, he conceptualizes the phenomenon and associates it with the Earth's rotation, which is the movement that the Earth makes around its own axis. For the demonstration, the teacher asks two students to move ahead, one will represent the Earth and the other, the Sun. To the student who represents the Sun, the teacher offers a flashlight, whose light is directed to the student called the Earth, and this rotates around its own axis, in order to demonstrate the light and dark periods. This same scheme is later repeated with the use of scrap metal – paper to make a ball – to represent the Earth and the lantern to represent the Sun. At this point, the teacher can also define the Heliocentric System and present the initial ideas of the Solar System. To close, he leads students to manipulate *Stellarium* again to better observe these phenomena.

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Evaluation

The evaluation will be made in an observational way of the participation of the students and the development of the proposed activities.

DIDACTIC SEQUENCE FOR THE FOURTH YEAR OF ELEMENTARY SCHOOL

Subject: Science

Theme: Calendars and cyclical phenomena

Contents worked:

- The Moon; Does the Moon orbit the Earth?; How long does it take the Moon to go around the Earth?; The calendar through the ages.

Skills according to the BNCC (BRASIL, 2017):

- \u2012 (EF04CI11) Associate the cyclical movements of the Moon and the Earth with regular periods of time and the use of this knowledge to the construction of calendars in different cultures.

Number of lessons: 4 lessons

Materials for the didactic sequence:

- Slate; Chalk; Calendar; *Stellarium;* Scrap materials (newspaper or wrapping paper, barbecue stick, gouache paint, string); Notebook; Writing pencils and coloring pencils; Sheets of paper.

Classes 01 and 02

The teacher introduces the theme by questioning students about the Moon. Along with this, he presents photographs or images of the Moon, and asks if the students have ever paid attention to this star and what they have heard about it. After the discussions, he presents the video of the episode "Four Moons for Luna", from *Show da Luna*. Then, he reinforces the concepts presented in the cartoon and asks the students to make an illustration that represents their observations about the Earth-Moon relationship. For the sequence of the class, the teacher takes the students to the *Stellarium*, so that they, using this OA, explore the translation of the Moon by the Earth. This exploration helps to understand that there are several "moons" in the sky, and correspond to the different phases that present themselves to observers. As a homework assignment, students are invited to collect images of the Moon and research the time it takes to go around the Earth.

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Classes 03 and 04

The teacher opens the class by asking students to present the requested tasks. After the presentation, he questions the students about the number of days it takes the Moon to complete one lap around the Earth. Then, he distributes copies of calendars in order to associate the duration of the month with the period of translation of the Moon, and explains to the students that there are movements that are repeated and are called periodicals, and have served as a basis for the construction of calendars throughout history. As reinforcement and complement, the teacher can use the texts available in the links https://calendariodoano.com.br/categoria/calendarios/ and https://revistagalileu.globo.com/Cultura/noticia/2016/01/oito-tipos-de-calendarios-usados-pelo-mundo.html. The purpose of using the texts is to explore the different calendars that have emerged throughout history in different cultures. As a final activity, students are invited to propose a calendar based on some periodic movement they know, with explanations about what criteria they adopted in its construction.

Evaluation

The evaluation will be procedural and formative and will be given by observation, student participation, development of the proposed activities and use of the correct terminology.

DIDACTIC SEQUENCE FOR THE FIFTH YEAR OF ELEMENTARY SCHOOL

Subject: Science

Theme: The sky, the stars and their movements.

Contents worked:

- What can we visualize in the sky?; The Milky Way; The rotation and translation of the Earth; The Moon and its phases; What do we need to observe the stars in the sky?; How to build a telescope?

Skills according to the BNCC (BRASIL, 2017):

- \u2012 (EF05CI10) Identify some constellations in the sky, with the support of resources (such as celestial maps and digital applications, among others), and the periods of the year when they are visible in the early evening.
- \u2012 (EF05CI11) Associate the daily movement of the Sun and the other stars in the sky with the rotation of the Earth.

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- EF05CI12"Conclude on the periodicity of the phases of the Moon, based on the observation and recording of its apparent shapes in the sky over at least two months.
- \u2012 (EF05CI13) Design and build devices for distance observation (scope, periscope, etc.), for magnified observation of objects (magnifying glasses, microscopes) or for image recording (cameras), and discuss the social uses of these devices.

Number of lessons: 8 lessons

Materials for the didactic sequence:

- Slate; Chalk; Calendar; Maps and star charts; *Stellarium;* Scrap materials (newspaper or wrapping paper, barbecue stick, gouache paint, string, flashlight, Styrofoam balls); Notebook; Writing pencils and coloring pencils; Sheets of paper.

Lessons 01 and 02

The teacher will lead a conversation circle, to raise with the students their knowledge about what is observable in the sky. Students are also asked to expose the differences between what is seen during the day-clear and during the night – they are expected to say that at night several luminous or illuminated bodies are observed. The teacher, when acting as a mediator, asks students to talk about what they believe they observe in the sky. Then, he distributes charts and celestial maps, so that they can observe the constellations and then, with the help of *Stellarium*, try to locate which ones are the main ones visible. The students then advance the time in the *software* so that they can observe the movement in the sky – and the different constellations and other bodies and planets that appear – in this way they are provoked to verify that the sky is not static, it moves just like the rest. In this activity they are invited to write down the name of the constellations and other bodies that are presented by *Stellarium*. One concept to be explored and highlighted is the Milky Way and its observation in OA. In the end, they are instigated to understand that the stars appear brighter at night because it is the dark period of the day, and they are not visible throughout the daylight because the Sun is the closest star to the Earth, and therefore occults the other stars. As a task, they are asked to observe the sky from home and try to write down what they saw, in order to identify the local galaxy, in this case the Milky Way.

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Lessons 03 and 04

In these classes, the teacher begins by resuming the theme developed in the previous class. Ask for the presentation of the homework submitted and organize an exhibition of the works. Then, he introduces the question: Why is the clear day sky different from the night sky? What changes? The teacher instigates the students to be able to build hypotheses and observe that the Sun appears in the sky throughout the daylight and that at night it is not present. These discussions will serve to build the concepts of terrestrial rotation and translation, to associate the length of the day (24 hours) with a revolution around the Earth's own axis, and to perceive the length of the year (365 or 366 days) as the movement of the Earth's translation around the Sun. Then, with the help of *Stellarium*, students can observe the occurrence of rotation and translation, manipulating the OA. At the end of this class, the teacher asks them to research what the Moon is and if it is always the same. He asks them to bring to the next class a cardboard box with a lid, a barbecue stick, duct tape, scissors and a flashlight.

Lessons 05 and 06

The teacher begins by asking students to present the tasks requested in the previous class. After that, he shows the video "Four Moons for Luna", in which the Moon and its phases are presented, and the construction of an experiment called "The Moon in the box" is suggested. The teacher guides students in the construction of this experiment, and in the observation of the different ways in which the Moon appears in the sky throughout the month. This activity has as its main objective to lead the student to realize that the Moon changes its shape daily and define its four main phases. As a task, to confirm what was seen in class, students are invited to photograph or draw the Moon for four weeks, writing down their observations daily to build a logbook with the time of the images and how they appear. This task should be delivered after the fourth week, when the theme will be resumed in the classroom. Finally, with the *Stellarium software*, students simulate the phases of the Moon and confirm what they have studied in class.

Lessons 07 and 08

In these classes, the teacher resumes the contents of the previous class and questions the students about how to observe the stars in the sky. At this point, the answer is expected to be "with the naked eye" or "with the help of objects" (such as binoculars,

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telescopes and others). In this class, the teacher will propose, with the help of the work *Astronomy: elementary and high school* (NOGUEIRA; CANALLE, 2009), the construction of a telescope for the use and observation of the stars, especially the Moon.

Evaluation

The evaluation will be procedural and formative and will be given by observing the participation of the students, the development of the proposed activities and the use of the correct terminology, as well as through written evaluations, the logbook of the observations of the Moon and its images, as well as asking the students to build comic strips or comics to illustrate what they have learned (ALBRECHT, VOELZKE, BOCZKO, 2020).

CONSIDERATIONS

After analyzing the *Stellarium software*, it is observed that it can be used for work in all years of Elementary School, in this case the initial years. The themes presented in the BNCC (BRASIL, 2017) are present in this LO, however the teacher's work is essential to mediate and, of course, encourage students to raise hypotheses and observe and formulate explanations, in order to build Meaningful Learning.

At the end of this work, it is possible to observe that the analysis of the possibilities of using this *software* in the classroom for the early years of Elementary School is positive and that it can help to answer the questions proposed here: What materials can be used to help the teacher to insert Astronomy in the classroom in the early years of Elementary School? Can technologies help in this work? What technologies can be used?

It is expected, with this study, to bring technologies closer to the classroom and assist in the practice of the teacher in the early years to promote Meaningful Learning and Scientific Literacy, with the exploratory analysis of *Stellarium* and the emphasis on the aspects of its usability in the classroom in line with the documents that guide Basic Education. It is also intended to contribute to the teacher of the early years, in this case with the didactic sequences presented here, so that they can be the starting point of the work with Astronomy, a theme inserted in few initial training courses, as pointed out by Bretones (2006) and Leite (2006) and reinforced by Pinto, Silva and Silva (2018).

The proposed didactic sequences are in line with the skills presented in the BNCC (BRASIL, 2017), a document that guides all Basic Education in Brazil. As the materials for the theme are scarce, it is intended that the teacher of the early years can appropriate

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them, use them, reuse them and improve them, and innovate in their practice, since Astronomy is an innovative theme and, as the concept of innovation is broad, it is expected that each educator makes his practice a modern practice, a differential to provide opportunities for Scientific Literacy.

It is hoped that this research will help the teaching work and serve as inspiration for other studies, in order to bring the teacher closer to the different technologies, provide opportunities for different discussions and contribute in a certain way to stimulate aspects of innovation in the different years of Basic Education.

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