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ARTIGO

Teaching about the Moon and its phases: an observational proposal for Elementary School.

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Abstract:

This paper exposes the results of an experimental research about the teaching of the moon and its phases, developed with children in the second year of elementary, in a public school. The inquiry seeks to verify the learning process by observation of the Moon in sky by students as the main basis, using drawings as a form of registration and conversation circles, both accessible to young children. Our aim is to verify which questions and ideas emerge when observation is at the heart of the process and what students demonstrate to understand from this methodological choice, in view of the formation of scientific concepts of Vygotsky for children. The research highlights students' learning regarding the observable movements of the Moon throughout the nights, the change in aspect, as well as other characteristics.

Keywords:
Moon; Elementary School; Sky Observation

O ensino sobre a Lua e suas fases: uma proposta observacional para os Anos Iniciais do Ensino Fundamental

Resumo:

Este artigo expõe os resultados de uma pesquisa experimental sobre o ensino de Lua e suas fases, desenvolvida em uma turma de segundo ano do Ensino Fundamental, em uma escola pública. A investigação busca verificar o processo de aprendizagem tendo a observação do astro no céu pelos estudantes como base principal, utilizando o desenho como forma de registro e rodas de conversa, ambos acessíveis às crianças pequenas. Nosso objetivo é verificar quais questões e ideias emergem quando a observação está no cerne do processo e o que os estudantes demonstram compreender a partir dessa escolha metodológica, tendo em vista a formação dos conceitos científicos de Vigotski para crianças. A pesquisa evidencia o aprendizado dos discentes a respeito dos movimentos observáveis da Lua ao longo das

Palavras-chave:
Lua; Anos Iniciais; Observação do Céu.
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noites, de sua mudança de aspecto, entre outras características.

La enseñanza de la Luna y sus fases: una propuesta observacional para los primeros años de la Educación Primaria

Resumen:

Este artículo expone los resultados de una investigación experimental sobre la enseñanza de la Luna y sus fases, desarrollada en una clase de segundo año de Primaria, en una escuela pública. La investigación buscó verificar el proceso de aprendizaje con la observación de la Luna en el cielo por parte de los estudiantes como base principal, utilizando el dibujo como forma de registro y círculos de conversación, ambos accesibles a los niños pequeños. Nuestro objetivo es verificar qué preguntas e ideas surgen cuando la observación está en el centro del proceso y qué los estudiantes demuestran comprender a partir de esta alternativa metodológica, considerando la formación de los conceptos científicos de Vygotski para los niños. La investigación demuestra el aprendizaje de los estudiantes sobre los movimientos observables de la Luna a lo largo de las noches, su cambio de aspecto, entre otras características.

Palabras clave:
Luna; Primeros años; Observación del cielo

INTRODUCTION

The Moon is one of the celestial bodies that awakens inspirations for different forms of human expression throughout the ages, in cinema, in the visual arts, in poetry, in tales, among so many others, in different centuries and cultures, which shows us how much it is remarkable in the sky and stimulates the imagination. Despite being the closest celestial body and the most noticeable in the sky, its observation has been little considered in research related to its teaching. There is a great diversity of resources used in studies and teaching processes on the Moon and its phases, which involve low-cost materials, such as Styrofoam ball, software, and simulators, with a strong tendency to approach the star and the phenomenon from the perspective of its occurrence in the Sun-Earth-Moon system, little including and considering the understanding of the satellite from its observation in the immediate and everyday environment, which could be especially used as a starting point or, at least, as an integral part of teaching.

The National Common Curricular Base (Ministry of Education, 2017) indicates the beginning of the pedagogical work with the Moon as a theme in the Early Years of Elementary Education, on the topic Earth and Universe , so that the student has experiences of observation, perceives its movement and understand its cycle, as well as phenomena arising from it. The lunar cycle can be followed in a period close to a month and even observation for a week, in a planned way, creates conditions for the perception of its movement and its change of appearance.

The core of this proposal is that the studies on the Moon should be started by observing them in the sky so that only later on, abstractions and modeling can be carried out. For Astronomy Education with children, this is an essential condition in the construction of comprehension processes. However, it is necessary to consider the importance of this type of methodological choice, regardless of the age of the students and the level of education, understanding that knowledge should not lose its relationship with our daily lives and the environment.

THE TEACHING OF THE MOON THEME AND OBSERVATION FROM THE SKY

In a previous investigation (Gonçalves e Bretones, 2020), we carried out a panoramic survey about the teaching of the Moon and its phases in Brazil. We analyzed 242 researches, including theses, dissertations, articles, and works presented at events from the 1970s to 2015. We found that, despite the star's proximity and a certain ease in its observation, this is not so much includedin the teaching and learning processes of most researches. We found some works that propose the dimension of the procedural observation of the Moon in the sky in the topocentric framework: Lima (2006), Lago (2013), Jafelice (2015), Pellenz (2015), and Lago, Ortega and Mattos (2018).

It is possible, therefore, to conclude that in these investigations on the Moon, the observational, experiential perspective, of the human scale, considering the panorama of the subject who lives on the planet Earth, little has been contemplated, in comparison to the total of works found on teaching the theme. On the other hand, the spatial dimension of the satellite and the phenomena that are related to it in the Sun-Earth-Moon system is the most discussed aspect.

It is important that, in science education for children, the immediate environment is considered in a primordial way. In this scenario, the Moon is the closest and most accessible star, without the need for great technologies for the most elementary contacts. We agree with Delizoicov and Slongo (2011) who point out that, “even before reaching school, the child has already made a significant journey, exploring its surroundings. The teaching of science in this school range should give the child the opportunity to explore the natural and social world in which he is inserted ”(p. 209).

Fracalanza, Amaral and Gouveia (1987) also affirm the importance of looking at the natural world, considering this basic stage for the growing abstraction:

> First, we have to provide the child with the knowledge of the facts at his fingertips, in time and space. Then stimulate their comparison and organization, in order to build authentic problems that motivate and guide their reasoning progressively towards greater abstractions. This includes understanding more complex relationships between the different physical

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> aspects involved with the phenomenon [...], as well as their true causes (p. 69).

With this in mind, it is interesting to ponder the teaching of this theme, as well as others in Astronomy and Sciences as a whole, in the set of this complexity that involves the dimension of the observer, their experiences and experiences in an elementary way, especially for children, but not just for them. The other scales of astronomical phenomena, in this perspective, begin to be understood in the construction of the relationships between what we see, the interactions on our planet, in order to progressively come to understand what happens in the dimensions outside the Earth, which mobilize complex and abstract knowledge.

Most basic astronomy can have its teaching started in this logic of prioritizing what we perceive as beings on this planet, which affects our daily lives, such as the sequence of days and nights, the Moon and its phases and the seasons of the year, because this encourages knowledge that is contextualized to the students' reality. Lanciano (1989) defends the importance of including the observer's perspective in the educational processes of Astronomy, understanding it as a significant part:

> (...) it is about being able and aware of accepting the possibility of maintaining the two different models, two models of language to speak of the same: maintaining the daily Ptolemaic vision and its relativity with respect to a world system in that everything moves and there are no relative local centers (p. 175).

Kriner (2004) understands that learning about phases of the Moon is not restricted to describing the phenomenon. Students need to be able to understand and relate their perceptual characteristics to the heliocentric model. How teaching has been prioritized, as well as a considerable part of the research developed in the area, seems to keep the focus on only one of the scales and dimensions of the phenomena, without favoring the construction of gradual understanding of the spatiality of events by students and teachers, which is a challenge indicated by some authors (Bisch, 1998; Leite, 2002, 2006; Kriner, 2004).

Kriner (2004) states that the theme of the phases of the Moon is complex to teach and difficult to learn, especially due to the high degree of abstraction required. This idea is reinforced because, apprehensively, some researches point out that, even after going through basic schooling or after completing a degree or other graduation and even among teachers, there is still a predominance of confused understanding about the phases of the Moon, which is one of the contents covered in the theme "Lua" (Peña & Quílez, 2001; Puzzo, 2005; Leite, 2006; Plummer, 2008; Subramanian & Padalkar, 2009; Langhi & Nardi, 2012).Thus, it is important to reflect on the teaching and learning processes about the theme throughout Basic Education, which can also serve to consider other issues and contents in the area.

In addition to privileged access to the natural environment, this proposal encourages the observation of the Moon to be developed even before a theoretical approach to the subject, being this the initial stage. This idea is inspired by the works of Lanciano (1986, 1989), Lorenzoni (1988), Bisch (1998) and Jafelice (2002, 2010), who make significant discussions about the need for children to have contact with nature and perceive it in the process of teaching and learning about Astronomy, without disconnecting what is approached from the accessible natural world. For Lanciano (1986, 1989) and Lorenzoni (1988), the meanings that young children establish with what they experience and see are fundamental for learning.

According to Lanciano (1986), the dimension of beauty and pleasure are important in education for the processes of knowing, learning, and remembering; and the experience of observing the sky is also related to this perspective. The emotion and astonishment of the action of contemplating the sky can be foundations for the construction of knowledge and generate desires for new knowledge. In addition, according to the author, the waiting time to observe a phenomenon, such as sunrise or sunset, can be a good moment of preparation for the body and mind to be in the phenomenon.

Lorenzoni (1988) highlights the school prioritization of memorization and reasoning and the scant appreciation of an education that sensitizes perception, which is the window of our representation of the world. Bisch (1998) explains that

> a “cabinet” Astronomy can be justified in the case of a professional, experienced, adult astronomer, but we believe that a bookish, disheveled, classroom astronomy is completely out of place in elementary school, where one of the most important attitudes to exercising students is their ability to observe nature, where it is essential to sensitize them regarding the beauty and diversity of the universe, instigating their curiosity and imagination (p. 125).

In this same perspective, Jafelice (2002, p. 12) states that it is an initially non-verbal and non-rational work to reestablish contact with the sky and with yourself: “It is an essential and first job, done before adding any specific content habitual or instruments that will mediate your observations ”. Therefore, students have the opportunity to think and build ideas about what they observe. Jafelice (2010) proposes a humanistic Astronomy approach in which the experience of phenomena is prioritized before systematization:

> from a pedagogical point of view, cognitive-analytical-reflective aspects - involving distribution and reading or production of texts with students, analyzes, conceptualizations, etc. - are only contemplated, in general, after the students have experienced - that is, done and meaning in the body, in practice - the phenomena or processes that we are interested in dealing with in that circumstance and have, for the most part, discovered for themselves most of the associations and information that are possible to be obtained experientially (pp. 216-217).

These perspectives are in line with Vigotski's educational theory (2009), which highlights the importance of the interconnection between spontaneous knowledge, developed by the subject in his relationship with the world, and the learning of scientific concepts, influencing each other:

> In the process of teaching the knowledge system, the child is taught what he does not have before his eyes, which goes beyond the limits of his current experience and the eventual immediate experience. It can be said that the assimilation of scientific concepts is also based on the concepts elaborated in the process of the child's own existence ... (...) Likewise, the assimilation of the scientific knowledge system is also not possible except through this immediate relationship with the world of objects, if not

> through other previously elaborated concepts. And this formation of concepts requires entirely different acts of thought, linked to free movement in the system of concepts, to the generalization of generalizations previously constituted, to a more conscious and more arbitrary operation with previous concepts (pp. 268-269).

Thus, it is essential to build this experience related to the accessible so that scientific knowledge is not just a direct teaching of concepts, which Vigotski (2009) highlights that is shown by practice and research “impossible and pedagogically sterile” (p. 247). The author further states:

> The teacher who embarks on this path usually fails to achieve, if not an empty assimilation of words, a pure and simple verbalism that stimulates and imitates the existence of the respective concepts in the child, but in practice, hides the emptiness. In such cases, the child does not assimilate the concept but the word, captures more memory than thought and feels powerless in the face of any attempt to consciously use the assimilated knowledge (p. 247).

We agree with the authors and understand that the construction of knowledge encompasses a greater complexity than the specific moments of the classroom, which involves the development of the child, the world around us, and our culture. We understand that it is on this basis of the relationship with the accessible world of the child that the knowledge about Astronomy can be built. However, this is not something without direction. The observation systematically proposed starts from the awareness that school is the space for the construction of systematized knowledge, scientific knowledge. This research is built, then, from these reflections on the relevance of observation, on access to the child's immediate environment, on the importance of his thought processes and on the scales that make up the phenomena related to the Moon.

METHODOLOGICAL PROCEDURES

This qualitative research and experimental intervention was developed with 22 children between the ages of 7 and 8 years old, attending the 2nd year of elementary school at a municipal public school in the interior of the state of São Paulo. Throughout the research, enrollments were moved, and the group was reduced to 17 students. According to Megid Neto (2011), intervention research occurs when the researcher introduces one or more new or variable elements in a process, with the experimental intervention being one effort to describe and analyze a given experiment with the introduction and manipulation of one or more variables.

In single-group experimental research, the initial and post-intervention stages are compared, looking for evidence that indicates a cause-and-effect relationship. In this way, students in their initial situations, their trajectories during the intervention, and the characteristics of the final stage are compared. There is a search for “presence of change”, based on verification structures, so that no evidence is produced, but a serious indication (Laville & Dionne, 1999, p. 146). In this article, we present some of the data found, which can be verified in their entirety in Simon (2016).

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The data were obtained through: semi-structured interviews before and after the observations; drawings made by children as a record; recorded classroom discussions; notes and follow-up by the researcher in a field notebook. The choice for the forms of record and data collection of the research was made especially because the children of this age group are in the process of literacy. Thus, their records by drawing and speeches served as a basis.

According to Sarmento (2011), drawing is a form of expression, communication symbolic of the child, which precedes writing, not only represents an external reality, "it transports, in the gesture that inscribes it, infantile forms of apprehension of the world" (p. 29). It is, therefore, considered an important instrument in the methodological process.

The children's drawings and discussions were compared together to verify the students' expressions, as they understand the fragility of the drawing, since an idea cannot always be clearly expressed through this tool. In addition, the notes from the researcher's field notebook were also consulted and compared.

The stages of the research with the students are described in Table 1:

Chart 1. Stages of the research, development time, and description.

N.	Stage	Time	Description
1	Initial survey of students' knowledge on the subject	4 classes spread over 1 week	Semi-structured filmed interviews
2	First Moon observation at school	1 hour/night	Knowing the Moon through the Telescope
3	Daytime sky observation at school	2 lessons on two different days	Observe and record the day sky
4	Individual Moon observations and recording	6 nights spread over 21 days	Individually observe and record moon changes over the nights
5	Record analysis	1 class after each observation	Classroom discussions about student records, systematizing the learning
6	Evaluation	6 lessons spread over one week	Synthesize what students learned throughout the research

Figure 1 shows a schematic representation of the pedagogical methodology developed throughout the proposal, including all stages:

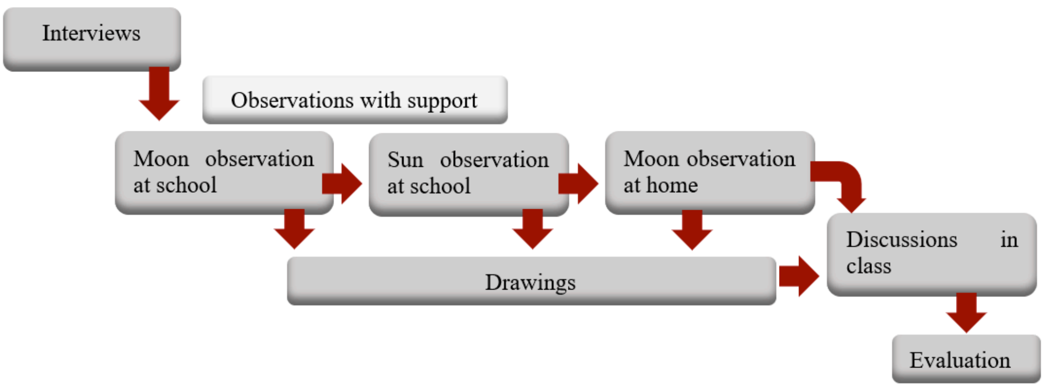

Fig 1. Schematic representation of the proposed pedagogical methodology.

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Source: the authors

We started the methodological proposal by talking to students about their knowledge of the Moon and went on to the first observations supported by the school. These observations had a structuring character so that students could develop the next stage of the proposal at home, in an autonomous way. All observations were recorded with a drawing, which included the recording of the local horizon, the date, and the time; the next day of each observation, discussions took place in the classroom through the conversation wheel.

In addition to the concern with students' learning, other possibilities emerge from this type of approach when starting from the complexity of nature and the child's view. It is possible to go beyond the conventionally privileged contents in the school space, when the planning is open to the questions that children can raise.

LEARNING ASTRONOMY BY WATCHING THE MOON: PRESENTATION AND DISCUSSION OF DATA

For the initial development of the proposal, we conducted semi-structured interviews with the students, in order to verify what ideas they presented concerning the Moon and its phases. The initial questions were: "Do you usually look at the sky at night?"; "What do you see?"; "What do you like most to look at in the sky?". If the Moon were quoted, the next question was, "What do you know about the Moon?" This open way allowed the student to speak freely and, based on this question, we explored the following topics: "Is the Moon in the sky every night?"; "Can we see it during the day?"; "Does it always look the same?"; "Is it always in the same place or does it change places?"

Regarding the first question, only two children said that they did not usually look at the sky at night. Thus, the question was followed about what the student most liked to look at in the sky, with the stars being most often mentioned, followed by the Moon. When children did not include the moon among the things they saw in the sky, it was introduced in the interview.

For specific questions about the Moon, Table 1 shows what the students' responses were:

Table 1: Student responses to questions about the Moon

	I don't know	No	Yes
Does the moon change places?	3	9	3
Does the moon always look the same?	0	13	2
Can the moon be seen by day?	0	6	9
Is the moon in the sky every night?	2	7	6

Source: Prepared by the authors.

As a result, most stated that the Moon changes its appearance (13), but does not change its location (9). The class was divided over the presence of the moon every night in the sky; and less than half of the students believed it was not possible to see it during the day.

About the first two questions, in the research by Plummer (2009) with children aged 6 to 8 years, the author finds that the students did not believe that the Moon had a precise movement in the sky, only 3 students of 63 believed that it did. Some students stated that it was standing more or less in the same place at night.

Regarding the presence of the Moon during the day and all night in the sky, Bisch (1998), in his study, finds that there is an understanding of permanent and synchronized opposition between the Moon and the Sun, which would mean that, when one of the stars are present in the sky, the other would not be. Only 2 students, of the 18 who participated in their investigation, said that the Moon could be seen by day. In contrast, in Plummer (2009), most students already realized that the Moon could be seen during the day.

Some students interviewed by us even mentioned the phases of the Moon, to tell what they knew about the celestial body:

> YA: Full Moon, waning, new Moon, crescent ... Moon ... that's all.
> Research: Did you say four names, are they four moons?YA: It's just one, but we see it in four different ways

In the work of Bisch (1998), the children demonstrated to understand that there was more than one Moon in the sky, as if each of the phases were a Moon,. which does not reflect YA's understanding.

The fact that some children mention the phases shows that they already have some knowledge related to the Moon, which may have originated in different ways, such as schooling itself and the media, such as television. Citing this information does not necessarily mean that the process is understood by the student and that the student knows what it means. Vigotski (2009, p. 247) indicates that it is a type of “pure and simple verbalism” in which the child knows the words, but has not assimilated a concept. Bisch (1998) calls “chavões” as terms memorized in a standard way, with a scientific origin, however still disconnected from a network of meanings for the individual who uses them. The author realizes this about the professors who participated in his research, but here we can extend it to the students.

Some children also detailed the explanation about the shape change of the Moon: "the darkness wraps the Moon", "the clouds are in front and hide a part", and "changes shape because of the Sun". Baxter (1989, 1998) lists at least five types of explanations, in addition to the correct one, that the children presented in their work to change the appearance of the shape of the Moon: clouds cover part of the Moon; planets shadow the moon; the shadow is of the Sun; the shadow of the Earth is projected on the Moon.

The goal, with these interviews, was to get to know the ideas that the children had about the Moon, so that the observations covered issues that they seemed not to know yet. The ideas and concepts that children present about the Moon and its phases are well addressed in the works of Baxter (1989, 1998), Beraldo (1997), Bisch (1998), Stahly, Krockover and Shepardson, (1999), Leite (2002) Furtado (2005), Gonzaga (2009) and Plummer (2009). Vigotski (2009) highlights that spontaneous concepts are important, as they are interrelated in the construction of scientific knowledge. It is not a question of replacing one with the other. According to the author,

> the system and the awareness of it are not brought from outside into the field of children's concepts, displacing the child's own way of informing and using concepts, but that this system and this awareness already presupposes the existence of concepts very rich and mature children, without whom the child does not have what must become the object of his awareness and systematization (Vigotski, 2009, p. 293).

Thus, these conceptions that children already have are fundamental and constitute a fertile ground for scientific knowledge, with the intervention of the educator.

Afterwards, it was asked whether the children had already observed the Moon through a telescope, and we found that none of them had this experience. Thus, we marked the first Moon's observation at school, right at the beginning of a lunation. The interest was in observing even with the naked eye, without the need for a telescope; however, this was used with the intention of attracting, seeking greater participation by families.

First moon observation at school

It was previously agreed with the children that they would each draw their observation. From the records developed that night, it was possible to realize that, although the proposal appears to be simple because it uses drawing, a language accessible to this age group, including the horizon was challenging. Students who could not go to school would observe in their homes.

Lorenzoni (1988), encouraging the observation of nature, suggests that, if done in relation to the Moon, the possible drawing, in an environment with an open horizon, would be something like Figure 2:

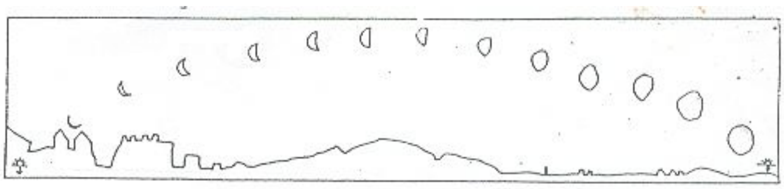

Fig. 2. Aspects of the Moon in the sky in relation to the horizon for the Southern Hemisphere.
Source: Adapted from Lorenzoni (1988).

We understand that, due to urban environments, this range of horizon would be unlikely, but, despite this, it would be interesting to check the possibilities of the proposal.

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The drawings made by the students showed great sensitivity in the observation of the sky developed at school, in the collective. Thus, they corroborate what Lorenzoni (1988) says about an educational process that sensitizes perception, which is the window of our representation of the world, as highlighted by Jafelice (2010), providing the experience before the conceptual aspects.

It can be seen in the NI drawing (Figure 3) the Moon together with the Three Marys (Orion Belt) and the planets Venus and Jupiter. In Figure 4, the area of sky recorded by the student, developed in the Starry Night software, is highlighted:

Fig. 3

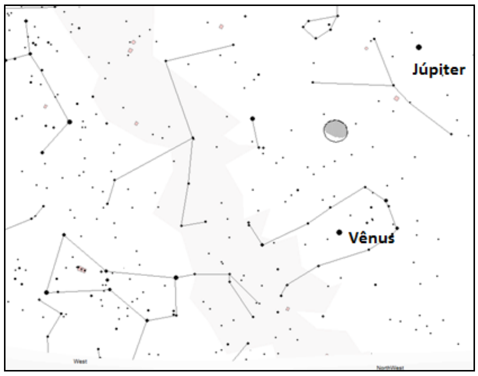

Fig. 4

Fig. 3 and 4. Record of the observation of the Moon at the NI school and the night sky (Starry Night)
Source: Research file.

As you can see, NI is included in the landscape with the horizon. There is no problem with that; the objective was to raise awareness of the surroundings, nature, and the horizon.

We also noticed, in this first observation, the difficulty of participating in the night period, despite the use of the telescope, since, by age, students depend on their parents to get to school. That night, only 10 students were present. We understand, based on this situation, that we would not have an observation sequence with many children, if we insisted on doing it at school. So, we rethought the project, including unforeseen steps, so that students could carry out the observations in their homes, autonomously.

Table 2 shows the organization of the observations, including the reworking in relation to the observation site:

Table 2. Observation days, locations, and student participation.

Order / Date	**Observation**	**Place**
1 – 05/22/2015	First night observation of the Moon	At school
2- 08/12 e 08/14/2015	Observations of the daytime sky	At school
3- 08/16/2015	Second Moon observation	At home
4 - 08/18/2015	Third Moon observation	At home

5 – 08/22/2015	Fourth Moon observation	At home
6 - 08/26/2015	Fifth Moon observation	At home
7 - 08/29/2015	Sixth Moon observation	At home
8 - 09/02/2015	Seventh Moon observation	At home

Source: Prepared by the authors.

Observation of the daytime sky at school

To develop tools and conditions for carrying out the proposal, we included observing the daytime sky at school, with the local horizon and the sun, being careful not to observe it directly. On two different dates in the same week, we sat in a wooded area, and each student registered with support and teaching intervention.

The activity was permeated with conversation circles in the classroom. The drawings produced demonstrated an understanding of the proposal, which offered the confidence for continuity. In Figures 5 and 6, we have the drawing produced by one of the students (JU) and a photo of the horizon represented by her:

Fig. 5

Fig. 6

Fig. 5 and 6. Record of daytime observation by student JU and image of the observation horizon at school
Source: Research file.

With the displacement of the night observation location from the school to the students' homes, the participation of the class was massive. All students developed the drawings, in their own way. It was noticeable by the conversations that some guardians helped the children in this process, accompanying them in the yard, on the sidewalk, or on the street so that they could observe, but, in some cases, it was clear that there was no help, and the student made the proposal alone. The families were aware of the activity, as it had been presented and explained in a meeting.

Each observation made was composed of the pages of the individual Observation Notebooks of the students, which were progressively assembled, according to Figures 7 and 8:

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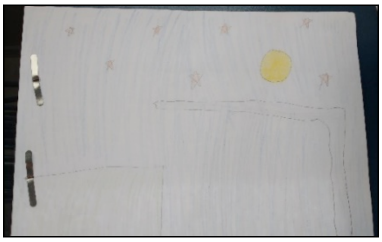
Fig. 7


Fig. 8

Fig. 7 and 8. Observation notebook under construction by students
Source: Research file.

Observations of the Moon by students in their homes

After these observations at the school with support and conversations, students were asked to observe the Moon on some agreed nights, trying to perform the task at the same time and in approximate places. In the same school period, students were learning to read the time on analog and digital clocks, and a standard time for everyone to observe was not determined, thus stimulating more individualized experiences and the possibility of the students. The observation was recorded on a sheet with space to take note of the observation date and time.

In the classes after the observation nights, conversation circles were held in which the children shared their records. There were discussions in the classroom about what they had observed, ideas, questions, and elaboration of explanations. The students showed their drawings and appreciated those of their colleagues. The drawings in Figures 9 and 10 show the first observations and records of the student GA, made in the first days of the crescent moon, with an interval of two days between them:


Fig. 9


Fig. 10

Fig. 9 and 10. Moon records of the student GA two days apart.
Source: Research file.

When observing the two drawings of the student GA, taking as reference the orange roof and her speeches in the classroom, we can assume that she realized that the Moon was more to the right on the second night of observation, maintaining similarly the horizon in which performed the registration. The following conversation took place in the classroom the day after the second observation and counts on GA's statement about the change of position:

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> YA: *She was just like a banana.*
> GA: *Yesterday the Moon was more or less the same, but it was not in the same place.*
> NI: *At our house, it was higher..*
> NI: *On Sunday, the moon "was" looking like a withered banana.*
> Research: *And how was she appearing yesterday??*
> NI: *A correct banana.*

We can see from the statements that the children noticed a change in the appearance and movement of the Moon in the sky in the first two observations.

Between the second and third observations at home, we asked the students if they believed that, on the next observation, the Moon would look different. Interestingly, the children, in their majority, said they believed that the Moon would appear "thinner", as if returning to the shape of "banana".

In conversation about the third observation at home, which happened 4 days after the second, the students demonstrated to notice that the Moon was quite different and that its place in the sky had changed, comparing the three drawings already produced scattered on the tables:

> GA: *This time, she was very different, she was a little bit fatter, she looked like a peeled watermelon and also like a boat.*
> Research: *And was it in the same place?*
> Choir students: *No.*
> Research: *And where was it? When you went to look, was it higher or lower in the sky?*

The students stated that the Moon was higher in the sky and one of them, AG, said that he had to go to a place different from the one where he made the previous observations in order to see it: *"First the Moon was here* [pointing to his drawing], *then went up a little bit, then stayed here behind the house, higher up ".*

KE's drawing (Figure 11) shows the perception of the *"fatter"* moon mentioned by the students and the limitation of their observation horizon, the window of the apartment where they lived:

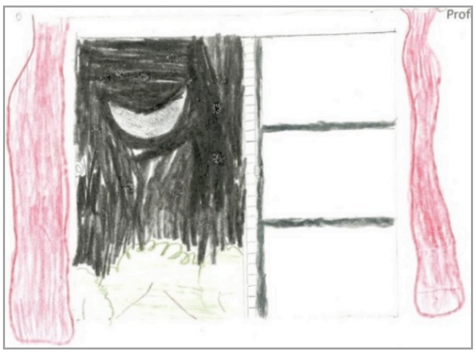

Fig. 11. Moon record of the student KE in the third observation
Source: Research file.

After four days from the previous observation, the students demonstrated to perceive a great change in the appearance of the Moon and its position in the sky, in relation to the previous observations. In this conversation circle, they were also asked if they believed that the Moon was important:

Research: *And is the moon important?*
KE: *For us to sleep, otherwise we will not sleep.*
HI: *Every day, when I look at the moon, I sleep.*
AC: *If it was daytime, we couldn't sleep..*
YN: *The Moon is very important, because when, like this, if there was no Moon, there was only the Sun and it was not at night, it was only during the day, and we would not be able to sleep.*
Research: *So, is it the moon that brings the night? Or would we have night even if there was no moon?*
GA: *No, it is the sun that illuminates one part, and the other is dark.*
GS: *Teacher! That's it, teacher, look, this is the Earth and this is the Sun [hand waving], right? The Sun only illuminates that side and here it gets dark ... Then ... I don't know, I forgot!*
KA: *Then, when the Sun illuminates this side here, it gets dark.*
GS: *This is what I wanted to say ...*

This dialogue reveals some interesting questions about the contribution between children in the elaboration of ideas and the first manifestations of the phenomena outside the planet, from the perspective of the *Sun-Earth* system. It is possible that students do not necessarily understand their explanation in a scientific way, they probably saw something about it in drawings or other sources, but they evidenced the idea in the course of the conversation. The statements indicate what Vigotski (2009) says about the systematization and awareness of the child in relation to the concepts of the child's displacement in his way of informing and using them, based on elementary concepts developed. In other words, there is a movement of interrelations, and not the substitution of one idea for another.

In this section of the conversation wheel, it is possible to notice that a discussion about day and night begins. The ideas presented by the children about an opposition between the Sun and the Moon, as if the first was responsible for the day and the second for the night, centered on a kind of relay in the sky, had already appeared in the initial interview. It is interesting to note which was a subject that had the collaboration of colleagues themselves to obtain a more correct explanation, even if not necessarily complete. According to Vigotski (2009),

> in collaboration the child can always do more than alone. (...) The greater or lesser possibility that the child will move from what he knows to do alone to what he knows how to do in collaboration is the most sensitive symptom that characterizes the dynamics of the child's development and success (p. 329).

We can see this by explaining the phenomenon correctly, initiated by one child and complemented by others.

Oliveira (2010) highlights that the emphasis given to the socio-historical dimension in Vigotski's theory is related to the thought that learning is a process that includes the relationship between individuals - in this proposal, not only between students and teacher in the classroom, but between the pairs:

> In the construction of the typically human psychological processes, it is necessary to postulate interpersonal relationships: the subject's interaction with the world occurs through the mediation made by other subjects. In the same way that development is not a maturation process, learning is not just the result of an interaction between the individual and the environment. The relationship that occurs in learning is essential for the definition of this process, which never occurs in an isolated individual (p. 56).

Thus, the conversation circles, the children's ideas, the questions that the researcher asks, are fundamental for learning.

Still answering the question about the importance of the Moon, student IA, who lived in a rural environment, said: *"The Moon is important, because sometimes someone is afraid of being in the dark"*. This denotes a different relationship from the one we establish with the star in urban environments, where, often, it is not even possible to perceive the illumination caused by the moonlight due to the interference of the artificial luminosity of the cities.

In the fourth observation at home, the Moon was just a few days from its full phase. As a result, the students' drawings looked like a full moon. In the conversations in the room, some children believed that it was indeed the phase of the full moon. Asked about the format, if it was indeed *"very full"* or almost, most children said it was almost; and so the conversation followed:

RI: *Hey, teacher, Saturday is full moon day.*
Research: *How do you know?*
RI: *I saw FULL* [spelling/syllable]
Research: *Where did you see it?*
RI: *Under the 29, it is written there full* [pointing to the 29th day on the calendar].
Research*: And what would be the one you saw yesterday?*
NI: *New moon ...*
GA and JU: *Full.*
NI: *Waning ... I think it's waning, because it wasn't too full ...*
GA: *New, I think ...*
NI: *Let me see, yesterday was the 27th?* [Going to the calendar].
GA: *Ohhh! It is growing.*
NI: *GROWING* [spelling/syllable].

The perception that the calendar of the room we used throughout the year to organize our activities registered the phase of the Moon was a discovery of the children, without the indication of the teacher. Thus, they have already anticipated knowing that, in the next observation, we would actually see the full moon. At that moment, student GA stated that *"the* [full moon] *turns very yellow",* which may express that the student recalled a previous observation in some situation in her life and perception.

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After the fourth observation, some students began to talk about seeing something or noticing something about the Moon outside of the agreed days for observation with record and outside the conversation moments on the subject, spontaneously. In one of the classes, a student said that he had seen the moon in the sky during the day, which led to a demonstration in part of the room and developed a conversation around this issue. Another student noticed the image of the Moon shown on TV during a football game. These speeches may be an expression of an interest in the star that extrapolates the space and time of planned school approaches, corroborating what was exposed by Lanciano (1986), who indicates that observation activities can awaken desires for new knowledge.

The fifth observation at home was scheduled for the day that would be a full moon. Here is part of the conversation that took place in the classroom after the observation weekend:

> Research: *How was the moon on Saturday?*
> Children: *It was full.*
> GA: *And she was shining, teacher, very strong!*
> Research: *And you said the other day that when the moon was full, it turned yellow. Was it yellow?*
> GA: *No ... but sometimes it is ...*

Noticing this change about the color of the Moon is something interesting, sensitive, and related to our atmosphere, especially when it is close to the horizon. This type of observation raises questions about why this happens. Even though she did not go into this question, the student recalled the coloring and observed the variation is very relevant in the sense of expanding what is known about the star in this experiential perspective. The drawing of the observations of students AG and KE are depicted in Figures 12 and 13.


Fig. 12

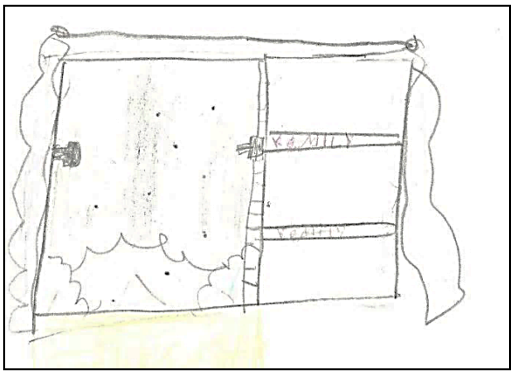
Fig. 13

Fig. 12 and 13. Moon records of the student AG (left) and student KE (right) of the fourth observation
Source: Research file.

We can see the AG Moon very close to the image of a full Moon and the observation situation of student KE, who, at that time, was no longer able to observe the Moon from her window at the same times and followed the Moon record of friends who had access to broader horizons.

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The last observation was set for a date when students would not be able to see the Moon at the time they used to make their observations. As a result, the astonishment and elaboration of ideas about this fact yielded long conversations and ideas about why they had not found the Moon in the sky. The proposals presented by the children varied, some considered that it could be on the other side of the house, behind a cloud, until a student raised the idea that it could be *"further down":*

> Research: *How did you see the Moon yesterday?*
> AC: *I didn't find the Moon ...*
> Research: *What about you, Ga?*
> GA: *No, I don't saw the Moon, because I think I saw it too late.*
> Research: *Why didn't many people see the Moon?*
> NI: *I think it's the clouds.*
> GA: *I think, in front of my house, it wasn't showing , but I think it was behind ...*
> [The children YA and NI stated, from the speech of GA, that they looked everywhere and still did not find the Moon. Thus, the student GA concluded:]
> Research: *Where would it [Moon] be then?*
> GA: *I think the moon was a little lower.*
> Research: *What do you mean lower?*
> GA: *It was a little bit lower.*

We understand that the speech of GA refers to the horizon, when it raised the possibility that the children had not found the Moon, because it would be "lower". According to the students' statements, we can observe a certain understanding about the apparent movement of the Moon, since some stated that they made the observation too late, that the Moon should be further down, that it could be in another part of the sky, it is not possible to see it from its local horizon.

The drawings by students AN and HI illustrate this situation:


Fig. 14

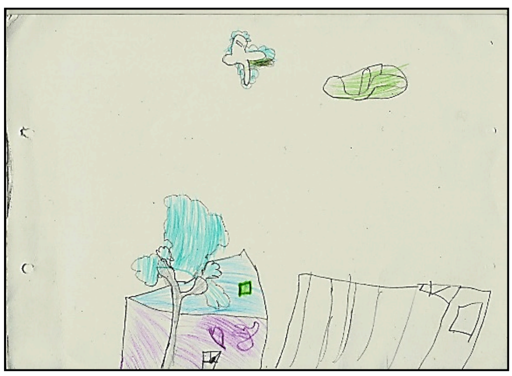
Fig. 15

Fig. 14 and 15. Records of student AN (left) and student HI (right) of the last observation.
Source: Research file.

The figures show drawings without the Moon, as the observation would actually be at the times when the students were used to it. In the drawing of HI, according to his speeches, we have in the sky the record of an airplane that passed while the student

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was observing at night, but illustrated in a diurnal and close way (central figure of the sky) and of a spaceship (on the right).

In addition to this perception, the aesthetic issue emerged in the speech of the student IA, who exposed the feelings that the Moon awakens in her: "*The Moon is very beautiful too, you can't stop looking at it; when I'm kinda 'sad', I keep looking at it, put a cloth on the floor and keep look at it ... ".*

According to Seniciato and Cavassan (2009), learning in natural environments can contribute to an aesthetic experience that is different from the relationships we usually maintain daily, mediated by functionality. This is also related to the discussion about the color of the Moon that student GA presented in the fourth observation. Thus,

> in the case of natural environments, this reflection ultimately implies how the educational process will contribute to the conduct of individuals in relation to natural environments. If the aesthetic experience, characterized by this approximation between man and the natural object, makes man reflect on himself, it makes him reflect, simultaneously, on the natural object (Seniciato & Cavassan, 2009, p. 397).

The rushed passage through the contents usually does not allow the creation of moments to feel it, for the aesthetic, which ends up leaving this dimension away from the school space.

As a summary, Chart 3 presents the number of observations and perceptions and knowledge demonstrated by the students through drawings and speeches in the conversation circles:

Table 3. Number of observations and perceptions and demonstrated knowledges

Order	Perceptions and Demonstrated knowledges
1	Identify and record the position of the Moon in the sky Identify and record planets in the sky: Venus and Jupiter Identify the constellation of Orion Getting to know the telescope Observe the lunar craters
2	Observe and record the horizon with support at school
3	Register the Moon autonomously
4	Perceive the changing position of the Moon, considering the horizon Perceive small change in its appearance
5	Note the change in aspect and position of the Moon Observing the Moon at other times, at the initiative of the students
6	Perceive the continuous change in the visible shape of the Moon Investigate the modification of the position of the Moon in the sky See the change of direction of the visualization and record the Moon Building the relationship with other spheres of our life: the calendar
7	See the brightness intensity View significant changes in its apparent color
8	Develop explanations for not observing the Moon on certain nights

Final Interviews

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After the last made observation, in order to add to the procedural data, we conducted a new interview with the children, intending to verify what they believed they had learned from the activities. These interviews were important to produce basic syntheses of the class, since not all children participated equally in the conversation circles, as well as the drawings did not always meet the proposal in a structured way by the students' age group.

The initial open questions were: "Do you remember the studies we did on the Moon?"; "What do you think you learned from what we did?" Regarding the interview with open questions, the students spoke about different aspects, and we conducted the conversation to see if they noticed the changes in appearance over the nights and the noticeable change in position, when the students did not include these themes in their speech.

Regarding the change in the appearance of the Moon, all children confirmed that the Moon changes its apparent shape, and some added by explaining that this situation occurred because of the Sun, others said that it was because of the Earth. Regarding the change of position in the sky, all students indicated that the Moon changes places, except for a child who did not participate in the last interview. Other students complemented their explanations with the information that the Earth is also moving. We believe that this type of statement reflects the first systematizations of the *Sun-Earth-Moon* system in its spatial relationship (Chart 4):

Chart 4. Students' perceptions about the change of the moon in the sky

Student	Initial interview	Final interview	Student	Initial interview	Final interview
AG	A	B	KA	B	B
AC	A	C	KE	A	C
NA	A	B	MA	A	B
BE	A	B	NI	B	C
CA	D	B	RI	D	C
GA	A	C	YA	D	B
GS	B	C	IA	D	C
HI	A	B	HY	D	D
JU	A	B			

Caption: A - Does not change places; B - Change place; C - Change places, and the Earth moves; D - Did not answer.

With the variation of students in the classroom throughout the year, we performed the complete process with only 17 students.

If the Moon is observed at an approximate time over the proposed time, we would have a drawing similar to that shown in Figure 2. Considering that the children did not have an open horizon as shown in the figure for observation and that the drawings could not express the movement clearly throughout the whole proposal, we asked a synthesis question to verify the perception about the observable movement. We presented two drawings (Figures 16 and 17) with any horizon, but explaining that the observations were recorded on the same sheet, and we asked which drawing was closer to the one that the student had observed in these studies on the Moon:

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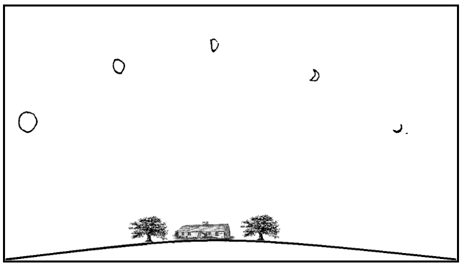

Fig. 16

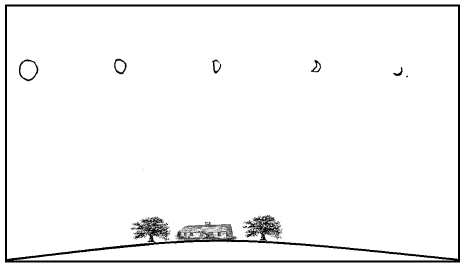

Fig. 17

Fig. 16 and 17. Apparent movement of the Moon: Option 1 and Option 2
Source: Adapted from Lorenzoni (1988).

Fourteen students stated that the option in which the Moon changed its height was the closest to what they had observed (Figure 16), 2 of them responded showing a certain insecurity; while some of the children spontaneously explained that they noticed her "taller" and "shorter" in a few days. Only 2 students chose option 2 (Figure 17); and 1 student did not participate in the interview. Thus, 82% of the children demonstrated to understand the movement observed during the nights, only 12% believed that it did not vary in height during the nights observed, and 6% did not answer this question.

With the comparison of the interviews, considering the entire route of the proposal, we can say that, except for the student who did not respond to the interviews, all the others showed development in relation to the concepts about the Moon, its change of appearance and its movements. This corroborates Vigotski's (2009) statements about the development of scientific concepts in children:

> The development of scientific concepts begins in the field of consciousness and arbitrariness and continues onwards, growing from top to bottom in the field of personal experience and concreteness. The development of scientific concepts begins in the field of concreteness and empiricism and moves in the direction of the superior properties of the concepts: of conscience and arbitrariness (p. 350).

Unlike direct teaching of concepts, pointed out by Vigotski (2009) as empty and sterile, the proposal based on observation, drawings, and dialogues with children sought to stimulate accessible and important experiences before the eyes of students, in a mediated and intentional way , without which the assimilation of the scientific knowledge system is not possible.

CONSIDERATIONS

Given the objectives of the proposal, we found that, when we prioritize the observation of the Moon in a systematic way and accompanied by the teaching interventions and the conversation circles between the students, they demonstrated the perception of a series of questions about the Moon and its phases, in an assertive way. Most of the students revealed to understand the observable movements of the Moon in the sky, as well as its change of appearance during the nights of observation, in part of a lunation. Some children established relationships between observations and information about the spatial phenomenon, obtained earlier, possibly in their schooling, in the media, etc.

Like the different pedagogical interventions, this proposal did not reach all students. Some stopped performing activities at certain points for several reasons, but the data show that the reach was significant.

We start from a proposal of experiential Astronomy and we seek to sensitize students to the observation of the sky and to the experience. Analyzing the trajectory of the pedagogical process and the results, we can affirm that, despite the difficulties, there was a development of scientific concepts, not in the full sense of our systematized knowledge in society about the Moon, but suitable for the school level and the age group of the students.

This type of methodology indicates the students' potential to conclude important questions of nature through experience, differently from the sharing of information and its accelerated accumulation. Certainly, there are other contents in Astronomy that are less accessible to experience, however, the most basic part of this area may include intentional observation as a principle for learning, without the anxiety and demand to exhaust and organize knowledge in a complete and finished way on a given subject. in a single school year. The relevance of this type of approach is centered on the processes, on the paths taken, and not only on the results they achieve.

This development of scientific concepts, from the perspective of Vigotski, continues to dialogue with the child's spontaneous ones. Thus, over time, the child will develop other concepts that dialogue and develop with these from the research, throughout their schooling, when this theme is again addressed in a more complex way. It is very possible that, as in this experience, students are able to organize and develop the observation and study of other stars, with assistance.

New research based on observation can include understanding the path that the Moon takes in the sky, the other phases, as well as advancing towards the spatial phenomenon, especially with older children. During basic schooling, if there are more practices elaborated in this perspective, making discussions more complex, it is possible to idealize that students progressively elaborate ideas and conclusions related, for example, to the Sun-Earth-Moon system, reflecting on the spatial relationship of the phenomenon. However, for the school level with which we work, considerations and studies related to the subject's perspective, topocentric, are essential.

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