

Research about the adaptation process of Astronomy didactic material - the Diary of Sky - from the context of the Northern Hemisphere to the Southern Hemisphere

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Abstract. This paper describes one of the phases of a broader research carried out by the Science Education Research Group (SERG) from State of São Paulo (UNESP, Brazil), which has evidenced the distance between the academic production of the area of Astronomy Education and the knowledges and practices of students and teachers in Basic Education. In this text, we seek to investigate the singularities found during the stages of translation and adaptation of a specific didactic material, in the form of a school diary – *Il Diario del Cielo* (*The Diary of the Sky*) -, originally created and idealized to the reality of the Northern Hemisphere (Rome, Italy) and adapted to the reality of the tropical belt of the Southern Hemisphere (Bauru, São Paulo, Brazil), as well as discuss the potential of this material, to work with concepts of phenomena related to Astronomy, in a training program of continuing training for in-service teachers in Secondary and High School in the area of sciences. Topics such as: the visible horizon, the time of birth, climax and sunset and the Moon, the duration of the day according to the time of year and the latitude of the place of observation, equinoxes, solstices, seasons, phases of the Moon, among others, are approached from a sequence of didactic activities developed with students, in regular schools, according to the bases of Position Astronomy. Among the results found, the data obtained evidence that teachers were in favor of the proposal, approving the use of the astronomical diary, offering them moments of reflection on what they know about the contents worked, what they learned during the course and the feasibility of an incorporation of the contents discussed to their daily practice, and can be understood as viable and relevant to potentialize and enable the teaching of astronomy concepts in basic education. It also stands out, among the results, that the need to record daily the data from the active and systematic observation of the sky and the environment in a diary, besides to reveal an interdisciplinary character, involving different areas of knowledge, also points to the need to diagnose, discuss and reflect on the student's difficulties in developing the habit of daily written record as well as the teacher in managing the contrast between times of astronomical phenomena (cycle day and night, lunar cycle, seasons of the year, eclipses, among others) and those of the school, between the open spaces for the sky and the confinement of the classrooms in schools, making the task of teaching about astronomical contents more difficult. Also points out the expectations and challenges faced by the teachers in relation to the teaching of astronomical phenomena, considering the relations of similarities and spatio-temporal differences between the realities of the North and South Hemisphere contexts, as well as the initial training of teachers, compromised by the way and the quality, or even by the inexistence of the same, which leads to the incipient domain of the disciplinary and pedagogical knowledges focused on Astronomy and sometimes the feeling of incapacity and insecurity, when working with the theme in schools.

1. Introduction

Observing and representing the celestial space of the place where one lives is an ancient practice of humanity. There are historical records that show that since past societies have been developing techniques to map the sky more accurately and effectively. But what is the importance of looking at the sky? This question implies a large number of answers, which both justify the importance of this action and the relevance of the study of one of the oldest sciences – the Astronomy. Learning about astronomical phenomena, contextualizing them and relating them to local and world issues, articulates with what is observed daily in the sky here and now, with what one thinks, one knows, one sees in books and in simulations at a local and global level [2]. In this perspective, the teaching of the notions of geographic location and spatial orientation, throughout the schooling process, is fundamental for the development of the geographic reasoning and for a more abstract spatial knowledge, constructed through observations, identifications and explanations about the location of astronomical phenomena in wider spaces [3]. Based on these ideas, according to research carried out by Scherma and Ferreira [12], the work with the spatial and geographical orientations can start from elements of Astronomy, among them, the observation of the sky. They highlight that from astronomical data, for example, the localization systems were being refined, since that ...

In the early days of human existence, orientation and spatial localization were necessary skills for survival, especially in terrestrial journeys to seek shelters and food. Over the centuries, with the knowledge of the stars, with the invention of the compass and with the use of maps, the location and orientation became more precise, allowing to guide the movement of explorers and navigators of lands and seas, at any time or condition of the environment. Currently, we have a range of information about any place, available to many people, through GIS, cyberspace and GPS [12]. (Translation of the authors of this research).

However, as Lanciano [6] affirms, although the sky is always present on the place where we live, we know, empirically, less and less about it, either because of the abusive use of television images, or even the current accelerated pace of life, according to which we have not had enough time for this venture. In the educational field, according to the author, the systematic and constant observation of the sky (astronomical element) is characterized in the main resource of exploration of the celestial phenomena. However, based on research it is possible to affirm that this expedient, until very recently, was hardly explored in school environments [6]. Still, according to the author, the topocentric reference can be used in teaching activities, in schools, from elements of Astronomy, among them, the direct and constant observation of the sky. And from astronomical data raised by students, it is possible to recognize systems of reference or geographical location and spatial orientation. Taking as a reference the experience of Lanciano [2], in the sense to promote the incentive and interest in Astronomy, many have been the contributions of international research on the subject, in the sense of being able to demystify common sense ideas about physical phenomena, which are experienced daily. From this perspective, in a literature review, it is noted, among the approaches that seek to contribute with teachers in the development of the teaching and learning processes of Astronomy contents, in primary schools, the researches developed by Plummer, Waskoa and Slagleb [10], whose studies with American students of basic education aim to develop more sophisticated mental models of the celestial movement, focusing on the rotation of the Earth and patterns of daily movement.

According to the authors, the research seeks to analyze the impact of these observational astronomy strategies, when they are disseminated in the long term in the school curriculum. The goal is to teach students how to use Earth's rotation to explain the daily celestial movement of the Sun and Moon, starting from the idea that the basis for understanding many aspects of Astronomy is the ability to use real motions and positions relative of celestial objects, such as the Sun and Moon, to describe the phenomenon observed and make predictions about future observations, understanding concepts that lead students to discover the reason for the seasons and phases of the Moon, for example. According to Plummer [11], additional researches are required to understand, on a deeper level, the interaction between teaching and cognitive growth of students at different levels of students' understanding of

concepts derived from observational astronomy. However, according to the author, development in this area can also be better obtained if it is carried out through the use of explanatory physical models and the kinesthetic experiences experienced by the students. Results of the research carried out by the Research Group on Pedagogy of the Sky, the Movement for Educational Cooperation (MCE) - Rome (Italy) and the Research Group on Teaching Science (GPEC) - UNESP - Bauru Campus, SP, Brazil evidenced the distance between the academic production of the area of Education in Astronomy and the knowledge and practices of undergraduates and teachers in Basic Education According to Langhi and Nardi [7], in the specific case of astronomy and its teaching, the need to stimulate the study and interaction of science elucidate that understanding the evolution of Astronomy Teaching in the scenario of Brazilian education allows us to understand its current stage and situate the present research. By means of studies already carried out on previous conceptions, conceptual errors found in textbooks, analysis of the guidelines contained in the National Curricular Parameters (NCP) and in the interpretation of the discourses of teachers who work in the Elementary School in public schools, it is possible to perceive the almost that absolute or inappropriate use of Astronomy contents in its formation. They also clarify that:

[...] it is not enough for initial or continuing training courses to focus on content training, divorced from the corresponding teaching methodologies; the great challenge is the question of didactic transposition, that is, to invest, simultaneously, in the pedagogical knowledge of the content. [...] More than the teaching of content itself, the questions related to the construction of pedagogical knowledge of content have been pointed out as one of the failures of undergraduate courses, in a general way. [8]. (Translation of the authors of this research).

According to the authors, the presence of gaps in the training of Basic Education teachers regarding astronomy studies and their teaching has generated the sensation of insecurity, lack of contextualization and adequate sources of information when working with the theme in schools. It is in this sense that this communication presents some singularities found throughout the stages of translation and adaptation of the specific didactic material *Il Diario del Cielo (The Diary of the Sky)* [2], in the format of an astronomical school diary, prepared by Profa. Dra. Nicoletta Lanciano from Università "La Sapienza" di Roma and coordinator of the Movement of Educational Cooperation (MCE), Rome, Italy. This is a proposal for working with concepts of astronomical phenomena, aimed at teachers and students of Basic Education, originally created and idealized for the reality of the Northern Hemisphere and adapted to the reality of the tropical belt of the Southern Hemisphere. : the visible horizon, the time of the sunrise, the climax and sunset of the Moon, the duration of the day according to the period of the year and the latitude of the place of observation, equinoxes, solstices, among others, are approached from activities developed according to the bases of Observational Astronomy.

The study shows the importance of considering the natural environment, which, in particular for this research, presents itself as a great outdoor observatory, available full time and at no cost to its use: the sky. It also discusses the teacher's difficulty in managing, among other things, the contrast between the times of astronomical phenomena, such as the day / night cycle, the seasons of the year, the lunar cycle and eclipses, for example, between spaces open to the sky and the confinement of classrooms [2]. The need to articulate and record frequently observed data in the sky and surroundings in a diary, in addition to revealing a highly interdisciplinary character, involving physical, mathematical, astronomical as well as geographic, historical and cultural knowledge, also points to the the need to diagnose, discuss and reflect on the difficulties and expectations of teachers when working with their students activities developed from the use of didactic material under analysis, within a longitudinal development coherent in itself and with everyday experience. This study has been considered in the planning of cooperation activities between the aforementioned research group and a group of teachers and students from primary schools of the public school system in the city of Bauru (SP).

2. Methodology

The observation and interpretation of Astronomy phenomena from different points of view leads to the realization that these are related to different reference systems, so as to allow the teacher and, later, his students, to construct a coherent vision and more broad in terms of its position in three-dimensional space and in the real time of astronomical events [2]. This way, the methodological procedure of this teaching proposal was initially characterized by the stage of translation of the book *Il Diario del Cielo* from the Italian language into the Portuguese (Brazilian) language. Initially, a bibliographical survey of support and reference was made to the study of the Italian language, bringing together vocabulary and native grammar structures, as well as the support of a bilingual professional. Although the two languages involved in this research situation contain many cognate words and expressions, this stage of the research proved to be quite complex, since it was not only a simple literal translation of words and phrases from Italian to Portuguese, but , but rather to guarantee the use of more adequate terms and expressions, so as to portray with fidelity and naturalness the linguistic reality of the context of the *Il Diario del Cielo* [4]. The figures 1 and 2, as follow, illustrate one of the procedures of translation of the original text into the Portuguese language, maintaining the original activity

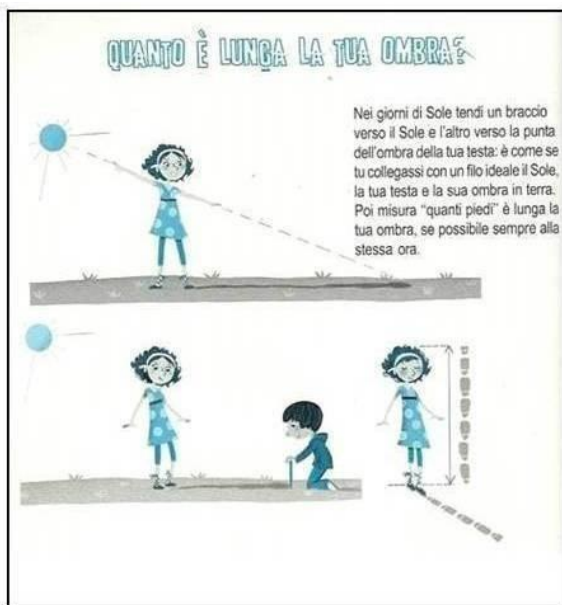


Figure 1: Original text in Italian [4].



Figure 2: Text in Portuguese (Brazil).

The next step consisted in adapting or refining the didactic sequence described in the Italian project *Il Diario del Cielo* to the reality of the specific locality of the tropical belt of the Southern Hemisphere, ie, Bauru municipality. In general, among the specific information adapted for *The Diary of the Sky*, we highlight those that articulate elements of the direct and systematic observation of the sky and the surroundings and of the work with explanatory astronomical models, bearing in mind the relation between the Sun and the Earth , to give meaning to, among others, astronomical phenomena, such as day / night cycle, seasons of the year, phases of the Moon and conjunctions of the stars in the sky, as well as to promote and allow the continuity of attention to such phenomena: of the school year, indicating the day of the week and the month; (b) monthly celestial maps; (c) proposals for didactic activities to observe celestial phenomena at the beginning of each month; (d) construction and use of different explanatory astronomical didactic models, appropriate to Observational Astronomy; (e) indication of the astronomical ephemeris of the sunrise, culmination and setting of the Sun and Moon,

conjunctions involving the Sun, Moon, planets and / or stars, the instants of the equinoxes and solstices and the entry of the Sun into the zodiacal constellations, according to the local geographical coordinates Latitude and Longitude, considering Brazil (Bauru 22°S and 49°O) and Italy (Roma 42°N and 12°E); (f) astronomical windows, spaces for the registration of the visible local horizon; (g) mythical tale to present aspects of Cultural Astronomy. The figures 3 and 4, below, illustrate the Italian and Portuguese (Brazil) versions, respectively, of the book *The Diary of the Sky*.



Figure 3: *Il Diario del Cielo* [4].



Figure 4: *The Diary of the Sky*, Portuguese language (Brazil)

As for its structure, although the academic rigor in its writing is not demanded, the Diary keeps, among other characteristics, spaces for the students' daily records referring to the date and time of the information entry, to the detailed notes, containing a daily narrative of the students' personal experiences, in exclusive moments of the day and / or night, to the drawings and other signs, besides the signature of the student, evidencing the authorship of the records, as shown in figure 5, as follows:

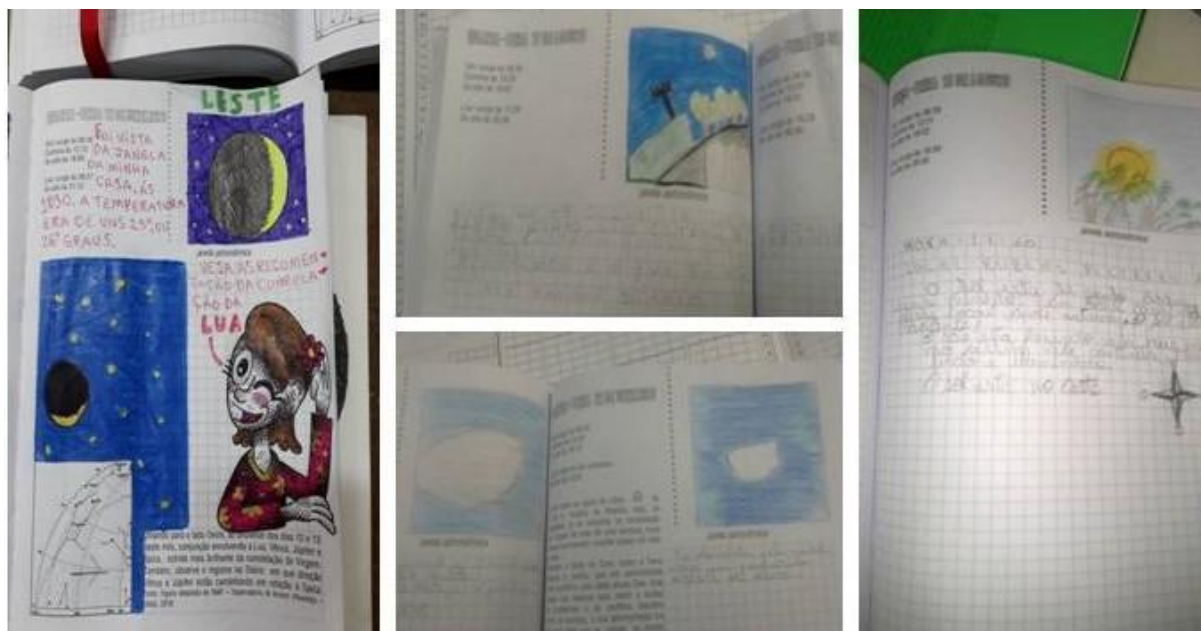


Figure 5: Set of images, illustrating the configuration of the information and spaces present in *The Diary of the Sky*, to favor the students' records.

The observations to be recorded in the *Diary* follow the guidelines of the didactic activities proposed at the beginning of each month of the school year, referring to the following astronomical phenomena: recognition of the planets and the main stars and constellations, following their movement over time and of the seasons, the instants and positions on the horizon of sunrise and sunset, the length of the shadows throughout the year, conjunctions involving the Sun, Moon, planets and / or stars and the indication of how to look at the sky the lunar phases of the Moon, eclipses, moments of the equinoxes and solstices and the beginning of the seasons, the entry of the Sun into the zodiacal constellations, among others [4], which can be continued in the following months of the year, in order to exercise the learning of the direct and systematic observation of the celestial phenomena, as well as the use of different instruments appropriate to Astronomy Observational. In this sense, like the beginning of the seasons, the equinox events and solstices are highlighted, which are given different names according to the locality, in different hemispheres, from where they are observed. Thus, when the Spring Equinox or the Summer Solstice in the Northern Hemisphere begins, respectively, the Autumn Equinox or Winter Solstice begins in the Southern Hemisphere. A reflection on the physical-astronomical and geometric aspects of the said events points to the Sun as a clock that marks the passage of time in space, based on the fact that on a given day of the year and at a given latitude there is a precise relationship between the hour and the height of the Sun above the horizon [5], so on the Summer Solstice, the Sun reaches the highest point in the sky; in the Winter Solstice, the lowest point and, at the Autumn and Spring Equinoxes, it remains at the midpoint [3]. Another example shows that for each day of the school year, in the Italian and Portuguese (Brazilian) versions, the *Diary* provides the precise moments of the birth, culmination and setting of the Sun and Moon, considering the geographical coordinates Latitude and Longitude of the two localities involved with the adaptation phase of the *Diary of the Sky*. In this sense, associated to the study of such concepts, it should be emphasized the months of the year, December and January, in which there are days and times, in which the Sun will meet exactly the Zênite in the investigated locality of the Southern Hemisphere (Bauru / SP), therefore, there is no shadow at solar noon. This situation will not occur in the investigated locality of the Northern Hemisphere (Rome / Italy), since there will be no Sun at any time of the year for this region of the planet, as shown in figure 6 as follow:



Figure 6: Activity of the book *Il Diario del Cielo* adapted to the reality of the investigated locality (Bauru / SP), tropical region of the Southern Hemisphere.

As for the various instruments used in Observational Astronomy, such as: celestial charts, quadrant, rose of the winds, gnomon, the body itself, Parallel Map-Múndi [2], among others the *Diary* highlights its operating instructions, helping teachers and students in the constant observations of the sky. In this sense, the Parallel Local Globe is a tool for didactic practice capable of combining manuality, observation, concrete experimentation and reflection. It allows you to see how the Sun illuminates the different regions of the Earth, promoting the understanding of time zones and real-time station changes, as well as clarifying the semantic and symbolic differences of the North-South, high-low, up-down, up-under, up-down, in different languages and cultures, as shown in figures 7 and 8, as follows:

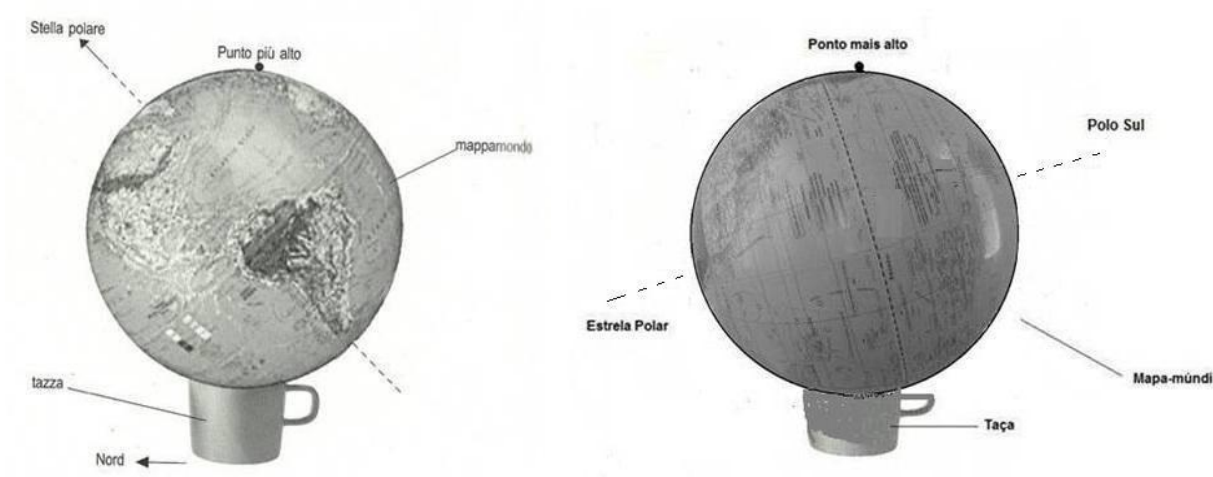


Figure 7: The Parallel Local Globe in Italy [4]. **Figure 8:** The Parallel Local Globe in Brazil [adapted from 4].

In this stage, which covers the interdisciplinary potential of *The Diary of the Sky*, directly related to objects and phenomena observed or perceived from the geographic space, the astronomical language is intersected by various mathematical concepts, highlighting elements of geometry such as: angles, constructions with rulers and squares, notions of circumference, geometric forms, measurements, proportions, reasons, also elements of physics, with emphasis on the study of the celestial sphere, movements of the stars and gravitational field, as well as elements of geosciences, highlighting notions of cartography, as : maps, graphical and numerical scales, position, orientation and distance. The adaptation of the *Diary of the Sky* also had the essential use of computer programs related to astronomy or software aimed at astronomical observation, such as *Stellarium*, *Heavens-Above* and *Skymaps* and the Yearbook of the National Observatory (ON) – 2018 - Rio de Janeiro / RJ [1], for the determination of the moments and positions, with respect to the horizon, sunrise and sunset and Moon, conjunctions involving the Sun, Moon, planets and / or stars, besides the moments of the equinoxes and solstices and beginning of the seasons, the entrance of the Sun into the zodiacal constellations, as well as the orientation of the Earth and system of legal hours and their diffusion.

3. Results

This communication describes, as a result of the adaptation of didactic material *Il Diario del Cielo*, some ideas about its use as a tool conceptual and didactic in teaching activities of Astronomy.

At first, during the translation process of the original *Diary*, designed for the Northern Hemisphere, it was realized how varied and complex the situation would be to translate it and adapt it, considering the various geographic areas constituting the Hemisphere South: the Ecuador and the tropical and temperate zones. While recognizing the rich and fertile horizon of research possibilities that scientific work in these conditions can offer, from a didactic-pedagogical point of view, for this study, in particular, highlighted the work with notions and knowledge of geographical location and spatial

orientation, whose educational practice can contribute to exploiting geographic knowledge and astronomical and spatial notions, to describe situations and solve problems related to students' daily lives [12].

It is emphasized that guiding, locating and representing are basic knowledge of Geography, Astronomy, Mathematics and related fields and are associated with cognitive development of the student, which has different conceptions of space, according to their level of acquisition of knowledge for the occurrence of learning [9]. The success of acquiring this knowledge individuals depends on the interaction they establish with the environment where are inserted.

In this sense, the *Diary of the Sky* adaptation, in general, has possible for a group of teachers and students of Basic Education to discuss and reflect on on teaching and learning situations in Astronomy related to thematic: movements of the stars and gravitational field; determination of moments and positions, with respect to the horizon, of the sunrise and sunset of the Moon and of the conjunctions involving the Sun, the Moon, planets and / or stars, the Equinoxes and Solstices and the beginning of the seasons; of the entrance of the Sun into the zodiacal constellations; positions of the Solar system; orientation of the Earth and system of legal hours and their diffusion; scales of time; Legal time and the summer time decree; notions of Cartography and orientation spatial and geographic location; use of topocentric reference; time zones; calendar and calculation for the Leap Year; phases of the Moon, apogee and perigee of the moon, eclipses and constellations and bright stars, such as: Aldebaran, Pollux, Regulus, Spica and Antares.

It is understood that the configuration of the *Diary* can offer the group of teachers and Basic Education students moments of discussion and reflection on what they know and what they are learning about the subject, by relating the object of study to the events that surround it. In this sense, it is understood that the articulation between the elements of direct and systematic observation of the sky and the surroundings and activities involving astronomical didactic models can provide them with perception, in the local space and in real time, of the phenomena studied as shown in Figures 9 and 10, as follow:



Figure 9: Set of images of the activities developed with the teachers during the Continuing Education Course in Astronomy - *The Diary of the Sky* - *Introduction to Astronomy for Educators*.



Figure 10: Set of images of the activities developed with the students (as) during the implementation process of *The Diary of the Sky* in schools partnering with the project.

4. Final Considerations

It is considered that the adaptation of the didactic sequence of the Italian project *Il Diario del Cielo* to the reality of a locality in the tropical belt of the Southern Hemisphere (Bauru - SP - Brazil) and its use as a teaching strategy may favor the articulation with what is observed daily in the sky here and now, enabling the group of teachers and students the sharing of hypotheses, inferences and the meaning of concepts, models and theories, as well as the distinction between interpretations of phenomena and experiences; the co-responsibility of the learners in order to make their own discoveries about the contents studied; the involvement of students in operations centered on the relationship between mind and body; the protagonism of students in tasks that require their control; the authorship of knowledge of the student, that is, carrying out the activities proposed in *The Diary of the Sky*, with the mediation of the teacher, becomes, the pupil himself, the author of the *Diary*; new understandings and teacher knowledge to define new interventions in the teaching and learning processes of Astronomy for Basic Education.

However, it also signals caveats, among which, gaps in initial and continuing teacher training in Astronomy and its teaching; the difficulty of managing time and space school for teachers and students to follow and understand the phenomena astronomical and the lack of the habit of direct and systematic observation of the phenomena natural products; growing distance from nature. In this sense, the present work, when describing this stage of the procedure method of constitution of the Journal, aims, essentially, to contribute to the educational training of teachers of Basic Education, in order to enable them to build their own learning trajectories. In this perspective, according to Lanciano [2], it is expected that working with the Journal will allow them to relationships between spatial,

geometric and geographical concepts, as well as facilitating learn to distinguish observations, descriptions and interpretations and to expose their own point of view, in addition to choosing the system of reference itself.

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