Zodiac Constellations: Student Representations From Cultural Astronomy And Contextualized Concept Cartoons

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Abstract

This article presents the research project that analyzed the 6th-grade students' perspectives from a private school in Bogotá, Colombia, regarding Zodiac constellations using cultural astronomy. The study employed a qualitative interpretative approach and content analysis in five phases. These phases included identifying students' ideas about the Zodiac and constellations, designing a contextualized cartoon, selecting and organizing students' narratives, and describing students' representations of zodiac constellations. The study found that cartoons can effectively promote inquiry skills in the classroom based on students' experiences. Additionally, the study indicates that the study of Zodiac constellations can significantly impact students' observation of the movement of celestial bodies. Finally, the researchers suggest that studying Zodiac constellations can help students understand the different meanings and historical relevance of observing the sky through a transdisciplinary approach.

Keywords: Contextualized cartoons, cultural astronomy, astronomy teaching, Zodiac constellations.

Introduction:

According to Camino (2012), observing the sky has always been marvelous to humanity, not only because of the deep sensations that can have on humans, the unreachable sky, but also because of the strong influence of celestial phenomena in daily life. Patrons given by the movement of heavenly bodies have allowed humanity to establish patrons to create tools such as clocks and calendars. (Gómez, 2002) (Iwaniszewski,2011). Thus, it is evident that the influence of systematic observation of the sky on society is not only to measure time but also about the reflection that cultures have created in the atmosphere of the environment surrounding them about the ecosystems and natural and cultural events. Iwaniszewski (2001) and (Ruggles,2011). Additionally, Camino et al. Al (2016) pointed out the importance of studying sky observation; hence, it is an activity that most people can perform without belonging to an educational institution.

Therefore, as educators, one line of teaching astronomy and even science should be focused on the importance of rescuing the observation of the night sky and its different interpretations through history, which means leaving to one side the vision of astronomy as a product of Modern Science to recognize its holistic and humanistic value through the frame of Cultural Astronomy Camino (2012), Lins (2010), Benevides (2010), Costa de Araujo et al. (2017), and Jafelice (2015 & 2010) Even Camino et. (2016). According to Jafelice (2010), transdisciplinary teaching allows for the recognition of the importance of effective, valuable, analogical, and emotional components.

To follow this line, Jafelice states that a non-linear path of topics that can be studied is given by studying constellations, which allows students to understand the different meanings and historical relevance of observing the sky and creating patrons. Gangui and Iglesias (2021) and Linguini and Gangui (2013) explore the night sky by studying zodiac constellations because of the close relationship between popular culture given by astrology and the horoscope. Even though learning the constellations and the zodiac constellations does not seem to be important in Modern Science, Studying zodiac constellations can have a significant impact on the observation of the movement of celestial bodies, such as the Sun, Moon, and Solar system planets. In addition, even if not all students are interested in astrology, most know their zodiac sign, although they cannot know the relationship with zodiac constellations. (Gangui and Iglesias,2021)

This research proposal aims to significantly contribute to the field of astronomy education by proposing a novel approach based on cultural astronomy theory. This approach enables students to understand astronomical phenomena and concepts more deeply by examining them from various perspectives about their cultural context. As Camino et al. (2016) and Camino (2012) highlight, studying astronomy in schools is crucial for developing critical thinking skills and preserving cultural identities. Therefore, it is essential to investigate the impact of indigenous and traditional knowledge in the teaching of astronomy.

In light of this, the proposed study aimed to examine the representations that 6th-grade students from a private school in Bogotá created during a series of cultural astronomy activities, which included reading and commenting on a concept cartoon that was developed using a questionnaire to identify students' ideas about constellations and the zodiac, using the Stellarium simulator to observe the apparent path of the Sun, the Moon, and the Solar System planets throughout the year and its relation with zodiac constellations, and finally, creating students' cartoons and mind maps.

Methodological process.

The research was conducted using a qualitative approach to identify external representations, as proposed by Pérez et al. (2010). Al (2010) and Salsa and Peralta (2010) suggest that signs allow individuals to represent real-world objects through different means and store them in various locations within their memory using notational or code systems based on their domain-specific knowledge. According to Pozo (2017), these codes are not just tools but also cultural artifacts that extend change and organize the mind. As such, they possess unique features such as being organized, independent, and persistent, and the code is familiar to the individual and explicit, among others. Studies such as Salsa y Peralta (2010), Kirsh (2010), and Pozo y Marti (2000) support this perspective. To conduct the research, the following methodology was employed:

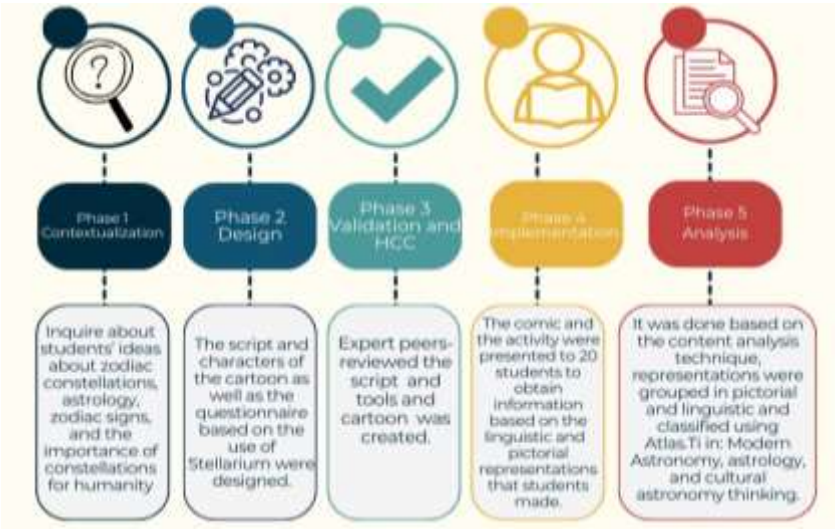


Figure 1 Developed methodology. Own creation.

The study was conducted based on Cultural astronomy teaching, which led to the creation of the first activity to identify students' ideas and context following the proposals of Jafelice (2010, 2015) and Belmonte (). A questionnaire was designed to identify students' ideas and lived experiences about the night sky, stars, constellations, and zodiac constellations to achieve this. Additionally, the questionnaire included additional questions regarding zodiac constellations based on the proposal of Gangui and Iglesias (2021).

The second activity consisted of designing a contextualized concept cartoon, a graphic representation of a situation using vignettes that include different explanations, including the scientific one, and are supposed to have equal value during the term. The cartoon should also relate to the student's ideas, and it is essential to maintain a balance of gender, recognize cultural diversity, use humor, and feature familiar situations. This approach is based on the work of Reyes et al. (2020).

Figure 2 CC design: What do stars say about my future?

The analysis of the cartoon sparked several questions, which were addressed using a simulator to simulate observing and considering planets and constellations with the naked eye. Students were also curious about using stars to predict the weather, so they read and discussed related myths in science class. This integrated an anthropological, environmental, and transdisciplinary approach, as suggested by Jafelice (2010).

Later, students created cartoons and mind maps to represent their understanding of zodiac constellations, drawing from their activities and ideas about the subject.

Results and discussion

The analysis was conducted using a qualitative-interpretative approach based on content analysis, which involved collecting data from various sources, such as pictorial, verbal, and linguistic materials. The study was performed from a qualitative-interpretative perspective to obtain a deeper understanding of the subject, as shown in Figure 3.

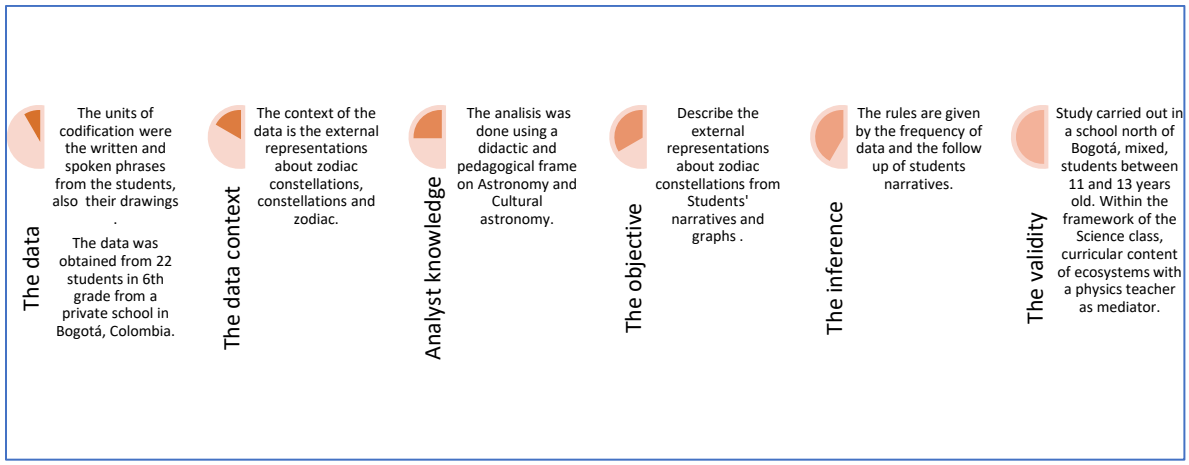


Figure 3 Analysis process. Own construction.

Two data sources were used: pictorial representations (e.g., drawings and models created by the students) and linguistic representations (e.g., responses, questions, and comments made during classes). Three categories were identified based on theoretical context and previous classroom observations: cultural astronomy, astrology, and astronomy.

A first approach to student's understanding of the zodiac and constellations

The questionnaire used in this study was designed based on proposals by Belmonte (n.d.) and Jafelice (2010), and it was used to identify students' ideas about stars, constellations, and prediction. The questionnaire was a starting point for several discussions about the student's experiences during the research. The students' ideas were classified into the following categories:

Recognition of Students' ideas about stars, constellations, and night sky observation

The recognition given is based on the question: "Is observing the sky, including the night sky, important? Can you identify any specific stars in the sky and explain their significance? What groups of stars do you know and why?" Students' narratives about the significance of sky observation are related to atmospheric conditions. When asked about this, the comments students made were primarily about "predicting the weather" based on the appearance of clouds.

“To have an idea about the weather.”
“To know if it is going to rain.”
“A person looks to the sky to locate himself in the time and the hour and to know when it will rain.”

Another group of students related their observations of the sky to their beliefs and thoughtful activities, such as reminding dead families or praying to God. Jafelice points out that cultural astronomy can relate to cognitive and affective knowledge, which works with beliefs and memories.

“I observe the sky to remember my great-grandmother and grandfather.”
“I use the sky to know the weather, and when I have a lot on my plate, I observe the sky and continue; I only use it as a sign to determine the weather and pray to God.”
“I observe the sky as entertainment; I do not use it as a sign of anything.”
“I observed the sky to watch the stars and look for shapes.”

Context

The stars that most students recognize are related to beliefs about the Catholic religion, so Belen’s star and three-wise men's asterism are recognized for them in this context. In addition, a famous polar star like the star helps travelers to locate the north, even when this star is not visible during the whole year in the Southern Hemisphere, which is different from the Northern Hemisphere.

“I know (from memory) the Sun and Belen star that, as far as I know, is a star to locate yourself when traveling.”
“I know Belen Star and the major/minor Ursa. I know that Belen Star is one of Jesus’s birth.”
“I know that Belen Star guides wise men. Polar Star: I know that points to the north.”
“I know of some famous stars; the Belen Star guides wise men where Jesus was born.”
“I have heard about the three wise men that simulated a drawing.”
“I have heard about the three wise men in the planetarium.”

Furthermore, when asking about groups of stars, the most common were the minor and major Ursa and the Zodiac constellations, highlighting the relationship between observing these constellations and familiar memories.

“The three wise men because of my family.”
“Minor and major ursa 'cause my dad taught me about it when I was a little girl.”
“I have heard about major and minor Ursa because my father taught me about them.”
“Gemini, Tauro, Capricornus. In Colombia, there are no constellations.”

Based on this idea, the narratives written by students about constellations are linked to their relationship with mythology, as the code "telling stories" was frequently used in their writing activities. Therefore, it can be inferred that the students acknowledge the cultural significance of constellations.

Recognition of Students’ ideas about the zodiac

Considering the findings of Longuini and Gangui (2013) and Gangui and Iglesias (2021), it is noteworthy that students were familiar with their zodiac sign, even among those who claimed not to believe in the zodiac. The most common comment in this regard was "Nothing because I do not believe in that," using the terms "Zodiac sign" and "Zodiac constellation" interchangeably. Another group of students acknowledged the differences between zodiac constellations and zodiac signs but did not differentiate them from other constellations.

“Zodiac signs Are the same as the constellations, and zodiac signs are due to constellations.”
“It is a zone of many stars.”
“That form shapes such as Leo with the shape of a Lion.”
“I know about Sagittarius, Leo, Scorpius”
“A group of stars that creates a drawing.”

Finally, as Gangui and Iglesias (2021) and Longhini and Gangui (2013) point out, even when students are aware of the existence of zodiac signs and their relation to the month they were born, they may not fully appreciate the connection between the zodiac signs and the apparent motion of the Sun, as the authors related

students do consider that this zodiac constellation is visible in the sky during this month.

"I am Capricornus; it is a goat at the end of December and half of January."
"I am Aries, and I think it is because the Aries constellation is more visible during that time of the year."
"I am Scorpio because of the moon and the stars."
Therefore, it is possible to state that the initial representations of zodiac constellations are within the category of astrology, and students recognize the concept of the zodiac but are closely related to the horoscope, zodiac signs, and predictions, even when they affirm that they do not believe in astrology.

Results associated with the Cartoon.

Considering previous studies ' results, we designed a contextualized concept cartoon (CCC). In line with the research by Reyes et al. (2020), the comic features three different perspectives, namely the astrological viewpoint represented by two teenage students named "Catalina" and "Valeria," the skeptical viewpoint expressed by a modern science student named "Camilo," and the cultural astronomy viewpoint represented by a student named "Laura." In the first two vignettes, the students discuss horoscopes and zodiac signs, attributing characteristics to "Camilo" based on his zodiac sign. In the following three vignettes, they discuss the zodiac constellations about the knowledge of Kogui natives in Colombia and how they "predicted" the rainy and dry seasons with the constellation of Taurus. Finally, the students acknowledge many aspects of the zodiac that they are yet to understand fully. Based on these results, we developed three categories.

Astrology

Figure 4 Frequency of words when describing CC. It can be observed that the signs and horoscope are the most repeated words.

Most students' understandings of zodiac constellations are limited to a closed context, as it pertains to their knowledge of Zodiac signs, supported by Longhini and Gangui (2013) and Leite (2022). According to these sources, Zodiac signs are a widely-discussed topic in the media and are deeply ingrained in people's lives, particularly in the Western world. This is evidenced by the most frequent words used by students to describe their understanding of the cartoon, which include signs (15), horoscope (12), and beliefs (5). The following statements are a collection of narratives students wrote when asked about their understanding of the cartoon.

“Nowadays zodiac signs are known most as part of the “popular culture” that defines the personality.”
“I understand from the cartoon that there are three girls that believe in the horoscope and say different things related to the horoscope, but there is a guy, whose name is Camilo, and he does not believe in the horoscope, but the three girls tell to Camilo to make him believe.”
“Different characters believe in the horoscope and that your zodiac sign is related to the personality.”

When students are asked about their lived experiences about the cartoon's topic, they link these experiences to astrology in the different contexts of their daily lives, both at home and school. This connection between the comic, the lived experiences, the relationship between the funny and the horoscope, and the

zodiac signs can be observed. The students' narratives include experiences similar to those discussed in the cartoon and even allow them to describe situations unrelated to the zodiac constellations but still generate a feeling of "judging." According to Reyes et. Al (2020), comics can help students evoke lived experiences and relate them to the concepts they are studying or situations that elicit similar feelings.

“In my previous school, they talked a lot about the horoscope and their zodiac signs, comparing themselves and “finding” the most compatible person with their signs.”
“One of the reasons my ex dumped me was because we both are Leo.”
“My cousin read my natal chart.”
“One time, I discussed whether the zodiac affected our personality, but she (my mom) kept believing it.”
“In my family, everybody says that, and my dad has bad temperaments due to our zodiac sign arias.”
“In generation “Zeta” is common to see this; I saw him with a lady in the street fighting with a man, saying, “You as Virgo are stubborn.”
“My mom everyday reads her horoscope and asks me to translate it because it is in English.”
“Everybody started to judge me without reason and to inquire about me, and then they stopped talking to me and begging to gossip about me.”
“Once I was having breakfast, and I told a girl from my school bus that his dad had found the cure for COVID, and everybody started to say different things and judge.”

Ultimately, when most students declared that they did not put faith in zodiac signs and were questioned about which characters in the comic strip they felt an affinity towards, some students pondered astrology, drawing parallels to beliefs most relevant to their surroundings.

“What is the horoscope?”
“Do the horoscope predictions become real?”
“Why is it said that every sign has its personality?”
“How did people start to believe in the horoscope so much?”
“Why does a grouping of stars define our personality?”

Cultural astronomy

According to Jafelice (2010), studying astronomy from a cultural perspective can foster curiosity and inspire an anthropological focus that benefits people of all backgrounds. Many students found it necessary to emphasize indigenous people's historical use of Zodiac constellations, even if unfamiliar. This suggests that using cartoons to introduce new concepts or theories to students can be effective.

“Nowadays zodiac signs are known most as part of the “popular culture” that defines the personality than for what was used before, to predict rain and dry seasons and to know the hour.”
“In the cartoon, they are debating if zodiac signs are real and if they can use it for things such as how to measure the time of the Sun.”
“It explains that the native people knew when it was going to rain and when to sow using the zodiac signs (constellations).”
“Laura saw a page that the Zodiac was a big help for many communities.”
“for example, they mention that native people use the Taurus constellations to know when was good to sow.”

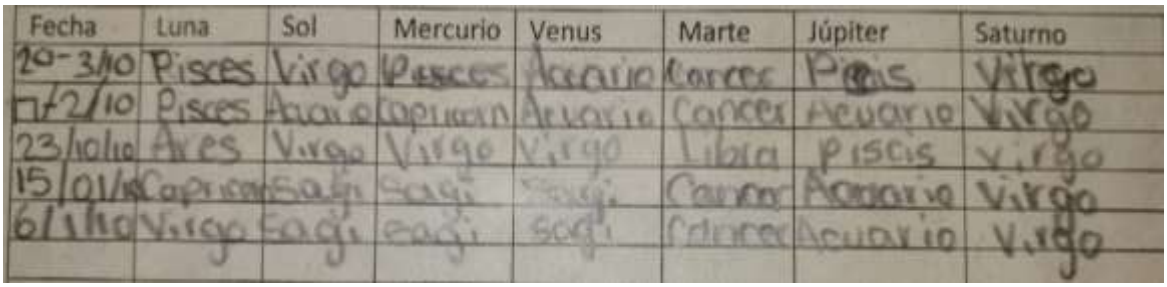
Some of the students’ inquiries were also related to cultural astronomy, and it can be said that the cartoons generated curiosity for new knowledge in students, just as Reyes et. Al (2020) states that the inquiry category appears with great potential since it develops in students' questions that they did not have before the cartoon. As mentioned previously, the cartoon allowed students to inquire deeply about their native knowledge as follows:

“How did it work on the method of the Kogui people?”
“How did they know they were going to rain with stars?”
“Is it true that stars affect plant growth?”
“What are the other uses of Zodiac constellations?”
“How are rain and zodiac signs related?”
“How did native people guide constellations?”
“What is the relationship between months and Zodiac signs?”
“How are stars related to your birthday?”
“Wondering how zodiac constellations get the months.”

Besides, the students inquired about various aspects of the Kogui people during the application, including their residence, way of life, identity, and whether other indigenous groups utilized the constellations for various purposes.

The analysis of the narratives created by the students and the frequency results indicate that despite their lived experience being related to astrology, the records change when students read the cartoon and question the relationship between zodiac constellations and ancient knowledge. This suggests that cartoons are a valuable tool for generating new student questions, as Reyes (2020) pointed out.

The questions triggered by the cartoon motivated the students to explore the zodiac constellations and their connection to the months of the year using the Stellarium simulator. They read about the various myths surrounding the use of zodiac constellations by native groups in Colombia. During the classes, several discussions were held, allowing the students to consider different perspectives, including the relationship between zodiac constellations and time measurement, their connection to culture and ecosystems, and finally, their connection to the ecliptic.



Fecha	Luna	Sol	Mercurio	Venus	Marte	Júpiter	Saturno
20-3/10	Pisces	Virgo	Pisces	Acuario	Cancer	Piscis	Virgo
1-2/10	Pisces	Acuario	Capricornio	Acuario	Cancer	Acuario	Virgo
23/10/10	Aries	Virgo	Virgo	Virgo	Libra	Piscis	Virgo
15/01/10	Capricornio	Sagi	Sagi	Sagi	Cancer	Acuario	Virgo
6/11/10	Virgo	Sagi	Sagi	Sagi	Cancer	Acuario	Virgo

Figure 5 Table done by students while researching the relationship between zodiac constellations and months.

Therefore, To better understand the relationship between Zodiac constellations and months, students used Stellarium, following the teacher's suggestion, to research the relationship between Zodiac constellations and months. The previous table was completed by students using this software; they chose different dates and determined where the Sun, The Moon, and the five visible planets were in the solar system. Notably, the dates that sparked their curiosity were the dates of their births, allowing them to compare their zodiac signs to the information provided by the software. During discussions, students noticed

that some of their classmates' birth dates coincided with the constellations where the Sun was "found," but not in all cases.

Figure 6 Comparison of the sun's location on two dates using a Stellarium.

The experience triggered new perspectives among students regarding the appearance of solar system objects and their movement through constellations. It explained the change in the motion of the planets and the sun through the heliocentric model. However, in some cases, it is also beneficial to incorporate the geocentric model explanations of students in subsequent studies.

In their pictorial representations, students used Taurus to illustrate the concepts raised in the cartoon. Through this, students could connect the Sun, the Moon, and the inner planets with the zodiac constellations and understand their movement about the sun's apparent motion.

Figure 7 Students' representations of Taurus after using Stellarium.

Students also read some cultural tales from the Kogui and Sikuani indigenous groups, two indigenous groups of Colombia from which we could find zodiac stories, that allowed them to relate the cartoon and the simulator with what was observed for these

two groups. In this phase, students felt motivated and curious about understanding the relationship between the tale, the zodiac constellations, and the movement of the Solar System bodies in the sky, which also allowed them to recognize the Colombian territory, bringing memories of journeys to different places and related it with their own experiences. Therefore, students studied ecosystems, geography, anthropology, and astronomy during this part, following the idea of transdisciplinary that Jafelice proposed by studying phenomena through cultural astronomy.

"When I highlight my approach, in particular, how transdisciplinary is to make explicit both the way of approaching, resignifying and directing the specific contents of the many conventional areas participating in the interventions that we have undertaken, as well as from the post-modern perspective with that the questions of method, theoretical references, and practices are only addressed and redefined, to attend to the comprehensive education of the highest order clam." (Jafelice, 2010 p. 220)

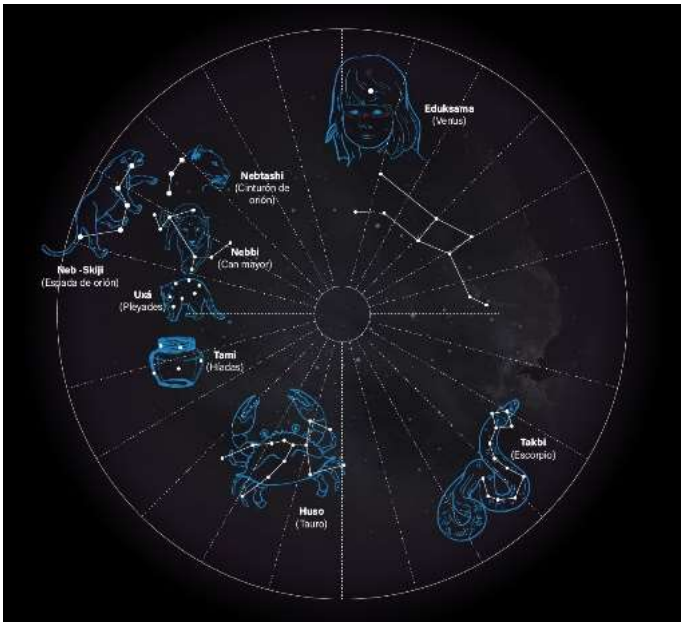


Figure 8 Kogui constellations. Own creation Based on Reichel-Dolmatoff (1975) Los Kogi de la Sierra Nevada.

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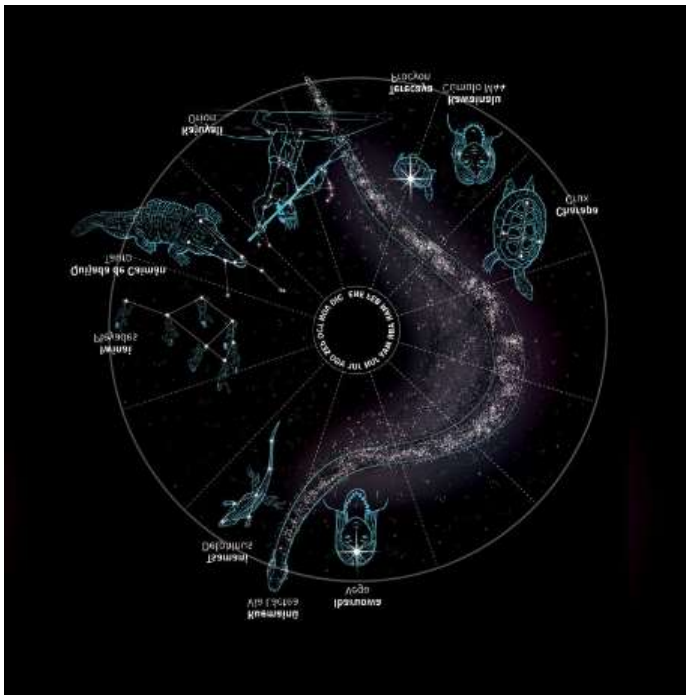

Figure 9: SURA (2015) SAI. Sikuani Zodiac.

Figure 10 Students using Stellarium while trying to understand the relationship between zodiac constellations of Kogui native people and zodiac constellations from modern science.

Students' creations

Based on these activities, students devised various methods for conveying their understanding of zodiac constellations, such as creating cartoons, mind maps, and posters. These are some of the presentations that the students made in class.

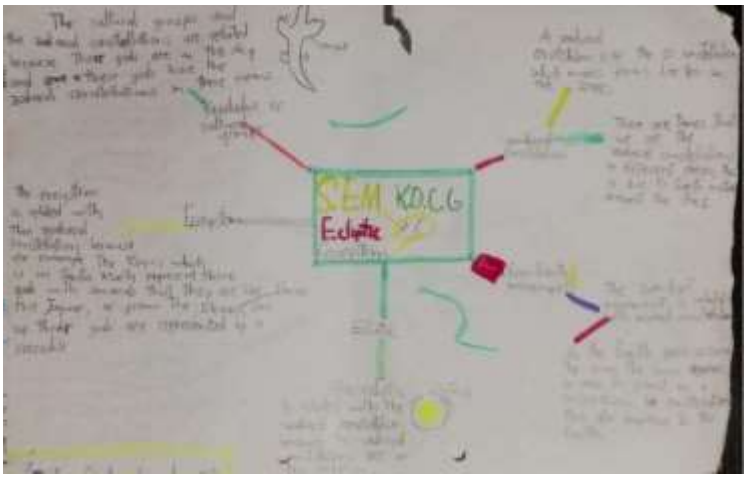

Figure 11 Student creation: Mind map of Zodiac constellations and solar system.

The student relates zodiac constellations in this Mind map with several concepts: ecosystems, Sun and Earth movement, and cultural groups. It is essential to highlight that the attempts of students to show how the observation of Zodiac constellations is related to the motion of different solar system objects, as Longhini points out, to study Zodiac constellations implies taking a geocentric position, as the student did in this case, to the motions of different solar system objects. As Longhini points out, studying Zodiac constellations implies taking a geocentric position, as the student did in this case.

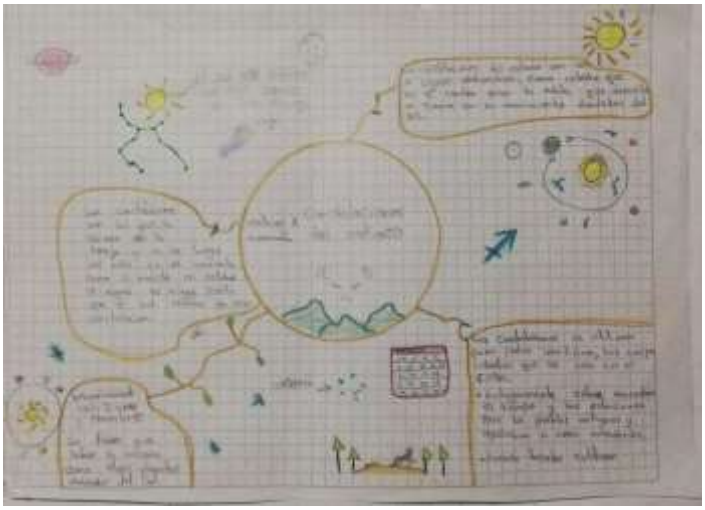

Figure 12 Student's creation: Mind map zodiac constellations and months.

In this Mind map created by one student, it is possible to observe the attempt to relate the birth of one baby with the alienation of the Sun and a constellation, in this case, Virgo. In addition, the student refers to Zodiac constellations with time measurement by drawing a calendar, and he connects this with important habits for people, such as farming activities.

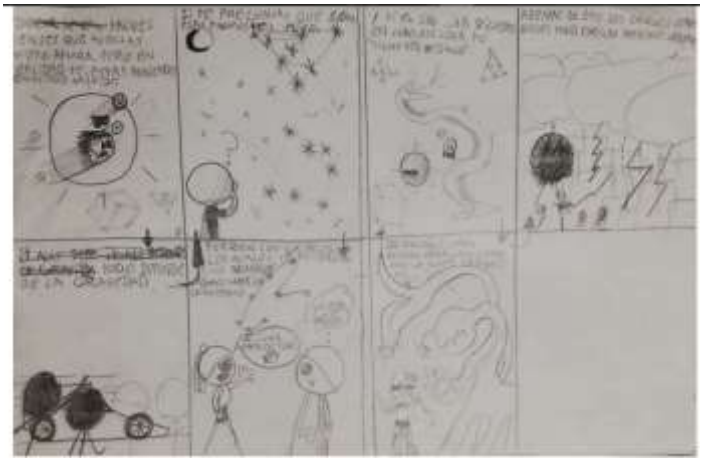

Figure 13 Cartoon created by student: Zodiac constellations and Greeks.

In this case, the student recreated a possible conversation regarding the cartoon he read and tried to explain the concept of constellation and zodiac constellation; it is essential to point out that in the case of this particular student, at the beginning of the study, he refused to talk about zodiac constellations for considering them as “astrology” so the cartoon did change his mind by giving him the chance to research about a new topic.

Figure 14 Student's poster about Zodiac constellations: Relates astrology, cultural astronomy, ecosystems, and solar system bodies.

In this case, the student states a clear difference between zodiac constellations and zodiac signs, describing the cultural meaning of zodiac constellations, but, more importantly, pointing out the relationship between ecosystems (Earth's world) and constellations (Sky's world), which according to Iwaniswesky is one of the essential characteristics of cultural astronomy and of the holistic that allows according to Jafelice's proposal and the definition of cultural astronomy: The sky becomes a reflection of the terrestrial landscape since observers seek to configure it from the ecosystem that surrounds them and also from the natural and cultural events they experience (Iwaniszwski,2001) & (Ruggles,2011).

Figure 15 Student's cartoon with the same narrative as CC.

Finally, in this cartoon, the student took what was most important for her. It was the reading of the zodiac for the Sikuani people. For the student, this particular group was because when we located them geographically, she found out that this group also lives in Venezuela, for she, as a Venezuelan student, was critical in highlighting the relationship between Colombia and her native country.

Conclusions

Based on the methodological process analysis, we gathered students' perceptions of Zodiac constellations and observed how various activities modified these perceptions. Furthermore, we can detect evidence of learning in students, considering their prior knowledge and how the inquiry process expanded upon this knowledge by incorporating new information through simulations, discussions, and questions.

The application of the CC can inspire inquiry skills in students and motivate them to explore new concepts. In turn, this leads to further questions, diverging from what was previously proposed and providing students with new avenues for exploration.

The transdisciplinary approach, grounded in the Cultural Astronomy teaching proposal, enables students to explore a novel concept from multiple perspectives and produce knowledge that surpasses the boundaries of the science curriculum. By employing maps, cultural narratives, and mathematical instruments, students can compare the traits of

animals and plants and establish connections between the sky of various cultures and the environments in which they lived.

By studying Zodiac constellations, we could connect a seemingly distant topic, such as stars, to the lives of our students. We were able to establish a link between scientific issues, such as ecosystems, and more scientific subjects, like the movements of the Sun and Moon and the Geocentric and Heliocentric models.

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