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**Immersive 3D Technology in the Indigenous Scholar
Education**

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Abstract

In the last 20 years, there has been an effort to recover, transcribe and interpret the traditional indigenous Brazilian knowledge related to the constellations, the moon, the sun, the planets and the worldview.

This study is the result of the application of the *NTIC (New Technologies of Information and Communication)* in order to use, within the indigenous Brazilian and Western school education, the traditional Brazilian indigenous knowledge that was recovered in a participative study.

The indigenous Brazilians learn through their direct contact with nature. The immersion with virtual reality 3D glasses satisfactorily simulates this contact and can enhance it.

Through the development of computer programming, modeling and animation an “individual indigenous Brazilian planetarium” has been built. The planetarium makes possible, for whoever uses it, the virtual visualization of the apparent motions of the sun, determine the solar day, the cardinal points and the seasons the same way the Brazilian indigenous see them in real life. Besides, it is possible to simulate the celestial firmament with the constellations used by the Brazilian indigenous as a calendar and as well as for other daily activities.

Keywords: NTIC, Indigenous Education, Traditional Knowledge

Introduction

Greece is the cradle of Western civilization; its inhabitants in the early days of use history were guided in their social life and their religious and civic duties by its myths. Their religious, social and civic obligations were dictated by their poets who exposed the mythology that before writing was transmitted by tradition and narrated by their poets and historians: Homer, Hesiod, Aeschylus, Solon and others. Settled down the religious order and the laws of Greek society, as Jean-Pierre Vernant shows (1983, 2001).

The sun, moon and stars regulated the Greek time, where the importance of the study of astronomy, like that of Ptolemy, that although overtaken by heliocentrism is a construction of a mathematic of greater complexity. They also regulated the sequences of the days and months that guided the religious and social celebrations and the economy. Sequenced the parties and religious liturgy, social celebrations and preside over the order by the laws dictate the economy and agriculture, which has its gods, following the plantations and crops.

Ancient Greeks believed gods and goddesses controlled nature and guided their lives. They built monuments, buildings, and statues to honor them. Stories of the gods and goddesses and their adventures were told in myths. The Greeks did not believe that gods and goddesses were all-powerful. They did have special powers, but they were just as flawed as humans were.

For K. Dowden (1992) the myths do not only masquerade history, but they have cultural significance. In addition, all this paper is about this myth significance in Greek life.

Similarly, Brazilian indigenous guide their religion, culture, economic life and agriculture by astronomy they have learned and taught their offspring. The Greek education much like that of the Brazilian indigenous has a reality perspective, i.e., applicability in life here and now, *hic et nunc*, or as Prensky says:

It is in the afterschool world, rather than in schools, that many of our kids are teaching themselves and each other all kinds of important and truly useful things about their real present and future.

What Today's Students Want?

Real, Not Just Relevant. An important result of the introduction of technology into our children's education is a much shorter span today between learning and meaningful action. Today's students know that when they learn something after school, they can immediately apply it to something real. When they learn to play a game, they can collaborate and compete with others around the globe. When they learn to download, text, and tweet, they can immediately participate in profound social revolutions, such as changing the music business and influencing government policies. As they learn to post their creations and ideas online, they become aware that even as young people they can truly influence and change the world. This gives a new urgency and meaning to the —Why should I learn this? I question that our students eternally ask, and demands that we have a better

answer than —Someday you'll need it. Today's students expect the same thing from their formal education as from the rest of their lives—that it be not just relevant, but real (PRENSKY, 2009, p.21)

We must learn from indigenous cultures because communities live intensely in a different culture from that which surrounds and involves them. This culture shows admirable resistance or resilience that needs to be studied. In the philosophy teachers show Greek vision and worldview and its myths. We must consider the history of ancient peoples, even prehistoric. However, why not teach and above all learn from the indigenous worldview studying their worldview and their myths in order to establish guidelines for good living.

However, living together, living together with different demands mutual respect, understanding and empathy with the ability and effort to not only understand, but also to accept the point of view of others, especially those who seem different.

It is not enough to describe only scientifically indigenous astronomy, but this is brought within indigenous culture and their living. We hope to study the firmament of not only on a speculative way, but the knowledge but also the lessons that it brings on how to live and see the world. Descriptions, of an indigenous way of and ethnoastronomy indigenous can be suggestions for our own lives.

This knowledge built and transmitted from generation to generation, in all ethnic groups, from all quarters, had a pedagogical and educational function. What is happening in heaven should guide the conduct on Earth, as shown in myths: Moon stains, the Boitató, the history of the various stars. The knowledge of the stars and the firmament directs these people to the agricultural planting.

Unlike the "civilized school", that teaches competences for the future, and just in case, education and indigenous education is real, it's for here and now.

Therefore, according to the author cited education cannot be how it was and is even today, to be confused with instruction, purely academic. Always was what Seneca said was miss interpreted:

"Non scholae sed vitae discimus" which means "We do not learn for school, but for life". In SENECA, Lucius Annaeus. ([Epistulae morales ad Lucilium, Epistula CVI, 12](#)).

It was interpreted as learning for the future life, but what it should mean is learning for the actual life. We learn children's needs now in their lives as children to their reality of their own age. Learn not only what is relevant, but also that which can be applied in their real life

What is taught to school, is useless, because it is just for school time, it useful only to that. It is not useful for the everyday life of the students. In other words, it is an early criticism that fits perfectly to the current academicism. Now this desideratum is applied to indigenous education, when they are educated by their parents, the elders, the Shamans and the Chiefs. When reading explanations of the exposed ethnography, it can be seen that everything has a meaning in life, or to live together, whether for Community and religious obligations.

When we go deeper into the world and the way of life of indigenous cultural world alive, full of ancient wisdom translated both in the indigenous worldview and in its astronomy and its myths we have much to learn. The indigenous universe it is not appreciated as it deserves by the national society, as it should be. Unfortunately, the indigenous Anthropologist always cited indicate that the indigenous have much to teach us, whether in the field of ecology, the healing through plants and herbs, the easy laughter, joy without trouble, in the absence of haste in peaceful coexistence and much other profound teachings, just be more humble to welcome them. We cannot fail to mention some wisdom pearls of these Brazilian people:

"Some indigenous, especially those isolated or with little contact with our surrounding society, spend the whole period of its existence having no more than twenty objects."

Anguish of absence: the wanderings through the villages is common sight elderly indigenous residing some distance from other houses, and there, living alone, still hours and days in the inner silence, with his thoughts, without distress, complaint, in contrast, apparently in deep state of peace and happiness.

Every day just a shame that the French coined as saying: 'A chaque jour suffit sa peine', which exists in almost every language. In fact, the origin is ancient and is found in the Gospel of St. Matthew: So do not be anxious about tomorrow, for tomorrow will care for itself, just each have their own pain (Matthew, chapter 6, v. 34).

The following statement corroborates this assumption:

As said magnificently Durkheim, the aim of education is not to transmit knowledge ever more numerous the student, but "to create him an inner and deep state, a kind of polarity of mind that the east in a defined sense, not only during childhood, but throughout life "(L'Évolution pédagogique en France, PUF, 1890, p. 38). It is precisely to show how to live need not only knowledge, but also the transformation in your own mental being, the knowledge gained in wisdom, and the incorporation of this wisdom for life. (MORIN, Edgar, 2003, p.47).

These assumptions are much more valid given that we live, more than ever a Heraclitean reality, a reality in transformation and change. What you learn today may not serve for tomorrow according to Pierre Lévy says:

The know-flow, the know-transaction of knowledge, new technologies of individual and collective intelligence are deeply modifying the problem data of education and training. What should be learned cannot be planned, not precisely defined in an advanced way. The paths and competency profiles are all of them natural and are less and less possible to be channeled into programs or curricula that are valid for the entire world. We must build new models of space knowledge. The representation in linear and parallel scales in pyramids structured by "levels", organized by the notion of prerequisites and converging to knowledge "superior", it has become necessary now

prefer the image of areas of emerging knowledge, open, continuous, in flow, nonlinear, which reorganize themselves according to the objectives or contexts in which each occupies a unique and evolutionary position.

We could still quote the OECD:

We live in a fast-changing world, and producing more of the same knowledge and skills will not suffice to address the challenges of the future. A generation ago, teachers could expect that what they taught would last their students a lifetime. Today, because of the rapid economic and social change, schools have to prepare students for jobs that have not yet been created, technologies that have not yet been invented and problems that we do not yet know will arise. (Andreas Schleicher).

Methodology

In the development of a product and its application in the education sector, there are several methods that can be employed. But you may need to think in two different stages. At the first stage, we look at the development of the software, development of techniques and skills to design the same. In the stage, we analyze the feedback that the product provides in relation to its target audience, in this case the students.

At first, we made a direct exploratory research to reveal which tools were the most suitable for the development of the proposed product. There are many software with different technical requirements for performing various processes, such as gamification, animation, 3D modeling.

Still exploratory, it was necessary to find resources to develop skills and knowledge to create the first prototype. This step is related to search videos, tutorials, user manuals. Finally, a compilation of a set of information needed to give early development.

In another step, it was time to present the prototype to the target audience. In this part of the process, we use the case study. This is the time to observe, record and analyze the data and reactions from the users.

However, for the prototype that achieves the high fidelity level, it is important to keep continuity to the development process and product update. This is when we recognize the Spiral Development Model proposed by Boehm in 1986. The original model is defined and designed, after this, it is demonstrated. Based on users feedback it is developed again and updated, until it reaches the high fidelity level and can finally be delivered to the society.

The five layers of interacting spiral development model of Boehm are (Cennamo, 2004):

1 - Define

This is the creation stage and organization of ideas around a problem situation. This is when prototyping defines its objectives and is made the

analysis of the universe which it will be inserted. At this time, the target audience characteristics are also considered, such as age, sex, geographic and demographic characteristics, and consumption habits.

In our case, we saw the lack of teaching materials and other forms of dissemination of indigenous cultures. From this premise, we believe in developing a product that causes interest within the Digital Natives society.

By observing the characteristics of Digital Natives, we decided to add high technology issues; it has a high impact on this generation. Thus, we assume success in order to achieve digital natives with traditional knowledge.

2 – Design

This is the stage of development of the first prototypes. Here occur research tools and techniques necessary for product realization.

At that stage we did an extensive study of the tools most suitable for the development of the prototype.

There are numerous software and hardware that enable the creation of interactions between students and teachers. In our case, we found that we needed a 3D modeling software (SketchUp) and a gamification software (Unity3D) for the success of our objectives. As one of the goals of our product causes immersion in virtual reality, we resort the OculusRift device, which currently has its technology replicated in Smartphones.

From these tools, we have developed techniques to design the Indigenous Solar Observatory, and a mechanism that simulates the apparent motion of the sky. Then, convert the software to OVR language (Oculus Virtual Reality).

3 – Demonstrate

This is the stage where the prototype is presented to the target audience. At that stage the facts should be noted, analyzed, and evaluated so that we can have a feedback on the effectiveness of the prototype. It is from this stage that the mistakes and successes can be checked and corrected in the development stage that follows.

In the case of Indigenous Solar Observatory several statements have been made for different target audiences. The prototype was presented to students of primary and secondary education and can be covered by students of Indigenous Education in Tekoá Itaty, Guarani village in Palhoça, SC.

The results were positive. The choice of OVR technology was right. By demonstrating the equipment, students formed lines to perform the activity, many returning to the queue end to repeat the session. This result was observed for both Digital Natives, and for the Guarani Indigenous.

There were a few negative results: some people suffering from labyrinthitis crisis complained of dizziness and discomfort.

The first prototype only contemplated the sun, which was the subject of suggestions as had an extremely bright, making it difficult to display their rising and occlusion.

Some participants showed curiosity about other aspects of the sky, such as the observation of the moon and stars.

4 – Development

At this stage, the developer must treat information received from the demonstration, to assess the positive and negative points and increasing changes in order to improve the prototype.

In this phase we continued the development based on comments and suggestions from our prototype. The sunshine was corrected, and the night sky was inserted.

The use of anti-aliasing tool gave sharpen the image. The scenario has been enhanced with greater realism (lawn, trees, etc.).

We had the privilege to hold several demonstrations, as we did to a group of Higher Education Pedagogy students because it had new feedback on possible improvements. This led us to correct the brightness, color and magnitude of the stars, to recreate a more realistic sky.

Currently the project follows in the development phase. The following steps are: development of the audio, with soundtrack and narration and an intelligent tutorial system, which is able to inform and assist the users in understanding through automated information.

5 – Delivery

The delivery phase refers to the closing and completion of the prototype, so this can be used for their purposes.

This is one of the most difficult stages for a developer because there is always something to improve. After several modifications, after presentations in educational institutions, we consider that the objectives have been achieved and the prototype could be delivered.

The Indigenous Solar Observatory

The Indigenous, who inhabit Brazil, relate the positions of the sun and its constellations with periods of rain and drought (in the north) or heat and cold (in the south). Associate the phases of the moon with local agriculture, for natural pest control. In this way they build their local calendars, which mark the times of agricultural work, tides, flowering, fruiting, reproductions of fish and animals, parties, disease appearances and protection procedures performed by shamans. For them, the earth is nothing more than a reflection of the sky. Thus, astronomy assists in society and survival is inextricably linked to indigenous culture, such as in their myths, rituals, music, dance and arts

Almost all records of the apparent movement of the sun were obtained by ancient people through one of the simplest and most ancient astronomical instruments: the gnomon or vertical sundial stem. It consists of a stuck vertically in the ground rod, from which it is observed the shadow cast by the sun on a horizontal ground. The gnomon was also used in major civilizations: Egypt (obelisks) in the 15th century BC.; in China in the 11th century B.C.; in Greece in the 7th century BC and several other parts of the world. The gnomon, simple

vertical stick, then had a very important and sometimes overlooked in the development of astronomy.

Brazilian indigenous determine the solar noon, the cardinal points and the seasons using the gnomon, which is called Kuarahy Ra'anga in Guarani and Cuaracy Ra'angaba in old Tupi. In general, the rod was made of wood or a large rock, isolated (monolith) and placed vertically.

One type of indigenous gnomon, found in Brazil in some archaeological sites, is composed of a rough stone block, arranged vertically in the ground, with about 1.50 meters of height approximately in the shape of a truncated pyramid and the cut faces artificially, pointing to the four cardinal points. This gnomon vertically points to the highest point in the sky (called the zenith), and its largest faces are oriented north-south line and the smallest for the East-West and can provide the same cardinal points in the absence of sun.

Overall, around this indigenous gnomon, there are smaller rocks (pebbles); forming a circle involving four lines oriented directions of the cardinal points and side, forming the rose of the winds. Moreover, starting from the gnomon there are four lines, also pebbles, oriented directions of sunrise and sunset in the days of early summer and winter (solstices). There are also two lines oriented to the cardinal points east and west, which are, respectively, the direction of sunrise and sunset in the days of early spring and autumn (equinoxes).

Most of these stones were a bit misplaced (or removed) from their original position by treasure hunters, and the central monolith (gnomon) remained in place due to its great weight.

For the Guarani Indigenous, pebbles represent eggs Emma, who Nhande Ru Ete left the four auxiliary gods create life on Earth. The circumference of pebbles is the earth as seen in antiquity, circular and flat.

Because of its relationship with the apparent motions of the Sun, we call this monument rocks, consisting of the gnomon and the pebbles, Indigenous Solar Observatory. This type of monument can assist in the learning of the cardinal points and the seasons. So, we built a replica of an Indigenous Solar Observatory, using monuments oriented rocks, found in archaeological sites, and knowledge imparted by the indigenous people (Afonso and Silva, 2012).

Then, to better understanding of the Indigenous Solar Observatory, we present more information on the determinations of the solar noon, the cardinal points and the seasons with the gnomon from indigenous procedures.

Determination of Solar Noon and the Cardinal Points

To determine the solar noon, indigenous verified that at sunrise on the east side, the shadow of a vertical rod is huge, getting on the west side. The Sun and the shadow of the rod always are on opposite sides. As the sun rises on the horizon, the shadow decreases to a minimum length when the Sun reaches its maximum daily increase, called Solar Culmination. Then the sun passes to the west side and the shadow of the rod also changes aside, going to the east side. As the sun goes down, the shadow of the rod increases, until sunset.

The solar noon is the instant when the Sun in its apparent diurnal movement, reaches its maximum daily high (completion) and the shadow of a vertical rod (gnomon) reaches its minimum length. At noon, the sun moves from the east side to the west side, being located exactly on the north-south line. At that moment, the slightest shadow of a vertical rod is always located in the opposite direction to the sun.

Depending on the observer's location and day of the year, the minimum shade may be pointing to the south or north cardinal point.

In the Guarani cosmogony, Nandi Ru Ete (our Holy Father) created four major gods who helped in the creation of the earth and its inhabitants. The zenith is Nhande Ru Ete and the four cardinal points represent these gods. The north is Jakaira Ru Ete, god's life-giving fog and mist to slow down the heat source of the good winds. The east is Karai Ru Ete, god of fire and the crackling noise of the sacred flame. In the south, Nhamandu Ru Ete, god of the sun and the words, is the origin of primordial space-time. In the west, Tupa Ru Ete is god of the waters, the sea and its extensions, the rain, lightning and thunder. Side points are areas of wives of these gods.

Determination of the Seasons

The day of the beginning of each season is obtained by observing the sunrise or sunset, always in the same place (e.g., the vertical rod). The sun always rises in the east side and sets the west side. However, only in the days of early spring and autumn the sun rises exactly in the east cardinal point and sets exactly in the west cardinal point.

To an observer in the southern hemisphere, in relation to the East-West line, sunrise and sunset occur a little further north in winter and a little further south in the summer.

The time taken by the Sun to rise (or occlude) twice consecutively in the same end point, relative to the east-west line, is one year. This end point can be reached on the start of the winter or on the day of early summer (solstices).

Using rocks, for example, we mark the directions of the four cardinal points, the four side and points of sunrise and sunset at the beginning of the seasons.

The Guarani calendar, for example, is linked to the apparent annual path of the Sun and is divided into only two seasons: ara pyau (or new time) and ara yma (or old time). Ara pyau is the spring and summer period, and ara yma is the period of autumn and winter.

The ara pyau is represented by the movement of sunrise and sunset on the south side, and the duration of greater day than the night. It part of the spring equinox and ends in the autumn equinox, the cardinal points east and west, on the equator. The maximum of the "new time" occurs on the summer solstice, when this movement reaches a larger distance to the south side, on the Tropic of Capricorn. At this point, the movement of the sun stops and it returns to the north.

The movement of sunrise and sunset on the north side, and the duration of night higher than the day represent the ara yma. It part of the autumn equinox

and ends at the spring equinox the cardinal points east and west. The maximum of the "old time" occurs on the winter solstice, when this movement reaches a larger distance to the north side, on the Tropic of Cancer. At this point, the movement of the sun stops and it returns to the south.

In the region located south of the Tropic of Capricorn, for example, in southern Brazil, the "new time" is the hot weather and food abundance and the "old time" is the time of cold and lack of food. Near the maximum of the new time, in January, the Guarani Indians celebrate the harvest of corn and baptism ritual of children.

In this region, when sunrise and sunset occur near the ends of the north side (winter), it is cooler and the duration of the night is higher than the day; when they occur near the ends of the south side (summer), it makes more heat and the length of day is greater than the evening. When sunrise and sunset occur at intermediate positions (equinoxes of spring and autumn), the temperature is cooler and the duration of the day is equal to night.

In the area between the tropics, the relationship between the position of sunrise and sunset with the temperature is less obvious.

In the Northern Hemisphere (north of the equator), the seasons are reversed compared to those in the Southern Hemisphere (South of the Equator). To view the paths of the sun in the Northern Hemisphere, just we change the North cardinal points, South, East and West of the figures south of the South by the cardinal points South, North, West and East, respectively.

Indigenous Constellations

At night, the Indians determine the cardinal points by the position of their constellations, such as the Southern Cross and Orion's Belt (Três Marias). When the Southern Cross is standing, its largest arm points to the south cardinal point and the Três Marias born next cardinal east and set in the west cardinal point.

The early seasons (equinoxes and solstices) is determined by the Indigenous, at dusk, just after sunset, through its constellations, most of the time, are emerging in the eastern horizon, i.e. are visible almost over all night. For example, for the Guarani, these constellations are Hummingbird in the spring; Old Man in the summer; the Deer in the fall and Emu in winter. They are called seasonal constellations.

In general, this knowledge, based on the observation of nature, is not taught in Western schools.

All these astronomical phenomena, among others, are shown in the Indigenous Centre of 3D Virtual Reality with immersion.

Conclusion

For a Brazilian student, it is much more interesting and attractive to start the study of the sky through Indian astronomy, as it is related to their history and culture, to allude to elements of nature (especially fauna and flora), promote

self-esteem, value traditional knowledge and assist in the understanding of cultural diversity. The importance of indigenous astronomy, an Amerindian science, should be emphasized for all levels of school education, including higher education, both indigenous and Western contexts because it involves different areas of knowledge.

In that sense, the development of a 3D product Virtual Reality with immersion, can contribute to support the Teaching Learning Indigenous Astronomy, within generate interest, disseminate and generate a transmission channel of traditional knowledge mediation in the newest technology, which allows the exploration of new horizons in regard to education.

This planetarium is portable which allows taking it to far and hard to reach places as well as places with no electricity, which are the places where most Brazilian indigenous live. Thus, the Brazilian indigenous knowledge can be passed on, in outdoor activities, to both indigenous and western students.

It was realized that the students learning interest increases significantly, when the NTIC are used, especially when associated to real life. Then, through the “virtual Brazilian indigenous planetarium”, one of the main purposes of education, which is the insertion of the student directly and intentionally into the knowledge produced by the humankind, was honored. This, in this particular case, is the traditional Brazilian indigenous knowledge.

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