Cave paintings, the case of Altamira as an issue to promote an interdisciplinary approach

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Abstract

Interdisciplinarity arises frequently in the institutional discourse and appears to reflect the need to re-acquire a certain unity of knowledge in a world dominated by increasing specialization. However, institutional practice, even in the early years of schooling, departs quite often from modalities of interdisciplinary articulation which require a lot of work preparation, and time is always scarce in the growing range of tasks that are posed to teachers. However, interdisciplinarity does not have to be a question of all or nothing, and can naturally take different degrees and involve a greater or smaller range of subjects or areas of knowledge. In more practical terms, the implementation of interdisciplinarity can be achieved in different ways, like: starting a theme approach, defining a problem situation, treating a problem of holistic content, adopting a certain didactic approach or even during an activity. In this paper we discuss the potentialities of the subject "Cave paintings: the case of Altamira" in the promotion of arts education and scientific and environmental literacy, especially in their dimensions related to 'learn Science' and to 'reflect about the nature of Science'. The implications in terms of acquisition of knowledge related with human history are also addressed, since the present theme intersects with paleoclimatic and ecosystemic aspects of the dynamics of the planet and of the evolution of the human being. This work seeks to draw the attention of in service teachers and future teachers to the enormous potential of this theme in promoting interdisciplinarity, indicating ways for its exploitation which are intended to be developed and tested in a formal learning context. It is also hoped that this example will promote other knowledge connections that can be materialized in the context of basic education, both in Portugal and in Spain.

Key words: Cave Art, Scientific Literacy, Artistic Education, Interdisciplinarity, History of Humanity.

An interdisciplinary approach in science teaching.

Today's society places educational demands on individuals who are confronted with complexity in many parts of their lives (Rychen & Salganik, 2005). This is the main pillar of competence-based education models, like that considered, for instance, in Spain (LOMCE, 2013). This approach of education calls for interdisciplinarity, which arises frequently in the institutional discourse (Knight, Lattuca, Kimball & Reason, 2013; Vincent & Focht, 2011; Hedges & Cooper, 2014). To provide the students with tools to face complex problems in the real world, it is necessary to prepare them in a more holistic approach, connecting contents that traditionally belong to different and disconnected areas of knowledge. This holistic approach is a main issue in Science teaching (Czerniak, 2013).

The definition of scientific competence given by the OCDE (2006) "The capacity to use scientific knowledge, identify scientific questions and draw evidence-based conclusions, in order to understand and help make decisions about the natural world and the changes made to it through human activity", reflects the need to re-acquire a certain unity of knowledge in a world dominated by increasing specialization. Understanding the real word and taking decisions require the acquisition of a certain unity of knowledge connections, a fact that can be complex in a world as the one described above.

In this paper, we discuss the didactic possibilities of the theme "Cave paintings: the case of Altamira" as a way to promote arts education and scientific and environmental literacy, especially explored in their dimensions related to 'learn Science' and to 'reflect about the nature of Science'. These possibilities are determined in the frame of the 6th grade of Primary Education in Castilla-La Mancha region curriculum and also in the Portuguese Curriculum of the 1st cycle of schooling (the first four years of Basic Education).

Cave paintings in Altamira. A brief approach.

The Altamira cave is located in Cantabria (north of Spain) at the top of a karst region from the Pliocene (Figure 1). Other caves with rock art from the Paleolithic can also be found like La Clotilde, Peña Caranceja, Las Brujas, Las Aguas, El Linar y Cualventi, among others also protected.

It was discovered in 1868 by Modesto Cubillas, who revealed this finding to Marcelino Sanz de Sautuola, who visited the cave for the first time in 1875. In 1878, Sautuola could visit the Universal Exposition in Paris, where he saw some prehistoric objects found in the south of France, so he decided to carry out his own research in Altamira. In 1880 he published "Brief notes about some prehistoric objects in the province of Santander", dating the paintings in the

Paleolithic period. But the authenticity of the caves was placed in doubt and rejected by intellectuals, evolutionists, creationists or historians, including Emile Cartailhac, a preeminent scientist from prehistory period. For this reason, Altamira was forgotten by the research community, until Cartailhac published "Les cavernes ornées de dessins: La grotte d'Altamira, Espagne. Mea Culpa d'un sceptique" in 1902, rectifying is position and admitting his contribution to an erroneous assessment of the importance of the cave (Moreno, 2014). From that moment, Altamira was considered as an icon of human history.

Figure 1: Location of the Altamira caves. Retrieved from: http://museodealtamira.mcu.es/PreparaLaVisita/comoLlegar.html

The Altamira cave was included in the List of World Heritage in 1985, as it represents a testimony of the human history. The carbon 14 test results suggest that the occupation of the cave could have been from 36160 to 14000 years before present (more than 22000 years of occupation) during the Paleolithic period for hunter-gatherers populations. Marcelino Sanz de Sautuola also discovered several objects made by silex, bones and antler, among others, and they were also used to help identifying the age of the paintings. The paintings and the objects found reflect the daily life of the human populations and their relation to nature towards symbolism. After the last occupation period a landslide blocked the entrance access for 13.000 years, and buried a part of the archaeological site (Moreno, 2014).

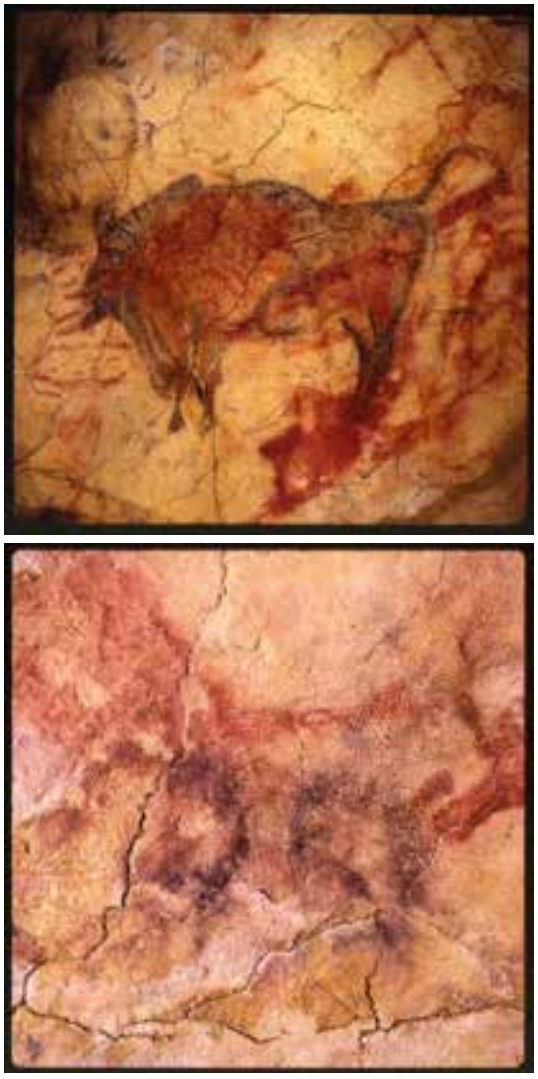
The route inside the Altamira cave is 270 meter long, in which we can find the archaeological site and the polychrome room (Figure 2), the Big Room (Figure 3) and a narrow tunnel with paintings and engravings.

Painting art is a form of symbol creation, limited to Homo sapiens. Art forms found in the Altamira cave are incisions, grabs in rock, drawings and paintings on the rock. The theme of the paintings are abstract figures, monochrome and polychrome bisons (Figure 3), female and male deers (the most represented), horses, hands and other figures (De las Heras & Lasheras, 2014). With these paintings, the inhabitants of the cave intended to illustrate thoughts or important ideas and reflections about their daily life. They are the first form of art known, maybe related to rites.

Figure 2. Room of policromes. Source: web of the Altamira museum. Retrieved from: http://museodealtamira.mcu.es/index.html

The degradation of the paintings started in the pre-history, even if the landslide that occurred 13000 years ago contributed to maintain stable the climatic conditions which were beneficial for the conservation. But after the descovering of the caves, changes and variations of air quality (temperature, humidity, quality of the air, etc.) contributed to its deterioration affecting the paintings. The cave has suffered damage because of the constructions of walls, roads and electric installations. The wide number of visitors has been increasing from year to year causing damages to the cave, until restrictions of access were necessary in the frame of a conservation program to preserve the cave (Ministerio de Educación, Cultura y Deportes. 2014). In 2015 the access has been controlled and limited to one visit of five people selected randomly per week, with 37 minutes of duration. Actions in the near environment of the cave

have also been carried out to preserve the cave (modification of roads, livestock installations, soil and environment pollution).



a)

b)

Figure 3. a) Bison. Retrieved from: http://museodealtamira.mcu.es/index.html. b) Hands in the "Big roof". Retrieved from: http://museodealtamira.mcu.es/index.html

Connections of Cave Art with different dimensions of Science literacy.

Experimental sciences should contribute to develop in students the competence to answer questions through case studies in a wide variety of contexts (OCDE, 2005; National Research Council, 2014). Besides, the complexity and interdisciplinarity that permeate the competency-based education model can be both achieved working through projects, particularly by choosing a theme that functions as a center of interest that provides enough didactic possibilities.

The cave paintings theme can allow the approach of different dimensions of Science literacy. For instance, regarding the dimensions of Science determined by the National Research Council (2012) we can find connections of cave painting projects with scientific and engineering practices (planning and carrying out investigations, analyzing and interpreting data, constructing explanations and engaging in argument from evidence), crosscutting concepts (cause and effect explanations, scale, proportion and quantity) and disciplinary core ideas (matter, organisms, ecosystems, energy, dynamics, biological evolution, human activity, extinction and inheritance). Contributions of cave paintings in Science teaching are also related to the knowledge of nature, evolution and aplication of scientific method (Michaels, Shouse & Schweingruber, 2007; National Research Council, 2012).

Cave paintings constitute a powerful didactic resource to develop the science curricula, not only connecting science and art contents, but also considering different dimensions of science that promote a better scientific literacy development.

Didactic possibilities of using Cave Art in Primary Education. The case of the Spanish curricula.

In this paper, the didactic potential of cave paintings has been explored at first in the Spanish context. Particularly, an analysis of the curriculum in Castilla-La Mancha (Spain) (Decreto 54/2014), in the frame of national legislation (LOMCE, 2013), regarding didactic possibilities of cave art has been carried out for the 6th grade of Primary Education. These didactic possibilities can provide together a holistic approach of contents of different blocks of Natural Sciences in the curriculum.

Table 1). Didactic possibilities of using cave art considering contents included in block 1 (Initiation to scientific activity) in the curriculum in Castilla-La Mancha, autonomous community in Spain (Decreto 54/2014).

Block 1. Initiation to scientific activity
Contents
- Initiation to scientific activity. - Use of different sources of information (direct, analogic and digital materials). - Use of Information and Communication Technologies (ICT) to search and select information, select process and to present conclusions.

Didactic possibilities
- Starting a theme approach by proposing a research project focused in Altamira cave paintings. - Scientific Literacy can be developed by developing a research project, and also by connecting different scientific knowledge. - Searching and selecting information using ICT about the Altamira Caves in order to determine: Age, location, characteristics of the paintings, when the cave was discovered and problems associated to the discovering of the cave. - A reflection about the nature of science can be promoted by studying why the authenticity of the cave was placed in doubt at the first moment, and how it changed over the years. - To develop a time scale to place the activity period in the cave in relation to S.XXI.

Table 2). Didactic possibilities of using cave art considering contents included in block 2 (Human being and health) in the curriculum in Castilla-La Mancha, autonomous community in Spain (Decreto 54/2014).

Block 2. Human being and health.
Contents
- Human body and its functioning. Anatomy and physiology. Systems. - Advances of sciences that promote health and nutrition (medicines, water treatment, aditives, etc.
Didactic possibilities
- Study of the evolution of human being. What humans in Altamira looked like. - Differences and similarities between men in the Altamira cave and nowadays (human anatomy). - The life in the caves. Did they use fire? Were they able to make symbols? - How they used materials and technology to prepare food and to live.

Table 3). Didactic possibilities of using cave art considering contents included in block 3 (Living organisms) in the curriculum in Castilla-La Mancha, autonomous community in Spain (Decreto 54/2014).

Block 3. Living organisms.
Contents
- Classification of living organisms. Levels of classification of live matter: virus, bacteria, protists, fungi, plants and animals. - The ecosystems. Components and characteristics. Relations between living

organisms in the ecosystem. Trophic chains. Human actions that endanger the equilibrium of the ecosystems. Extinction of species. - Biosphere: different habitats of living organisms. - Interest for the observation and rigorous study of living organisms.
Didactic possibilities - Identification of elements in the paintings (symbols and animals). - Classification of the animals that are represented. - Was the habitat in Altamira 36000 years and 13000 ago similar to the one we find nowadays? Research about the characteristics of the ecosystem in the age of Altamira Caves, in particular regarding the paleoclima in that moment. - Relation between men in Altamira caves and animals and plants: Trophic chains. - Extinction of species. Species involved, how it happened and why. - How biodiversity does affect humans.

Table 4). Didactic possibilities of using cave art considering contents included in block 4 (Matter and energy) in the curriculum in Castilla-La Mancha, autonomous community in Spain (Decreto 54/2014).

Block 4. Matter and energy.
Contents - Heat and temperature. - Renewable and non-renewable energies. - Sustainable and equitative energetic development.
Didactic possibilities - Sources of energy in the Paleolithic. - How did they manage to cook and to get warm? Did they use fire? - It is also possible to study the reasons why the access to the caves has been restricted (chemical reactions produced by changes in the air inside the cave because of human presence), in the frame of the theme Chemical changes, combustion, oxidation and fermentation (5th grade). - The concept of air as a form of matter can also be addressed.

Table 5). Didactic possibilities of using cave art considering contents included in block 5 (Technology, objects and machines) in the curriculum in Castilla-La Mancha, autonomous community in Spain (Decreto 54/2014).

Block 5. Technology, objects and machines.
Contents - Remarkable researchers, inventors and scientists. - Science: Present and future of the society. - Use of Information and Communication Technologies.

- Guided search of information on the network. - Presentation of projects.
Didactic possibilities - To promote a reflection on the impact of the discovering of the Altamira caves in the construction of Scientific knowledge as an example of the nature of Science. - The development of the research project provides a framework to search information in the network on a guided form, and to present the results to other children, promoting a peer to peer dynamics in the classroom. - To study why studying evolution is important nowadays to develop therapies and vaccines, and which is not only an issue of ancient times.

Didactic possibilities of using Cave Art in Primary Education. The case of the Portuguese curricula.

In the case of the Portuguese curriculum (Ministério da Educação, 2004), the focus was on the issues that can be related or explored with the theme of cave paintings. The interdisciplinary approach can be better achieved in the 3rd and the 4th years of schooling (Table 6) due to the contents but also the pupils' age.

Table 6: Contents of natural and social sciences and art expressions that can be related to the "cave paintings" theme.

Curricular area - Natural and social sciences
Contents
- Relationships between nature and humans beings since ancient times - The interference of humans on ecosystems and their contribution to the extinction of species - Notions of geological and historical time - Ways of living of human beings through the ages and the conditions that led to their survival - Notions of biodiversity - Implications of climate change
- Food chains - Identification of the animals painted in the cave

- Tools and forms of technological innovation
- Sources of energy most commonly used over time
- Human impact by tourism in the caves

Didactic possibilities

- To develop several science process skills, especially observing, comparing, classifying, measuring, predicting and inferring
- To promote relations between historical, ecological, geological and biological knowledge
- To understand the impact of human beings in nature

Curricular area - Plastic expression

Contents

-Different plastic expression techniques

-Building Models and recreating spaces

-Drawing and painting

Didactic possibilities

- To develop aesthetic sensitivity of children through complex works of art but also possible to be understood by children
- To promote the development of an integrated curriculum with intense relations between art and natural and social sciences

Conclusions and future research.

Didactic possibilities of cave art in Science teaching are very wide and all together can provide a holistic frame to address contents of different topics of the Natural Sciences curricula in both countries. Besides, considering painting cave as a center of interest provides an interdisciplinary approach to different areas of the curriculum, like natural sciences, artistic education and social education.

The use of cave paintings as center of interest integrating different elements of curricula contributes to promote in students the competence to build progressively more sophisticated explanations of natural phenomena far from a teaching process focused on description, as the National Research Council (Schweingruber, Keller, & Quinn, H., 2012) recommends, a fact

that should be promoted in the early grades and not leaving this explanations only to the later grades of Primary Education.

Regarding this recommendation, exploring didactic possibilities of using cave art to connect contents and dimensions of science and to promote the developing of more sophisticated explanations of natural phenomena in children is considered as a future line of research. Besides, the use of other forms of art, or even paintings from other ages as a didactic resource to provide a holistic view of disciplines can be explored. The use of cave paintings to promote other knowledge connections can be considered as futures lines of work, for instance, to connect arts, sciences and history subjects.

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