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Elementary Education**

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## **Dichotomous Keys and Collections in Elementary Education**

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### **Abstract**

This study aims to provide the necessary resources and motivation to develop the scientific competence in the second cycle of pre-primary education in Spain. The aim of this paper is to contribute with proposals such as the development of collections and dichotomous keys to study with children from three to six years old, taking into account the mathematical competence, the learning to learn competence and the competence of interaction with the natural environment, so that scientific literacy can begin from the early stages of education.

Undergraduate students of Pre-primary Education Degree are used to studying with these procedures, which involves, not only knowing the basic characteristics of the natural elements collected (organisms or inert matter), but it also requires the development of skills and abilities characteristic of scientific study.

**Keywords:** Collections, classification, experimentation, observation, dichotomous keys, 3-6 years old children.

## **Introduction**

One objective in the pre-primary education is to learn how to differentiate between living and nonliving things, and to learn about the existence of diversity in nature and the need to respect and protect.

Nature and geodiversity is related with biodiversity to understand the landscape, and the way it is formed and evolves according to the development and evolution of each of its components. Concerning to geodiversity and biodiversity is the result of the idea that natural systems are complex and in them numerous biotic and abiotic factors that interact with each other.

This understanding of the natural history and composition of a place called holistic perspective, and is the result of a good knowledge of aspects of independent and isolated way to analyze the interaction between them and the understanding of the whole as a system, is more than the sum of its components.

The holistic approach allows us to study geological and biological aspects of a system in a globalized and integrated way. In addition this approach facilitates the implementation in the classroom in the second cycle of pre-primary education and it promotes the development of attitudes of respect and conservation of the environment, from an ecological perspective.

Therefore diversity, both geological and biological, is defined as the variety and variability of elements, structures and living beings, and the ecosystems that they integrate. One way to study this variety in the earliest stages of education is through collections and classification systems and determination. Living organisms and inert elements have common characteristics among themselves, which can be grouped into a classification system (Vilches et al., 2012). Thus, a first classification may be: living things or elements that come from them as eggs, feathers, flowers, insects, seeds ... on one side and inert elements (fossils, rocks, minerals, sands ...) on the other.

Classification involves organizing into groups or sets of different elements that share one or more characters, which in turn, can be distinguished from members of other groups (Lanteri et al., 2004). Classification and determination of a collection's element (or identify) are not always an equivalent meaning: determination means to assign to a group already classified by others and determine whether or not it belongs to that group.

The development of collections and the use of dichotomous keys allow to study with the concept of classification and identification, through basic characteristics of classified elements.

Traditionally, the use of dichotomous keys has been limited to the scientific area or higher education due to the complexity of these related with the terminology used and the features to which they refer (Mendez and Castellanos, 1991 cited by Leyva Barceló et al., 2007 and Vilches et al., 2012). In recent decades dichotomous keys have been incorporated to textbooks at the school, finding out determinants of living beings.

This study aims to provide alternatives to solve this limitation in the use of dichotomous keys and collections of natural elements. The idea is to focus on the basic characteristics of the elements, their classification and the study of the diversity of collected groups.

### **Justification**

In the Curriculum of the Education Ministry for Pre-primary Education in Spain, the contents in the second cycle within the area of "Knowledge of the environment" are the identification of living beings and inert matter and observation of features and changes in living things and the approach to the quantification of collections (RD 1630/2006 of 29 December fixes the core curriculum in early Elementary education are regulated).

The education law (LOE), that covers the studies referred to earlier stages of education, proposes a job based on skills development, classroom and attitudes, values and learning strategies; the core competences, that are included in the Royal Decree 126/2014, organize not only with the conceptual content but increasingly put more emphasis on procedural content and attitudes (attitudes and values).

Therefore, students should know how to study with the collection and use of dichotomous keys. Then it will help understanding the concept of classification and development of processes such as observation, experimentation, development of hypotheses or data registration between other. The content related with the natural environment (Natural Science) allows the students to create a project that takes into account the assimilation of concepts through procedures of scientific study, facilitating the acquisition of various core competences. According to the aforementioned RD, students should have acquired these basic skills by the end of their degrees.

Until a few years ago, the majority of teachers had chosen teaching methodology, thus the teacher was the responsible of the teaching-learning and therefore there was no need to study the skills and competences directly based on the student.

From the LOGSE and especially in the LOE and LOMCE, there is an emphasis on the acquisition of skills and learning to learn, or mathematical competence and basic competences in science and technology, creating the need to study with teaching methodologies in that students acquire greater importance in the teaching-learning process while the teacher is only a guide for them. Through constructivist methodologies in which the student acquires knowledge by studying with procedures that allow them to learn from an active form, with less memorization.

For a successful process, firstly, effective scheduling is essential. In addition, it is important to note that, to approach scientific content, you need an appropriate design of strategies to enable the development of core competences. In this way we will be able to form thoughtful and decisive

students, who will possess a high degree of scientific literacy by the end of compulsory education.

### **Collections of Natural Elements and Dichotomous Keys**

When we speak of keys to the determination, dichotomous or synoptic, we refer to the set of criteria to determine a general level (group, family, type) or a more specific level, natural elements, depending on the complexity of these.

The use of dichotomous keys in the classroom of the second cycle of pre-primary education is nonexistent. The reasons for this statement are various but mostly due in part to ignorance of the teachers of this educational stage (most teachers of this educational stage know what a dichotomous key and therefore use) and secondly the lack of simple keys so that children can manipulate them independently (no one has yet been spent time to design these specific scientific materials for use in the earlier stages of education).

A dichotomous key is designed specifically to assimilate and identify the basic characteristics of natural elements, and study sorting them from these characteristics. It can be a tool of great didactic-scientific value to start to study from childhood scientific competence as necessary for the scientific literacy of citizens.

Dichotomous keys with children 3-6 years can be taught basing on the use of natural elements contained in collections developed specifically for use in pre-primary education. Collection comprises a set of elements belonging to the natural reality that are included in the same scientific category (Pardo, 2011).

Pardo (2011) proposes the collection as an educational tool for different skills that go beyond those provided by the elements themselves, leaving in the background the collection exhibition concept commonly used in museums.

This article also develops a number of motivations for using collections in the classroom, but it does not specify the age to study with and we can clarify that for Pre-primary Education all these motivations are excessive. Moreover we can specify in more specific as they can be motivated:

- *The manipulation and interaction with natural elements* (rocks, minerals, fossils, seeds, leaves, flowers, feathers, eggs, nuts ...)
- *Development of skills and own skills of scientific study* (based on the scientific method we can study observation, experimentation, data collection, use of scientific models, presentation of hypotheses ...)
- *Classification and collection of elements of the natural environment*, and therefore immersed in their everyday environment, and easily recopilables (accessible to children).

The use of collections and dichotomous keys classroom second cycle of Pre-primary Education can be studied in an integrated way the three knowledge

areas of the RD 1630/2006. It facilitates scientific study with children of 3-6 years and integrates it in their daily lives.

This scientific material specifically designed for this educational stage fulfills the following objectives of in the law (LOE):

- To study autonomously, activities and simple problem solving tasks.
- To observe and actively explore the surroundings.
- To Know and value components of the natural environment.
- To start acquiring logical-mathematical skills and literacy.

It is not common to study the scientific competence in pre-primary education, often because the real classroom context does not allow it (it is not included in the syllabus and therefore takes time, materials and spaces to develop a scientific activity; it also can be because the teacher himself has no training or motivation to do that, or because there are not the resources to carry out this kind of activities).

This study aims to develop the scientific aspect (scientific literacy) in an integrated manner, using scientific-teaching drawing and design collections and dichotomous keys to study with near daily environment of the child natural elements strategic axis.

Studying with collections of natural elements allow us to develop our own content on different areas of knowledge, so that, learning will be globalized and more significant:

- It uses the senses (through procedures of the scientific study as observation and experimentation of natural elements collected)
- Elementary study and organizational habits.
- Practice healthy habits
- Objects and materials in the environment.
- An approach to quantifying collections...
- Exploration and identification of situations to be measured (sample).
- Identification of living beings and inert matter.
- Observation of features and changes in living things.
- Curiosity, respect and care for the elements of the natural environment, as own attitudes of scientific study.
- Observation of phenomena in the natural environment.

Based on this rationale, we can use in Pre-primary Education of collections and dichotomous keys and we can say that this resource becomes an indispensable teaching materials for scientifically literate 3-6 years old children.

#### *Development and Use of Collections in Child Education*

Pardo (2011) proposed all the uses for collections of natural elements in the classroom. For the Primary Education, it would be a combination of the

three uses proposed: use centered examples, method centered approach and focused on the discovery.

The proposal of this study is the development and use of collections for primary education that allow both the classification of the elements (centered in the samples use) as the study of the characteristics of these elements through the application of specific methods of study (determination / identification) as dichotomous keys (focused on the method use), or experiment and study with the elements of the collection to discover its features and assimilate them in an appropriate way (focused on the discovery use).

To achieve this objective, the development of collections that involves, not only the collection of elements, but also adequate and motivate presentation of them, the identification with tabs for both teachers and children, adding inventories and dichotomous keys and activities. When you create a collection, you establish criteria to classify its elements. While a dichotomous key allow you to identify, this is to determine these elements.

### **Classification, and Determination Dichotomous Keys**

We propose a design of specific dichotomous keys for each type of collection (either geological or biological factors) not only to study directly with natural elements, but also to develop logical-mathematical experimentation with this kind of elements (centered discovery method and use according Pardo 2011).

Teachers can study classification with children using their own natural material. This material gives us the opportunity to study with this type of classification of elements:

*"We often think that only the Logical Block Dienes we provide mathematical possibilities for classification action, why? It can study with any material generated by us, from everyday objects to simple designs ... "*  
Fernández Bravo, 2012.

Dichotomous keys allow us to study classification in second cycle of pre-primary education natural elements. We can set partitions as a criterion or several criteria to discover, from a set of elements, the significance of an item. Depending on the age at which they are directed these dichotomous keys will be more or less complex. Less complexity allow students classified into two or three groups maximum or through affirmation or denial criterion to identify or determine that element.

Depending on the age of the children, the classification / determination can be made on the same kind of elements taking into account their properties

#### *Development of dichotomous keys for use in Pre-primary Education*

To make a classification you must choose a criterion and make as many ratings as criteria are elected (Mestres and Torres, 2008). These criteria should

be the basic features chosen from the elements under study, which should be united to become the keys to the classification.

Dichotomous keys designed to classify/identify natural elements must be composed of a series of dilemmas (every dilemma associated with a classification), for example if the classification criterion is the color, you can define a dilemma associated if the element collection has color or has no color. Each dilemma lets you to choose between two options. Solving the dilemma and choosing an option allows you to pass to other criteria linked to another dilemma and so on until you finish the complete characterization of the element and therefore identification.

The dilemmas serve as criteria for classification / identification. A dichotomy is a choice between two options in this exclusive event. This type of classification is very basic classification into two groups would be suitable, therefore, for the elementary education (affirming and denying the criterion).

Assuming that you have a collection of minerals (pyrite, quartz (crystal rock), aragonite, talc and cinnabar), it is suggested to determine this group of minerals by the eye of the children. You can think about three simple to classify features: color, shine and shape. If they can touch and manipulate, they will also be able to check the texture and weight.

In this case you can use these criteria to develop the dilemmas that you will have the child to observe and classify the above mentioned minerals, without any previous knowledge. We should note that the age of the children in elementary education may not have developed the ability of reading completely, so you must provide dichotomous keys with which to study autonomously most of the time. Therefore a methodology of discovery with teacher's guide it will be applied (the previously study every features that appear in the dilemmas of the key).

In this case the first dilemma could be the choice of those minerals that have definite and those who have no definite shape or geometric. Continuing the above example of the collection of minerals, if the student was studying with one of the items in the collection, such as pyrite, she would have chosen the first option of this dilemma.

Mestres and Torres (2008) said that any dichotomous key has the dilemmas sorted by number in the left margin (in the case of second cycle of elementary education, to 9, which are numbers that they must learn according to their stage education).

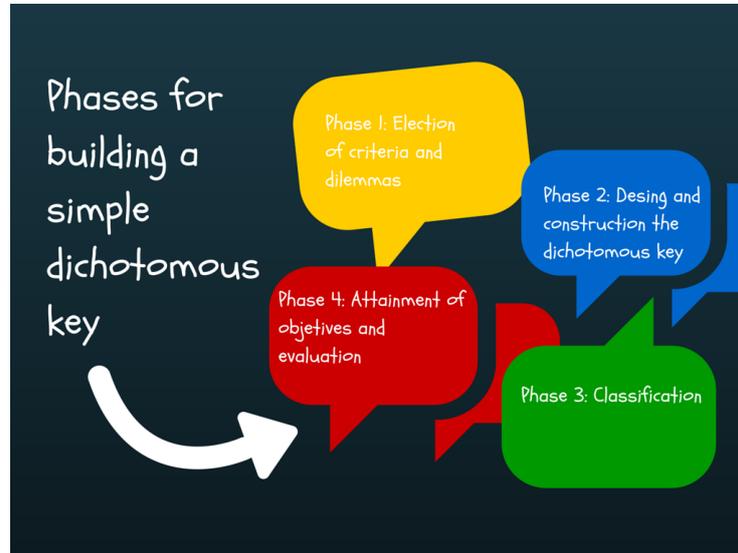
Usually every dilemma consists of two mutually exclusive propositions, and they bear the same number. Through observation and experimentation sometimes (taste, smell or induce any outcome) they should accept one and reject the other, though it may happen that some dilemma has more than two propositions.

The chosen proposal forward, the student, by a number in the right side to another alternative in which shall be selected again, and so on up to the complete determination or name of the item itself.

Here we present an example for the development phases of a dichotomous key ID (identification) of minerals for children 4 years old (figure 1):

- Phase 1: Election of criteria and dilemmas
- Phase 2: Design and construction of a dichotomous key
- Phase 3: Classification
- Phase 4: Attainment of objectives and evaluation

**Figure 1.** *Phases for Building a Dichotomous Key.*

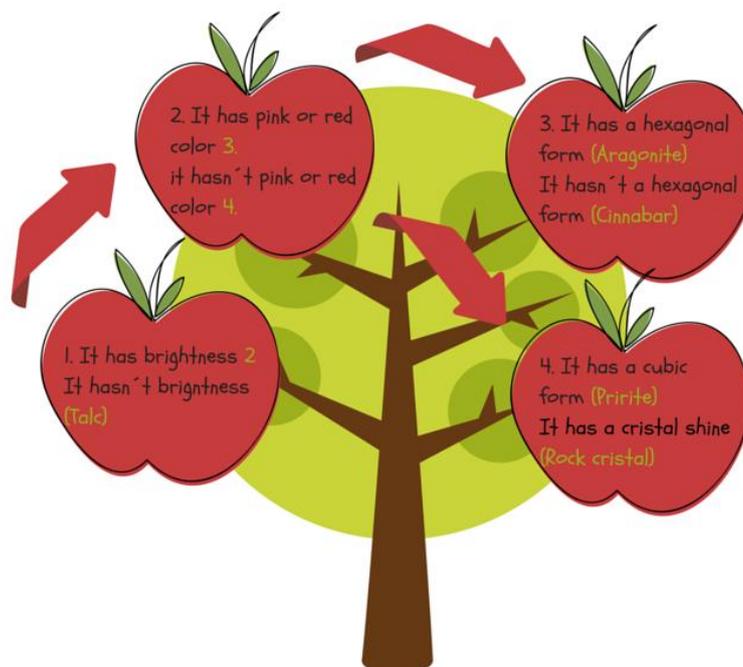


Eventually the child will know that:

- Content Conceptual (shape, color, or shine) (figure 2.):
  1. The pyrite has a cubic shape and has golden color.
  2. The aragonite has hexagonal shape and is brown-pink.
  3. Rock crystal pyramid-shaped and has no color
  4. Cinnabar has no definite shape and metal shine.
  5. And Talc has no definite shape and does not shine.
- Procedural and Attitudinal Content
  1. Experience, observe and raise provisional explanations of what you are seeing.
  2. Use specific scientific material to study geology.
  3. Sort and account collections
  4. Reflect on the action taken
  5. Study geodiversity and eco to conserve

**Figure 2.** Dichotomous Key for Mineral Example

## DICHOTOMOUS KEY FOR MINERALS



This is an example of proposed study of minerals by observation and experimentation, through the use of dichotomous keys with the collection of minerals in Pre-primary Education (figure 2).

### Conclusions

This paper presents design and development of dichotomous keys guidelines, the use of a set of items in a collection and it invites elementary education teachers to think about the best way to teach Natural Sciences creatively and innovatively.

The principal aim is to bring science to the daily lives of the children to get the scientific competence in a autonomously way.

It is possible that part of school failure in areas such as science and mathematics in compulsory education can be based on the limited development of scientific competence from early stages of education.

We think that spending time to make students think, reflects and studies these processes can be the solution of this great problem.

## References

- Fernández Bravo, J. A. 2012: "The concept of numbers and other concepts" in FERNANDEZ BRAVO, JA: Development of logical and mathematical thinking. Madrid. Mayéutica-Education Group, 2012, p. 124-146.
- Lanteri, A., Fernandez, L. and Gallardo, F. (2004): "Biological Nomenclature" in: Lanteri, A. and Cigliano, M. (Eds): Biological Systematics: theoretical and practical exercises. EDULP. 241 pp.
- Mestres Izquierdo, A. and Torres García, M. 2008: "Some guidelines for the development of dichotomous keys and classification trees" available at: <http://bit.ly/1VNHN8i>. Login October 17, 2013.
- Pardo Santano, P. 2011: "The collections as a resource for learning of Sciences" in Teaching Earth Sciences, 19.2, p 204-209.
- Spain. Royal Decree 1630/2006, of December 29, whereby the core curriculum of the second cycle of child education are regulated. [Internet] Official Gazette, January 4 July 2007, no. 4 pp. 474-482 [accessed 28 October 2013]. Available in: <http://bit.ly/1dg2Swi>.
- Spain. Royal Decree 1513/2006, of December 7, whereby the core curriculum of primary education are regulated. [Internet] Official Gazette, December 8, 2006, no. 293, pp. 43053- 43102 [accessed 28 October 2013]. Available in: <http://bit.ly/1GsQFWf>.
- Spain. Organic Law 2/2006 of 3 May, of Education. Official Gazette, May 4, 2006, no. 106, pp. 17158- 17207. [accessed 28 October 2013]. Available in: <http://bit.ly/1djMwIf>.
- Vilches, A .; Legarralde, T. and Berasáin, G. 2012: "Development and use of dichotomous keys in biology classes" in Proceedings Third Conference on Education and Educational Research in the field of Natural Sciences. Available in <http://bit.ly/1hzRDrq>. Login October 17, 2013.