



From prior knowledge to conceptual elaboration: A case in primary education

Del conocimiento previo a la elaboración conceptual: Un caso en educación primaria

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Abstract

In the Venezuelan Primary Education (MPPE, 2007) the environment was inserted as an integrating axis that connects with the disciplines of the area of mathematics and natural sciences, from this perspective the learning of this concept is fundamental for the understanding of the associated scientific concepts. In order to describe the cognitive dynamics involved in their learning, it was considered necessary to investigate the development of the same in third grade students, from their previous notions to the conceptualization of the environment as a complex system. The study was framed in a Field Investigation, under an action research design. In order to gather the necessary information from 20 selected informants, an open response questionnaire was applied at the beginning and end of the period. For the analysis of the information, the individual and group temporal triangulation was used, identifying the conceptual operators used and the convergent aspects among them. From the analysis made five (5) categories emerged that bring together all the ways of conceptualizing the environment for the moment 1 and Five (5) categories for the moment 2, of these, the latter makes reference to the systemic-complex vision where they were located 11 of the 20 informants. It is concluded that the method used allowed to contrast the advances of the students in the development of their conceptualizations and the cognitive dynamics involved.

Keywords: Knowledge, learning, concepts, teaching, didactics, education.

Resumen

En la Educación Primaria Venezolana (Ministerio del Poder Popular para la Educación -MPPE- 2007) se insertó el *ambiente* como un eje que integra las disciplinas del área de matemática y ciencias naturales, desde esta perspectiva el aprendizaje de este concepto es fundamental para la comprensión de los conceptos científicos asociados. Con el objetivo de describir la dinámica cognitiva implicada en su aprendizaje se consideró necesario investigar el desarrollo del mismo en estudiantes de tercer grado, desde sus nociones previas hasta la conceptualización del ambiente como sistema complejo. El estudio se enmarcó en una Investigación de Campo, bajo un diseño de investigación-acción. A los fines de recabar la información necesaria de 20 informantes seleccionados, se les aplicó un cuestionario de respuesta abierta al inicio y al final del lapso. Para el análisis de la información se utilizó la triangulación temporal individual y de grupo, identificando así los operadores conceptuales utilizados y los aspectos convergentes entre ellos. Del análisis realizado emergieron cinco (5) categorías que reúnen todas las formas de conceptualizar el ambiente para el momento 1 y Cinco (5) categorías para el momento 2, de éstas, la última hace referencia a la visión sistémica-compleja en donde se ubicaron 11 de los 20 informantes. Se concluye que la metodología empleada permitió contrastar los avances de los estudiantes en el desarrollo de sus conceptualizaciones y la dinámica cognitiva implicada.

Descriptor: Conocimiento, aprendizaje, conceptos, enseñanza, didáctica, educación.

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1. Introduction

The topic on the environment and its conservation is so important that the United Nations (UN, 2002, 2005) through (UNESCO, 2012, 2015) permanently insists on the mandatory inclusion of Environmental Education programs for the sustainable development at all levels of the education system worldwide, with the aim of training parents, teachers, workers, employers, entrepreneurs and politicians towards the preservation of the environment as a system from the perspective of the complex approach, leading to an inclusive vision of its social and natural components from the relationship and interconnection of the processes that occur in it. In this sense, it is essential to orient the training of students towards a vision of the environment closer to their reality, considering it as another component of their interactions, which intervenes with the students in their community, their health, their diet, their diseases, their employment, among others.

In view of these provisions, the Bolivarian National Curriculum of the Primary School Subsystem (MPPE, 2007) was included as an integrative axis: "Environment and Integral Health" to organize and integrate knowledge (p. 20), which is mainly connected with "Mathematics, Natural Sciences and Society" (p. 57). Among its contents for the third degree, it is considered: "Notion of the environment: observation and interpretation of the environment in my community, region and country. Biosphere research. Establishment of inferences to determine that the biosphere is made up of living beings: humans, animals, plants and microscopic organisms" (p. 59).

There are some questions based on the requirements of the current Venezuelan curriculum: What is the notion of environment that students have when they start the third grade of Primary Education? How to develop this notion of environment according to institutional and curricular requirements? Is it possible for

third graders to develop an environment conceptualization as a complex system? To answer these questions, the authors considered necessary to conduct a field study in the National Educational Institution "Meregoto", located at Sucre Municipality of Aragua state, in order to deepen the notion of third graders, based on the application of a Learning Project designed for this purpose.

2. Research objectives

- To specify the notion of environment that third graders have at the beginning of the course, through their answers.
- To design a Learning Project based on the ideas and concerns provided by students in relation to their previous notion about the environment.
- To examine the progress made by students in developing the notion of environment after the implementation of the Learning Project.
- To show the cognitive dynamics involved in the development of the concept of environment achieved by students from their answers.

3. Background

As noted in previous paragraphs, the concept of the environment is included in the Bolivarian National Curriculum of Primary Education (MPPE, 2007), one of the integrative axes of the Learning Area of "Mathematics, Natural Sciences and Society", and in it are found the contents concerning the need to develop a notion of environment that evolves from the first degree as: "Notion of environment, construction of the concept from the identification of environmental components" (p. 34); in the second degree: "Notion of environment, concept, identification and description of the components of the environment, the environment in my community" (p. 46); in the third grade: "Notion of



environment: observation and interpretation of the environment in my community, region and country, research on the biosphere” (p. 59).

In the above description of the contents, it is observed the link of various terms typical of the natural sciences: air, water, soil, human body, animals, plants; it also includes the study of the water cycle, climate, pollution, among others, increasing its range of action and complexity as the degree increases; hence, the construction and apprehension of this concept is essential for understanding the complexity of the environment and its different components. On the other hand, it is important to mention that the new Organic Law on Education (2009) in its article 14 states that “environmental education... is mandatory in official and private institutions and educational institutions” (p. 10), and article 15 numeral 5 reaffirms the purposes of Education: “Encouraging the formation of an ecological awareness to preserve biodiversity and socio-diversity, environmental conditions and the rational use of natural resources” (p. 12), thus legitimizing the importance of education Venezuela.

Additionally, different authors (Meira, 2006; Ochoa García, 2015; Alfonso Martínez, 2016), facing the globalization of development and its impact on the environment have proposed the need to provide the population with a series of notions about how it is and how the environment works, so that people can act responsibly on it. In this sense, the author has carried out studies on how scientific concepts are developed and processed cognitively (Arana & González, 2006; Arana, 2007a and 2012), in relation to the development of the concept of environment in school contexts and situations, the students’ previous knowledge as well as the processing and evolution have been monitored from the mental representations they build, and that they externalize through written propositions, drawings, conceptual maps and frameworks, estimating the important mediating role of the teacher in the construction of knowledge.

In this sense, it is considered that one of the main conditions for the achievement of the success of any educational reform is that teachers generate a change in the educational strategies they plan, reason for which this research aims to contribute to the transformation of educational practice in classrooms, developing didactic initiatives for the Natural Sciences Area, and more specifically, to the intention of modeling the previous conceptions of students when they enter school, which according to Meira (2006), are usually colloquial and superfluous, consisting of fragmentary or isolated actions, perceptions and conceptions.

Taking into account the requirements posed during the first three years by the Bolivarian National Curriculum (MPPE, 2007), and also those provided in all the agreements signed on Environmental Education with respect to a notion of the environment as a complex system, it is essential to focus students’ training towards a more notion of environment in their vision of complexity (Arana, 2012), closer to reality, analyzing its components and how they relate to it, with its community, with its health, with its food, with the employment and poverty (Unesco, 2015).

4. Methodology

The study was descriptive type, under the qualitative approach of an Action-Participant Research design that according to various authors (Barcedas, 2005; Becerra & Moya, 2010; Colmenares, 2012) is an appropriate methodology when the opinion of program’s participants is critical, or when it is necessary to consider how the protagonists live, feel and express themselves. As a result, it seeks to deepen the learning process of the concept of environment in students of the third grade of Primary Education of the “Meregoto” School from their prior knowledge up to a conception of the environment as a complex system, analyzing its components, how it relates to each other, with itself and with its



context. To this end, a learning project called “Developing my notion of environment” was designed and executed with the purpose of involving participants in activities in and out of the classroom in order to bring them into contact with the environment to which they are part of. In this regard, Colmenares (2012) states that the participation of those involved are also researchers and beneficiaries of the findings and solutions or answers, so that the researchers participated as advisors in all the activities executed, in order to facilitate and guide the learning of students as protagonists.

In addition, Bausela (2004) states that research-action is presented as a research methodology oriented towards educational change configured as a spiral of cycles of planning, action, observation and reflection, i.e., the action procedure according to Corral, Corral and Corral (2016) is developed following a spiral model, in successive cycles that include diagnosis, planning, action, observation and reflection-evaluation. This research process is described with different nuances according to different authors, varying in terms of its complexity. Figure 1 shows the main phases:

Figure 1. Phases and sequences of methodology applied from the action research

This research process is described with various nuances according to different authors, varying in terms of its complexity. Figure 1 shows the main phases:



Source: Buendía et al. (2000, p. 297), adapted by the authors.

5. Key informants

The study was conducted in two sections (C and D) of third grade in the “Meregoto” UEN, where one of the authors works as a third-grade teacher, because children at this level of Primary Education have more developed literacy skills, which allow to apply the techniques and instruments specific to this type of research. Key infor-

ants were selected at the end of the course, after having reviewed all the information collected for the students who performed all the evaluation activities, since it was necessary to obtain information consisting of the subject under study. The group of informants was made up of 20 informants (ten in each section), out of a total of 50 students.



6. Techniques and Instruments for the collection of information

Because of the phenomenon studied and according to Martínez (1996 and 1999) in terms of the interests of the research process, non-participating observation was used as a technique for collecting information, through the application of an open question questionnaire submitted to expert evaluation (Hernández, Fernández & Baptista, 2003), for the purpose of knowing more about previous ideas they have about the environment at the beginning and end of the course, in order to compare the progress made by students during the implementation of the learning project. This instrument was structured on the basis of four exercises aimed at obtaining information on: (a) the definition of the concept of environment (propositional representation), b) the actions they take to preserve the environment, c) pictorial representation of the concept and d) graphical representation of it.

7. Design of the Action Plan and Implementation of the project

The concept of the environment to be developed in this project is a complex systemic vision of it, where the knowledge and action applied to biological processes are inextricably linked to social and historical processes, i.e., they include all the complexity of the relationships established between humans and socio-natural elements. By adopting this view, according to Pacheco (2005), a redefinition of this concept can be developed leading to a change in its meaning, which would allow the emergence of new conceptual and methodological tools in the adaptation and intervention of the environment on the part of the human species. One of the keys to this project was based on the questions students ask to themselves about the subject under study. Arana's approaches (2007b and 2010) on the planning of integrative strategies were taken into

account for the development and design of the teaching-learning strategies of the educational project. The project was implemented in the last quarter of the 2012/2013 school schedule, in a four-week period, specifically from May 20 to June 26, 2013.

8. Organization and methodical analysis of the information collected

Once all phases of the learning project have been completed and the course was completed, the information collected through the application of the questionnaire was organized:

- At the beginning of the course in order to investigate what the informants know about the concept of environment. Based on these results and considering their concerns, the learning project was designed to promote an advancement of the notion of environment as a complex system, which would allow the development of an integral vision of its components and the inclusion of the human being, as another element of that system.
- Once the learning project was implemented, the same questionnaire was applied in order to contrast the progress made by the informants in relation to the concept studied, and to be able to analyze their progress with respect to the institutional concept of reference (Arana, 2008).

The definitions provided by each informant were ordered, and a continuous comparison analysis was carried out (Glaser & Strauss, 1967; Osses, Sánchez, & Ibañez, 2006), to detect all ways of expressing the concept of environment by informants (individual level temporal triangulation) and conceptual operators were extracted (set of criteria attributes that allow to recognize and express what it is or its meaning) used in the expression of their propositions for each section



(see Table 1). Subsequently, depending on these extracted operators, the definitions provided by both groups (interactive collective-level triangulation) are compared against each other in order to find patterns or similarities between them. According to Pérez (1998), triangulation is an analysis procedure involving the collection of data and methods on the same subject or problem, which are collected from different points of view, in order to make multiple comparisons of a single phenomenon of a group at different times and using different perspectives. In this regard, Barcedas (2005) agrees that triangular is: “to use cross-checking information, seeking to compensate the weakness of the methodology with the complementarity and convergence of different procedures, subjecting the cross-check to the views of different participants on the same subject” (p. 34).

9. Integrated analysis of the results ordered by section

Section C

The results from question No. 1 are provided at the two times programmed as well as the analysis formed by the elaboration of their ideas by the informants of Section C, depending on the conceptual operators used (see Table 1).

At first glance, it is observed that all informants improved their definitions of the environment in the second application of the questionnaire, which was expected after the experiences and learning strategies carried out during the implementation of the project

Table 1. Answers of the informants (Section C) of question No. 1

1. Define in your own words what is environment to you?

Key Informants	Evaluation 1 (M1) Previous Knowledge	Conceptual Operator	Evaluation 2 (M2) Final Evaluation	Conceptual Operator
C1	Love, peace, because it is neat and without garbage, and because there are animals that need the clean environment to live.	Love, clean living room peace to live	It is the interaction between the things of nature, man and society, for example: the child who catches the bus to go to school accompanied by his mother and the pet.	Interaction, Nature, man and society.
C2	It is what gives us life, what surrounds us, and all the elements of this planet, such as water, air, fire and earth.	What gives us life, what surrounds us, all the elements of this planet	It is the interaction of elements such as the hydrosphere, lithosphere and atmosphere so that there are conditions for the life of animals, plants and humans.	Interaction of elements, hydrosphere, lithosphere, conditions for life
C3	Life, air, without it we cannot live, breathe, to me it looks like the jungle.	Life, air, we cannot live without it	It is a set of elements that relate to each other (animals, plants, man and things made by humans).	A set of elements that are related.
C4	They are animals, the forest, the air, pure and clean, the trees, the environment is a source of life for animals and people.	It is a source of life.	It is the animals (my pet, the lucky elephant), the people (my mom, dad, my companions), the technology (houses, cars, the school, my T.V.) that act with each other to keep us alive.	They act on each other to keep us alive.



Key Informants	Evaluation 1 (M1) Previous Knowledge	Conceptual Operator	Evaluation 2 (M2) Final Evaluation	Conceptual Operator
C5	It is for me the best that life has given me and the atmosphere for me is beautiful.	Beautiful	It is the people, the buildings, the animals, the plants, the table, the chairs, the doors, the fan, the school, the church, it is all that surrounds us.	People, buildings, animals, all around us.
C6	The atmosphere is the place where we can live, the atmosphere is big, so big that you can see it, if the atmosphere was not clean we could not live.	A place to live, if it is not clean we would not be able to live.	They are the elements that interact to keep life, but man damages and endangers the planet.	Elements that interact with each other to maintain life.
C7	It is an environmental phenomenon. A natural place where all humans are happy and think it is great for the land, a place to live.	Environmental phenomenon, a place to live.	It is a system that includes all living beings that develop in the biosphere, which must be taken care of to maintain life.	System, Biosphere, care to keep life.
C8	The atmosphere is all around us.	Everything around us.	It is the interaction that happens between human beings, living beings and communities.	Interaction between human beings, living beings and communities
C9	It is all around us.	All that surrounds us	It is the people, the plants, the animals, the things created by man and God.	Things created by man and God.
C10	It is all that surrounds us: the plants, the animals, the air, the river.	Everything around us	The environment is a home for animals, plants, and living things, it is very important for me to keep it clean so that we do not get sick.	Home, important to keep it clean.

Looking in more detail at the answers provided in the first evaluation (M1), it is noted that four of the informants (C2, C8, C9 and C10) express an anthropocentric view of the environment “everything around us”, five other informants (C1, C3, C4, C6 and C7) are oriented towards a vision linked to life, place or space to live, some of which (C1 and C6) emphasize that it must be clean. And an informant (C5) expresses an aesthetic vision “The atmosphere is beautiful” locates it into the pre-concept categories.

Generally, none of these definitions approximates the concept of the environment associated with the systemic approach (Institutional Concept of Reference), because they are notions that have structured from their experiences, as pointed out Vigotsky (quoted by Benbenaste, Luzzi & Costa, 2007), the use of

these definitions show daily knowledge, these notions are based on the basic, familiar way, so that the individual realizes his/her environment, it is how he/she gives meaning to the world.

A progress of informants towards higher levels of elaboration can be seen in the second evaluation (M2) by using conceptual operators typical of the systemic approach, such as: system, interactions, set of elements related among them, elements that interact with each other, which denote a closer approach to the institutional concept that wants to be developed. This is the case for informants (C1, C2, C3, C6, C7 and C8). From this analysis, six categories emerged, bringing together all the forms and meanings used by these informants in their conceptualization on the environment (see Table 2), for both moments.



Table 2. Comparison of emerging categories in diagnosis (M1) and final assessment (M2) in section C

Categories	Diagnostic		Final evaluation	
	Informant	Frequency	Informant	Frequency
Preconcept	C5	1	----	0
Magical Religious Vision	-----		C9	1
Anthropocentric Vision	C2, C8, C9, C10	4	C5	1
Source of Life Vision	C3, C4	2	-----	0
Life Space Vision	C7	1	-----	0
Conservation Vision	C1, C6	2	C10	1
Systemic Vision - Complex	-----	0	C1, C2, C3, C4, C6, C7, C8	7

The categories were ordered chronologically according to their approach to the most up-to-date institutional concept of reference (Arana, 2008). It can be seen in Table 2, that six of the informants (C1, C2 C3, C6, C7 and C8) advanced towards levels of more complexity in their definitions, expressing a terminology more associated with the concept of environment as a system developed in the learning project, which highlights the conceptual progress experienced by the informants.

It is interesting the case of the informant C4 that has an initial vision of the environment as a source of life, then introduces socio-technological elements as part of the environment and dimension: “that they act with each other to keep

us alive”, i.e., it is oriented towards the systemic-complex, but it is still incomplete.

Likewise, the case of informant C9 who moves from an anthropocentric view to a magical-religious one, which remains being contradictory, considering that the religious topic was not addressed during the project. Finally, it can be concluded that nine of the ten informants moved towards levels of more complexity in the elaboration of their definitions.

Section D

The following are the results and analysis of the responses provided by the informants in section D.

Table 3. Answers of the informants (Section D) to question No. 1

1. Define in your own words what is the environment to you?

Key Informants	Assessment 1 Previous Knowledge	Conceptual operator	Evaluation 2 Final evaluation	Conceptual operator
D1	Flowers, animals, river, lagoon, grass, birds.	Natural elements	It is where all living beings live in the sphere of life, but we must take care of it or we will all die.	Living beings live, sphere of life.
D2	The atmosphere is all around us.	Everything around us	It is very important, it is not possible to live without it, we have to take care of it to have a better environment.	Life is not possible, take care of it.
D3	The environment is to take care of the trees, animals and flowers.	Caring	It is everything around us like humans, animals, buildings, and we have to take care of it.	Everything around us, take care.
D4	It is everything around us: plants, animals, birds, trees, lights, houses, people.	Everything around us	The environment for me is a home for animals and living things, and it is very important because thanks to it we are alive.	Home, we re alive.
D5	That is all that is around us.	Everything around us	It is the medium where I live, the school, the house, the beach, the zoo, and I have to keep it clean.	Where I work, keep clean.



Key Informants	Assessment 1 Previous Knowledge	Conceptual operator	Evaluation 2 Final evaluation	Conceptual operator
D6	What surrounds us: plants, trees and mountains.	Everything around us	They are the elements of nature (animals, plants) and social (people) that interact with each other, but it is in danger by man.	Elements, interaction with each other, danger by man.
D7	It is all that is around us.	Everything around us	It is the interaction of nature, humans and society, but any imbalance created by human beings can threaten all life.	Interaction of nature, human beings and society, imbalance
D8	It is all around us.	Everything around us	It is the interaction of the elements present in nature, and those created by man, if one disappears it endangers others, example: bears need ice to live, we depend on plants, animals and water to live.	Interaction of the elements, disappears, we depend to live.
D9	The natural environment is all that surrounds us.	Everything around us	Everything we humans interact with and depend on to live.	Everything we interact with, we depend to live.
D10	It is all that is around us.	Everything around us	Elements of the environment, such as water, air, soil, plants, people, society, which relate to each other to live better.	Set that relate to each other, live better.

As in the previous group, all informants improved their definitions of the environment in the second application of the questionnaire, and in fact this is easily evident, since, at the beginning, most (8) of these informants expressed a notion of the anthropocentric environment “everything around us”, linked in some cases to a naturalistic vision (D4, D6, D9). On the other hand, the informant D1, only refers to natural elements and the D3 points out that the environment is to take care of the natural elements, in both cases they do not show a conceptual statement, they can be classified as preconceptions.

However, the second moment of evaluation shows more enrichment in the operators used to define the concept. As shown in Table 3, the elaboration of statements in the first five informants is changed towards the consideration of the environment as a living space (D1, D2, D4, D5) and that we must take care of (D2, D3, D5), leaving behind, the anthropocentric vision, except

for the case of D3, denoting the inclusion of social elements and itself as parts of the environment.

The conceptualizations of the last five informants were closer to the institutional conception of reference, especially the informants D6, D7, D8; describing it as the interaction between natural, human and social elements or the D10 “set of natural elements, people, society, which relate to each other” (paraphrased) note the progress with respect to their previous notions. The D8 informant stands out, when he adds: “... if one disappears the others are in danger”, so informants D6 and D7 argue the threat posed by human beings to the balance of this system, i.e., they are aware of their responsibility in the face of environmental issues.

However, informant D9, even when using the “interaction” operator, still has an anthropocentric view by stating, “It’s everything we humans interact with”. Table 4 shows the categories that emerged from the previous analysis.



Table 4. Comparison of the categories obtained in the diagnosis and in the final evaluation in section D

Categories	Diagnose (M1)		Final Evaluation (M2)	
	Informant	Frequency	Informant	Frequency
Preconcept	D1, D3	2	-----	-----
Anthropocentric Vision	D2, D4, D5, D6, D7, D8, D9, D10	8	D3, D9	2
Source of Life Vision	-----	---	D1, D2, D4, D5	4
Systemic Vision - Complex	-----	---	D6, D7, D8, D10	4

Note that the elaboration of statements of all informants have moved from very simple notions to more elaborate conceptual answers, richer in terms of the conceptual operators they use and also at a more complex level. The fact that the systemic-complex category emerged at the end evidences the progress by one of the informants from their previous ideas towards concepts associated with the institutionally pro-

posed scientific contributions, so that it can be said that the pedagogical activities carried out throughout the learning project were significant to the achievement of the proposed objectives, especially the inclusion of human beings as another element of this system, thereby fostering comprehensive formation, the vision and holistic thinking in the students that would allow them to interpret their reality from a new perspective.

Discussion and conclusions

In summary, various answers emerge from the study that provide interesting conclusions regarding the learning of concepts and these are listed below:

1. The inclusion of the environment as an integrative axis in the Primary Education Curriculum promotes various learning opportunities based on educational projects, this is one of the main strategies for children to understand the functioning of socio-natural systems that enable a broader view of their reality, their problems and better solutions, from an interdisciplinary approach and as required by the Bolivarian National Curriculum (MPPE, 2007).
2. The teaching-learning of scientific concepts guarantees in students inclusive teaching strategies aimed at the activation of mental processes of observation, association, comparison, conceptual elaborations, among others, which can be externalized through definitions, drawings, graphics, information processors such as mind maps, conceptual maps and others, so that the teach-

er can compare the progressive progress from the beginning of the course.

3. It is confirmed that the prior knowledge expressed by the informants, for the most part (12 out of 20) is related to a notion linked to anthropocentric conception and others (3 of 20) to a conception linked to the possibility of life or space of life. The conservationist attitude was only seen in two (2 out of 20) of the informants, which agrees with other research carried out (Arana & González, 2006), at higher levels of education, and which demonstrates the conception of humans as the central axis of the environment.
4. In examining the progress made by the informants, there was an increase in all groups in the number of conceptual operators used to develop their definitions (M1 and M2), i.e., there is an increase in progressive concepts (Arana, 2007a) that provide greater meaning in the cognitive network of each of the informants, which is evidenced by the coherence in their written expressions, and the examples referred in some cases.



5. The informants moved their concept elaborations to more complex levels, progressively approaching the institutional concept of reference, as noted by different authors (Villegas & González, 2005; Moreno, 2012; Rey-Herrera & Candela, 2013) in relation to the construction of cognitive structures that increase the interpretive capacity of the environment, as well as the development of a conservationist attitude (10 out of 20 informants). See Figure 5, shaded and with (*).
6. Generally, the cognitive dynamics involved in conceptual learning appear to be due to a forward movement whose trajectory is progressive in terms of its complexity (see Table 5). This dynamic is best seen when more than two assessments are carried out, as seen in previous research by the author.

A schematic interpretation of the trajectory is presented below:

- 6.1. Note that informants in the preconception category (←-----→) advance to intermediate categories, anthropocentric vision (C5 and D3) and living space (D1).
- 6.2. Informants in the anthropocentric category (←-----→) advance to the space-of-life category (C10* D2*, D4, D5*) and complex systemic vision (C2, C8 C3, C4, C7* C1, C6D6*, D7*,D8* D10).
- 6.3. All informants located in the categories source of life and conservationist (←-----→) advance to the systemic-complex vision category (C3, C4, C7* and C1, C6*).

Table 5. Cognitive dynamics

Initial categories	Cognitivity mobility	Final categories
Preconcepts C5, D3 D1.	←-----→	Magical-religious vision C9
Anthropocentric vision C2, C8 C9, C10 D2,D4,D5, D6,D7,D8, D10 D9	←-----→	Anthropocenic vision C5, D3*
Source of life or Space of life C3, C4, C7	←-----→	Source of life or space of life D1* C10* D2*, D4, D5*
Conservationist vision C1, C6	←-----→	Complex systemic vision C2, C8 D6*, D7*, D8* D10 C3, C4, C7* C1, C6*

*The informants marked with the asterisk have a conservationist attitude.

7. The methodical analysis applied was appropriate for the purpose of the cognitive dynamics involved in the development of concepts, which is important for educational research and for teachers, since in teaching it is essential to know how

to develop the concepts in the students, analyze how previous knowledge is reorganized with the integration of new information and how these new contributions are processed in them.



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