

# **The Measurement of the Development of Systems and General Thinking in Agricultural Areas of Colombia: Preliminary Results**

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## **Abstract**

The present research started with two hypotheses: the development of an organic vegetable garden by children between 7 and 10 years old, living in agricultural areas in Colombia, develops their systems thinking, and there is a direct relationship between the development of system thinking and the level of general thinking of these children. The research has been based on the application and adjustment of an empirical methodology and its tools in an initial project in the rural town of Barichara, Colombia. It is planned to further refine this methodology and its tools by its application in other Colombian towns resulting inductively in a general application plan within Colombian rural towns in general. The final goal of the total project is to be able to decrease the social, environmental and economic problems of the people in agricultural areas in Colombia by the development of systems thinking of these communities.

The research methodology and its tools of the initial project have been developed empirically using the knowledge and experience of the research group members. The tools were applied within the three research phases: before, during and after the children's activities in the organic community garden. Before and after the activities, tools have been applied to measure the general thinking level and system thinking development of the children. During the activities, a tool has been applied to guide the children in their learning process of the garden, and to measure the development of their systems thinking.

The initial project has been applied within the rural town of Barichara, Colombia and has been developed by an interdisciplinary research group, coordinated by 1 project leader. The group of children consists of 11 rural and 11 urban children, with a reference group of 22 (11 urban and 11 rural) children. The organic community garden has been developed conceptually by the research group and physically (before the activities of the children) by local experts in organic gardens all coordinated by the project leader. During the activities, an expert in social projects with the children of the community has been accompanying the project leader with the guidance of the children with their activities.

*Keywords:* systems thinking; organic agriculture; rural areas; Colombia.

## Introduction

Fifteen years ago, Famoc Depanel, by means of its CEO Javier Ramirez, started a organic vegetable garden to decrease the impact of the mowing of grass in between the production facilities. In time, this project resulted to have different subproducts which can be resumed below the concept of "eco-consciousness" [1]. Through its subproducts this concept has shown to be interesting. The Barichara project is a first step towards the intention to scientifically prove the concept of "eco-consciousness" and its sub-products as the initial goal of Famoc Depanel S.A.

The project is lead by a interdisciplinary workgroup coordinated by a part time project coordinator and financed by three parties: Famoc Depanel, San Lorenzo Foundation and the Los Andes University; with Famoc Depanel as the main financier. The start of the project was the need for a scientific prove of the eco-consciousness concept created by the work in organic vegetable gardens. To make this possible and applicable, the San Lorenzo foundation offered to do the project with the preliminary school children from 7 to 11 years old of the village of Barichara, giving the project a new dimension making it possible to contribute to the education of the development of the respect for the natural environment [2]. To guide the project in its scientific aspects, the Los Andes University contributed by the development of the methodology and the development of the tool for measurement of the systems thinking level.

In this way the following two hypothesis were established and worked on partly in this paper: The development of an organic vegetable garden by children between 7 and 11 years old, living in agricultural areas in Colombia, develops their systems thinking, and there is a direct relationship between the development of system thinking and the level of general thinking of these children.

The application of the eco-consciousness within the context of children in a village, created the existence of a macro project with different goals as the initial goal of Famoc Depanel. The macro project focuses on refining the methodology and its tools by its application in other Colombian communities resulting in a general application plan within Colombian rural towns in general. The final goal of the total project is to be able to decrease the social, environmental and economic problems of the people in agricultural areas in Colombia by the development of systems thinking of these communities resulting in a critical consciousness as Freire (Freire, 1993 [3]) calls it. The Barichara project, as subject of this paper, is resulting in various other products like a organic vegetable garden for the village, a supplemental education for the children, a continuation of the activities of the San Lorenzo Foundation and the application and empowerment of various personal projects of the interdisciplinary team members. This paper only will focus itself on the scientific results

The Barichara project has been developed in three areas:

1. The implementation of the project within its context (project management)
2. The methodology of the process
3. The tools used within the methodology

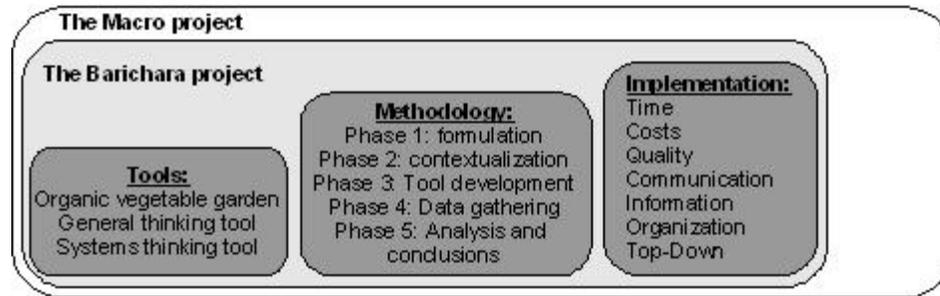


Figure 1: The Areas of the Project

The project has been developed until the 4<sup>th</sup> and 5<sup>th</sup> Phase; both phases are being processed in this moment. The project is planned to last until September 2006.

As mentioned before, this paper only covers the results of the Barichara project from a scientific point of view.

## The Project

Laszlo (Laszlo, 1996 [4]) states that a shift from a classical [reductionist] to a systems view of the world is necessary to be able to solve the actual problems of society. In the same text, Laszlo states that natural systems have a variety of concepts that we, as humans, must get acquainted with when willing to shift to a systems view of the world. This same relationship between the systems world view by systems thinking and nature was stated by Capra (Capra, 1996 [5]) when defining the origin of systems thinking. So to be able to solve the problems created by the actual development, systems thinking is necessary. The macro project, in which the Barichara project is having its role, has its hypothesis that systems thinking can be created by learning from and working in a natural environment; in this case a organic vegetable garden. As not only being a scientific project but also a social development project, the main goal of the macro project is bettering the world vision of people, as important influence in their culture, being this one of the main goals of the DIPS research group.

## The General Research Design

Within the macro project, the Barichara project was created to make a start in finding the answer to the macro project's hypothesis. By the development of an organic vegetable garden, a natural environment, by children between 7 and 10 years old, living in agricultural areas in Colombia, the project is trying to develop the systems thinking of the children. To take a reference, besides the level and development of the systems thinking of the children, their general thinking level was measured at the same moments.

As mentioned before the macro project has its final goal to initiate a social change. Taking into account the systems thinking characteristic that the final goal of a sub system is the final goal of the system to which the sub system belongs, the Barichara project also has been aiming initiating a social change. In this project, this change has been tried to be initiated by engaging in dialogue with the informants about their analysing of observed and reported events and activities as Bogdan (Bogdan, 1998 [6]) calls it. This dialogue as the source of a critical attitude [3] leading to the critical consciousness. In this research this dialogue has being implemented by involving

in the project the school teachers of the children, as research subjects, trying to let them see how to better the children's school situation.

The project has showed to be within the area of the loosely scheduled traveler as Bogdan (Bogdan, 1998 [6]) refers to, mentioning a qualitative educational researcher. The questions to be asked and the data to be collected have emerged in the process of doing research. The design of the research methodology and its tools took more than one year, before being able to start working in the organic vegetable garden. And especially the application of them within the children's world has showed a great learning process and, resulting from it, a methodology and tool redesign/adjustment.

To make possible a response to the two hypothesis of the Barichara project, an interview schedule and a vast structure of workshops has been showed to be necessary. In keeping up with the qualitative tradition of attempting to capture the subjects' own words and letting the analysis emerge, the interview schedules allow for open-ended responses ([6]).

To be able to develop insights on how the research subjects interpret their world, insights on their world vision, the gathering of the descriptive data in the subjects' own words, a dominant strategy for data collection [6] was used; using a strict order of interview questions equal for all research subjects before and after the project part in the organic vegetable garden. As mentioned before, every question allows an open-ended response, avoiding the "yes" and "no" answers, and the interviewers let the research subjects tell all they wanted to answer to assure the authenticity of the data.

### **The Selection of the Research Subjects**

As mentioned in the introduction, in the Barichara project the preliminary school children were chosen as main research subjects. According to Martí (Martí, 2003 [7]) these children from 6 years old on start to reason in a more logic form, are less dependent on the perspective appearance of the stimuli, have a more selective attention, develop the processes of memorization and expand the quantity and quality of their knowledge about the world around them. Therefore this group of children is very suitable for the Barichara project having a change of the world view as a main goal.

At the same time, children from 6 years old and older, coordinate at the same time information, ideas and concepts ([6]). This integrated coordination and processing ables them to attack different tasks from different dimensions, where various variables are coming into play. The solution to these tasks can only be found by understanding the relationships between these variables; an important element within the systems thinking.

To summarize, it can be stated that the research subjects of the project, children of 7-11 years old, find themselves in a period of their lives that enables them to elaborate structured beliefs about different aspects of the world they live in. Being these beliefs solid enough to construct their first intuitive theories about some knowledge areas; something that is of vital importance taking into account that the project's main goal is measuring if their is a transformation of the intuitive theories of these children about the living world; believed to result in a social change.

According Gardner (Gardner, 1993 [8]) in the age of 5 to 6 year old, children developed powerful senses concerning three superimposed habits. In the world of the physical objects, they developed a theory of material; in the world of the living organisms, they developed a theory of life; and in the world of the human beings, they developed a theory of a mind incorporating a

theory of I. These theories in time consolidate more and more throughout the experiences of every individual, a complex process resulting in which the children order and understand the world in which they live in.

According to Gardner (Gardner, 1993 [8]) the processes of manipulating, experimenting, observing and comparing the different objects in their daily live, make it possible that children get to this understanding of the world around them. Therefore in the Barichara project was chosen to let the children not just work in a organic vegetable garden, but also to let them design, build and maintain it.

## **Garden Workshops**

To guide the work, design, building and maintenance of the organic vegetable garden by the children, workshops were designed in which researchers work together with the children's school teachers. At the same time the work, design, building and maintenance is also the process in which the project intends to create more systems thinking within the children. These workshops were based on the experience of the "pequeños científicos"<sup>1</sup> project of the Los Andes University in Colombia. Theoretically this project is merely based on the guided inquiry idea implemented in the beginning of the nineties by Charpak. The guided inquiry as a pedagogical practice recovers the intuitive way of learning of children by introducing them and guiding them gradually in the world of sciences, making it essential that the children observe, manipulate, state and verify hypothesis, experiment (apply what they have learned in the classroom) stimulating the child in its entirety: the body and the emotions [10]. In this way it is possible for the children to compare their knowledge and experience, as being important elements of systems thinking. The most efficient context for this process of comparing knowledge and experience can be found by making groups of children, making it possible not only to compare the thinking of a child but also between children.

In the Barichara project, the eleven workshops<sup>2</sup> in the organic vegetable garden are therefore designed to make it posible for the children to apply in any form what they know working together in groups. The guidance of the researchers and teacher together makes it posible for the teachers to get feedback on their classes on the elements of organic vegetable gardens.

## **Methodology**

The Barichara project exists in five phases:

### **Phase I: Formulation of the project**

Research plan, formulation of the interdisciplinary working group<sup>3</sup>

### **Phase II: Contextualization of the project**

Interaction with the people in Barichara (social construction of the project), selection of the research subjects (a main group and a control group; the "placebo effect");

### Phase III: Development of the tools

Definition of the three fundamental pillars of the project (the design of these pillars started in phase II with the interaction with the people in which especially the measurement tools saw their first pilots):

1. The adaptation of the earth and the construction of a rain water recollection system
2. The design of the eleven workshops to be able to realize the activities within the organic vegetable garden.
3. The design of the tools to measure the systems thinking (1 tool) and general thinking level (2 tools).

### Phase IV: Recollection of the data

Application of the measurement tools (before the workshops), the workshops and the measurement tools (after the workshops).

### Phase V: Analysis and conclusions

Analysis of the results of the tools and comparison of the systems thinking and general thinking level before and after the workshops in the organic vegetable garden.

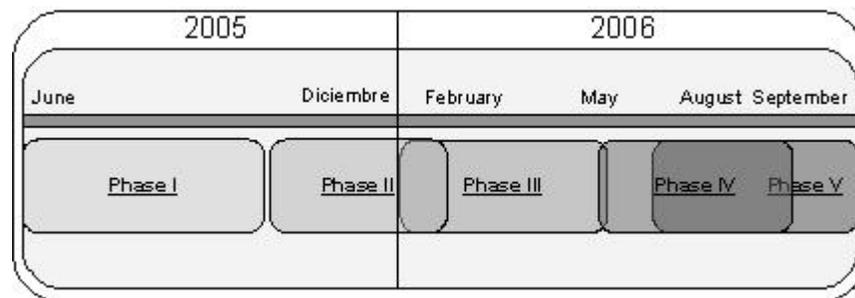


Figure 2: The Five Project Phases in Time

The rest of this paper will show the design and results of the systems thinking tool and the results of one general thinking tool (Badyg) with their results before the start of the workshops in the organic vegetable garden.

## Tools

To be able to measure the systems thinking level of the children, a measurement tool was developed based on the different concepts of the general systems theory mentioned in Johansen (Johansen, 1982 [11]) and as applied in the ultimate 4 years in the product design and general systems theory workshop for the Industrial Design bachelor program at Los Andes University. These concepts were concentrated in three groups representing three levels of systems thinking according to Witjes (Witjes et. al., 2006 [12]). Level 1 represents the lowest level of systems thinking and level 3 the highest level.

1. Systems, sub-systems and synergy

A system is build up by sub-systems. The input and output flows of the main system and more than the input and output flows of the sub-systems summed up.

The mutual relationships of the parts of a system create one big whole. In the lowest level there is represented a multitude of interacting parts but without these parts are organized to create the whole.

2. Possesiveness and feedback

The sub-systems present an order or hierarchy and a control or synchronization of all the input and output flows in the system to make the concept of synergy possible. In the highest level there is a visualization of the whole a an abstract way without paying attention to the parts. In the lowest level there is a visualization of the multitude of interacting parts without understanding how they are organized to form the whole. The child visualizes the interacting parts of the drawing and understand how they are organized to create a whole.

3. Chaos and order

The development of a system exists by the equilibrium between chaos and order within the system.

The child understands the whole of the drawing and how the interrelationships and interdependencies between the parts of the drawing and therefore understands the chaos or order.

These three concepts were transformed into questions using the experience of the "pequeños científicos" project in question design.

- System, sub-system, synergy - What things do you see in the drawing?
- Possesiveness and feedback - What relationships do you think there are between the things of the drawing?
- Chaos and order - What do you think that will happen in the drawing?

As a fourth question (and as a question to be able to help to reconfirm the systems thinking level of the child), the child was asked: "What could you ask me about the things that there are in the drawing?".

The four question were asked for every of the three drawings made by hand of possible situations of the usual context of a child of Barichara. The answers of the child were written down by the researcher (member of the working group) and recorded on tape (as a back up).

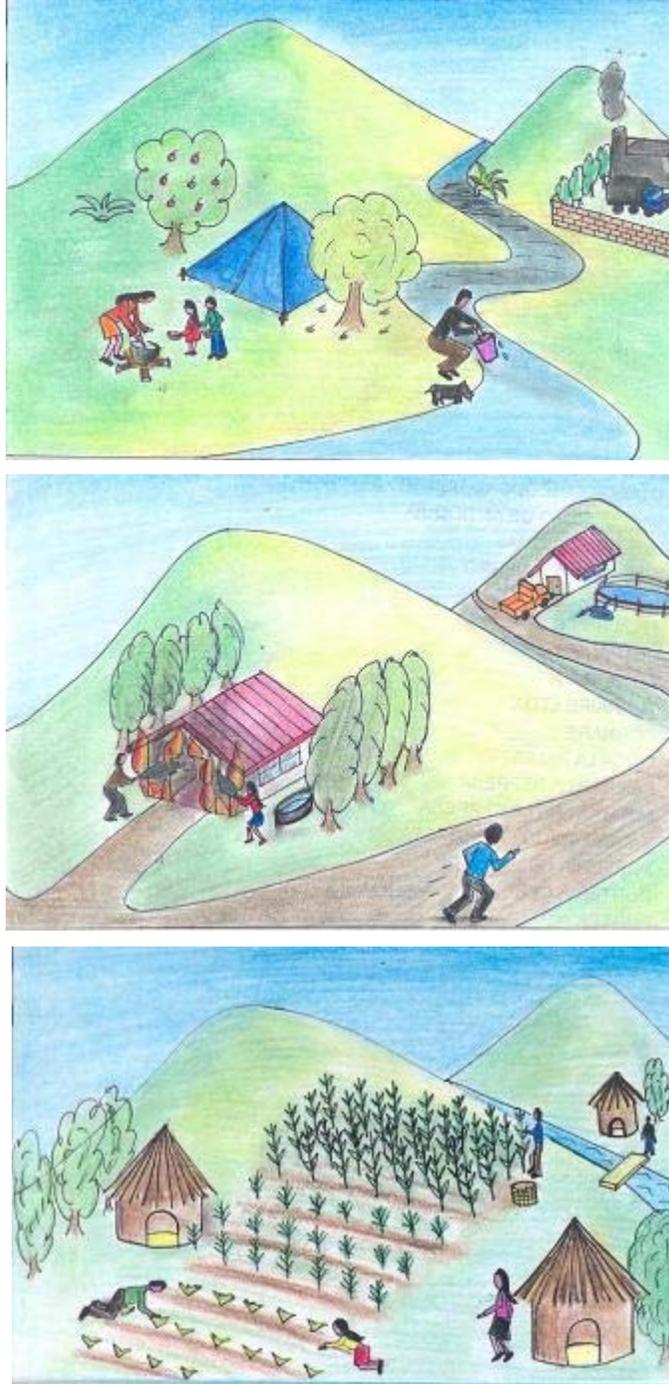


Figure 3: The Three Drawings

The children were asked to answer these questions in relation to three drawings.



group of children from the town of Barichara and one from the rural area one hour outside of Barichara, and for both groups one group of children that are going to participate in the organic vegetable garden (main group) and one that is not (control group). Every of the four groups hereby created had almost the same amount of children:

	Main group	Control group
Barichara	10	9
Rural area	11	8

Figure 5: Amount of Children per Group

For the systems thinking tool results, the three systems thinking levels were given points to be able to represent the result graphically: the first and lowest level (systems, sub-systems, synergy) was given 5 points, the second and middle level (possessiveness, feedback) was given 10 points, and the third and highest level (chaos and order) was given 15 points.

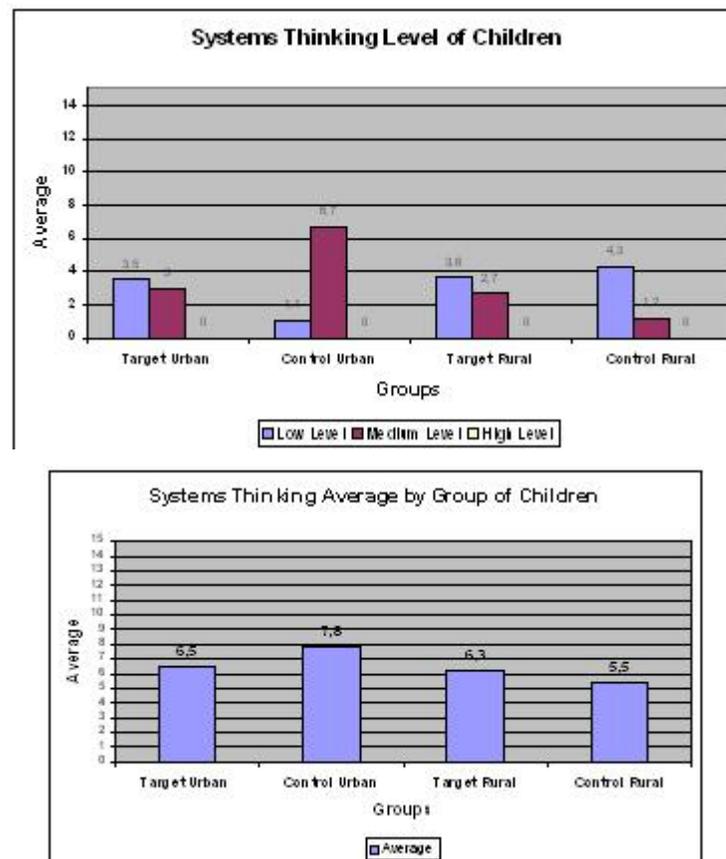


Figure 6: Results Systems Thinking Tool

The urban control group has the highest systems thinking level resulting in a higher overall level of systems thinking of the urban children compared to the rural children. Overall the systems thinking level of all children is medium to low.

The results of the Badyg tool are given according the tools' criteria.

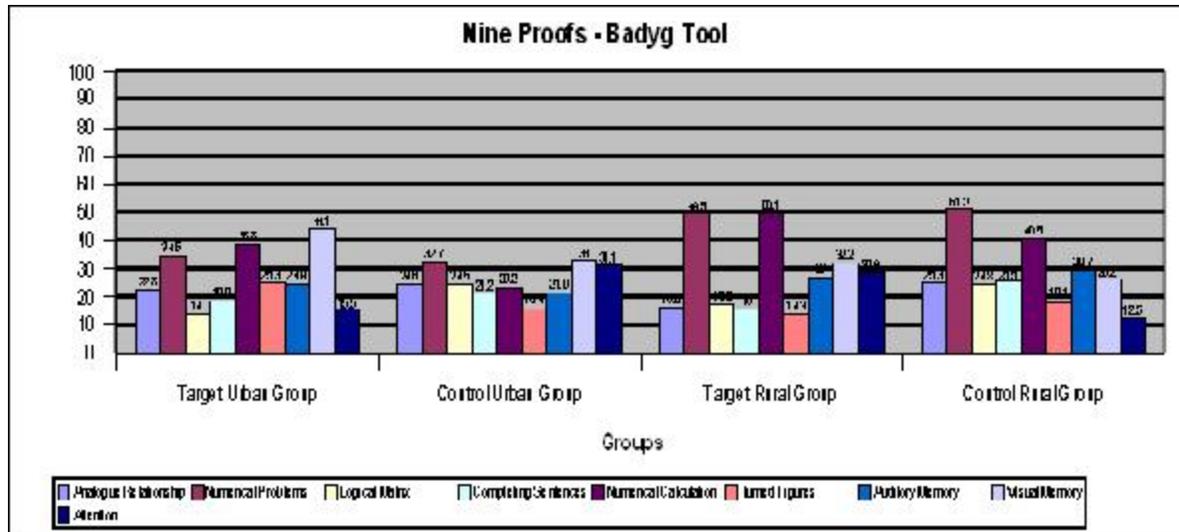


Figure 7: Results Badyg Tool

The numerical capabilities of the rural children are higher than the one of the urban children. Overall the level of general thinking level of the children is low compared to the reference: the panish children.

## Conclusions

In general can be concluded that both tools give results that can be interpreted and be analyzed to, finally, be able to get to an answer to the two hypothesis of the Barichara project.

The results of both tools show that the level of systems thinking and general thinking is, in average, low, which leaves enough space to see a bettered level in both after the organic vegetable garden workshops.

Comparing the results of the systems thinking tool and the BADYG tool, it is interesting to see that the rural children have a low systems thinking level but a medium numerical level. This could result in a additional hypothesis for later on in the Barichara project: a medium to high numerical level means a low systems thinking level.

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## Notes

- [1] "Pequeños Científicos" - Little Scientists "is a program that searches to renovate teaching and learning of experimental sciences in preliminary school in Colombia. Through observation, experimentation, manipulation, confrontation and the discussion of ideas, this project aims to involve children from their first years in school on in a different way in sciences [9].
- [2] 1. the fruit seeds; 2. description of the seeds; 3. compost for the earth; 4. adaptation of the earth; 5. description and germination necessities; 6. water cycle; 7. irrigation system; 8. sowing the seeds; 9. biologic control; 10. morphology of the plants; 11. competence and necessity of the plant.
- [3] The project has had one visionary leader and one coordinator with a interdisciplinary group of people as the working group (Javier Ramírez, Economist, Carolina Montoya, Industrial Designer - Famoc Depanel S.A. Ángela Jiménez, Architect/Artist - San Lorenzo Foundation, Juana Morales, Children Psychologist, Liliana Carbone, Industrial Engineer - Sumercé, María Figueroa, Bióloga ("Pequeños Científicos"), Sjors Witjes, Industrial Design Engineer - Los Andes University).