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THE USE OF CONCEPT MAPS AND TERRARIUMS TO THE ENVIRONMENTAL AWARENESS OF ELEMENTARY SCHOOL STUDENTS IN SCIENCE CLUBS

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Abstract. The climate changes as a consequence of perturbations in the environment due to human actions and the global warming are subject of great attention in the world media. In this context the education of the citizens with respect to responsible ecological actions is fundamental. These activities are part of a project named "Science Clubs Creation", developed at the Universidade Estadual de Ponta Grossa, which aims at developing pupils' criticism by means of actions that involve the application of scientific method. In this work the results of activities developed at the Ipiranga, Paraná – Brazil Science Club are presented, the objective is to raise awareness of Brazilian basic education students from Ipiranga about environmental problems. This work reports on an investigation about the conceptions of different education level pupils concerning environmental issues. The instruments adopted were the construction of concept maps and the assembly of a Terrarium. The main result of this research points out that the levels of education influence the way that concept maps are constructed because each level of education presents different ways of approaching the contents in science.

1 Introduction

Education in Science requires the use of methodologies that can make lessons more creative besides providing situations that allow the contextualization of the science contents towards the learner reality. Students should be encouraged to establish relationships and to understand the influence and importance that Science and Technology have on their lives and as a consequence, have attitudes reflecting the assimilation and learning of the content being studied. The responsibility to develop activities in this regard rests with the teacher, from which it is required knowledge, creativity and expertise to bring these issues to the classroom. However, inadequate training, a non-stimulating career, a rigid administrative structure and curriculum hinder dedication as well as the ability to provide stimulating lessons for Science classes, thus limiting teachers' educational practice. (Brasil, 1998; Brasil, 2002; Paraná, 2008, Andrade, 2007; Henning, 1998).

By considering the context explained above, the Group of Instrumentation for Physics Teaching of the Physics Department at Universidade Estadual de Ponta Grossa has developed the project "Science Clubs Creation", which is inserted in the program "Universidade Sem Fronteiras" (University Without Boundaries), in the subprogram support for teacher training of the Secretary of State for Science, Technology and Higher Education of the Paraná State in Brazil (Paraná, 2010). The project "Science Clubs Creation" aims at disseminating and creating spaces in non-formal basic education schools to enable discussion of issues important to the daily life of society, providing pupils with a differentiated way of learning Science. Another project goal is training teachers of Science by providing activities that allow interaction with pupils and their daily lives, as well as with the school in an environment not as rigid as the classroom. This partnership and the possibility of further studies following a scientific methodology provide students with rich extracurricular experience.

This work reports on an investigation about the conceptions of different educational level pupils concerning environmental issues. The tools employed were the construction of concept maps and the assembly of a Terrarium – a small representation of an environment where global variables can be controlled – and activities resulting from the observation of the Terrarium.

2 Methodology, results and discussions

The team carrying out the project consists of undergraduate students of Chemistry, Biology and Physics, a newly graduated student of Science and three professors from the Department of Physics. In the Science Club the partners are pupils from elementary and high school who take part in a meeting at the beginning of the school year and propose the themes for the development of the projects and studies. The topics should provide discussion on citizenship, social

and environmental responsibility by bringing knowledge about new technologies and especially the contextualization of concepts of Sciences. The acceptance of the subject, the definition of projects and studies depends on the decision of students, who are free to choose and set up working groups.

This procedure allowed the terrarium to be employed as a guiding theme for discussion of environmental issues as well as the causes and effects of human actions on the planet. This activity was developed in the Science Club of the "Colégio Claudino dos Santos" in the city of Ipiranga – in Paraná state, in a non-formal atmosphere, with pupils, divided into groups formed predominantly by pupils of the same age. The work was coordinated by the monitors of the undergraduate courses of the Universidade Estadual de Ponta Grossa, who organize and trigger the formation of clubs.

A lecture about global warming was given to the students to review concepts associated to environmental issues. These concepts were used for the construction of concept maps. In this lecture some scientific concepts and terms that were not familiar to students were clarified. In another meeting students were told about Terrariums and how to observe changes in their interior.

From the observations carried out by the students it was possible to verify pupils' knowledge and develop complementary activities and further their education through lectures. These were presented so that Club members could get acquainted with the basic scientific research activities. These lectures clarified some concepts and scientific terms that members would use later in their comments, and provided them with information about the assembly and functions of a Terrarium. Following the lectures, two Terrariums were assembled, which despite some differences, simulated rain forest environment with a humid climate. Both were built using glass containers like an aquarium, and components such as sand, stone, soil, seedlings, vegetable seeds, bird seed, water and small insects. After built, the Terrariums were fully closed and placed in sunlit locations for about an hour.

The development of the Terrariums observation began after the completion of another activity in which concept maps were built (Moreira, 1999, 2006). The construction of concept maps was proposed to be developed soon after the Terrariums were built. The following questions were proposed as a guide to the club members to the construction of the concept maps: What is it?, What happens?, What's inside and What is the purpose?. These concept maps are representative of the perceptions and conceptions that club members' have in relation to elements of the Terrarium and the natural phenomena reproduced as well as their occurrence in nature. Concepts produced during the lecture were each written on small pieces of paper and laid on a Tablewhere they were prepending expletive dial-up between the concepts. Each group rode their concept map on a poster. Two of these resulting concept maps are presented in Figure 1.

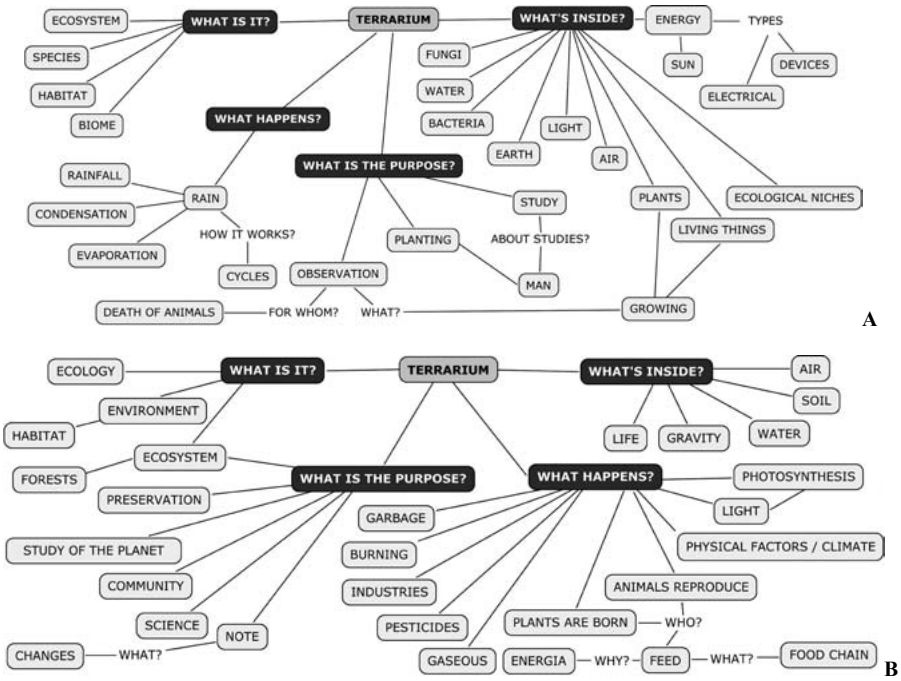

Figure 1. Concept maps constructed by Science Club members. A) Older and more educated pupils, B) less educated and younger pupils.

The maps developed by older students (Figure 1A), show higher levels of branching and more linking words which reproduce a map with more complexity better structuring their knowledge that results from greater influence of school. The map showed in Figure 1B has more elements that highlight environmental issues without depth that may result from the school for this age group having its main focus on this aspect.

The club members carried out daily observations about the occurrences inside the Terrariums which were recorded in notebooks following the scientific methodology. As the discussions progressed, further experiments were proposed and carried out to better understanding of what was observed. Thus, the research groups went into action with study and experimentation, for example, the study of the water cycle, of the atmospheric temperature and pressure, about botanic, zoology, etc.

A weekly meeting was held as part of the routine activities of the club, during the first half of the meeting the works proposed were presented and discussed with all members of the club. In the second half, the work proposed was developed by the groups, accompanied by the monitors. The conclusion of the works was performed as an activity that involved the whole group, in which it was noticed that the club members achieved the initial objective that was to compare the phenomena that occurred in the Terrarium to natural phenomena that occur on Earth, understanding the interconnection of all beings and characteristics of the local and global environment.

This activity consisted of a circle formed by members of the Club and a roll of string. Initially, the student in charge of the activity held the end of the string and threw the roll to another member asking him a question at the same time, the latter answered the question and threw the roll and another question to a third member and so on. Members were asked to prepare questions to each other according to the observations they had previously registered. At the end of the question and answer procedure, a web of string was formed inside the circle, so it was possible to clearly visualize and explain the interrelationship between the research themes: climate, water and living beings that had been developed from the construction of the Terrarium. To finish this activity, a question was proposed to the club members about what they had learnt from the activity.

The analysis of activities carried out by members of the Science Club for fifteen weeks of observation was made in a qualitative way. The choice of qualitative methodology arises from the values and ideals, history and social importance involved in the issue of the environment, as well as theoretical knowledge of the subject involved in this activity, and given the important significance of the subject in the training of concerned citizens. For the analysis of responses statements were chosen that were common to the whole group, taking into account the objective proposed to use the scientific method to observations.

After the Terrariums were closed, it was elicited from the pupils what might occur inside them. The assumptions were varied and contradictory. The answers that summarized their hypotheses were: "*I think it will not survive as the air and water are going to finish; The insects will survive because they have enough air, water and food*; *The Terrarium will die, because there is not enough water or oxygen for the plants to grow.*"

It could be observed that all of them related the survival of living beings to the existence of air, water and oxygen. However, other factors such as the natural cycle of life, reproduction, and temperature were not related. This suggests that there are difficulties in relating elements not so obvious or abstract, with what is being observed. By mentioning the element oxygen pupils of higher grades reveal more subsumers.

In the first week after the Terrarium had been sealed, it was possible to see that the seeds had sprouted and that some insects had died. After a weekend students made the following observation: "*We were surprise when we arrived; almost all the little seeds had sprouted and are now about 7 or 8 cm high; unfortunately, some insects have died.*"

Note that the students did not expect that the seeds would sprout in the first week and showed disappointment with the death of insects. The impact of this observation prevented them from noticing another important visible phenomenon. The walls of the Terrarium had steamed up after some time in the sun. The phenomenon was only noticed when prompted by the monitors.

After four weeks, the Terrariums had a piece of dry grass and plants such as weeds had been born. Bird seeds in

development were also observed.

"*Terrarium 1: The weather is rainy; there are animal carcasses, part of the grass is dry but there is green grass and clover and other seedlings are growing. It means that there is still life, mainly oxygen and water.*"

"*Terrarium 2: The weather is rainy, there are three leaf clovers, birdseed, and most grass is alive and has enough oxygen.*"

Pupils were already familiar with the water cycle and attributed green plants to the existence of oxygen. No one mentioned other factors that could influence the process of death and life in the ecosystem. The observation group of living things began to investigate the structure of plants. In the eighth week the seedlings of birdseed and grass were apparently dying as a natural consequence of climate, since it was winter:

"*Terrarium 1: Presence of little grass observed. No animal life and plants have all nearly died.*"

"*Terrarium 2: A lot of grass growing, some of the seed sprouted some died. There is a three-leaf clover. This seams to be very little.*"

The insects had already died because of their life cycle and due to lack of reproduction. Most of the grass and "*seedlings*" had also dried; the group was disappointed with the activity because the living elements of Terrariums were apparently all dying. However, there were no questions about why that was happening. Remark registered after fifteen weeks that the Terrarium was built:

"*Terrarium 1: There is little grass, bryophytes (moss), it is raining, Terrarium one, could not survive alone.*"

"*Terrarium 2: It's raining, there is plenty of grass and clover grew a lot, various other plants were born.*"

The closure of the Terrarium observation activity with the web of string group dynamic provided an overview of the process with enthusiastic pupils' participation. The activities carried out during the observation period were remembered showing that learning was significant. Everyone understood the behavior of a self-sustaining terrarium:

"*Nothing will be born; nothing will grow if the water, living beings and climate are not linked.*"

"*I thought nothing would survive because the terrarium is sealed, but they are surviving.*"

The activity allowed pupils to understand that all matters discussed during the observation period were interrelated.

3 Summary

The reports from members of the Science club made it possible to observe the difficulty to correlate phenomena, their causes and effects, because in many instances the members observed several phenomena in the small ecosystem but did not question why such events happened. In other words, it was difficult for them to insert abstract questions to that context, or even factors which were not so evident such as temperature, pressure and solar radiation. Thus, the participation of monitors, and the activity of monitoring, studying and experimenting in parallel were fundamental to the learning process. Therefore, using a Terrarium as the theme generator is effective in teaching-learning activities which are developed in an informal approach. This can also become an important tool when combined with formal education, contributing effectively and meaningfully to the contextualization of the content seen in the formal classroom and experienced in the Science Club. It also provides an opportunity to introduce scientific methods to the study of these issues and processes of environmental education and training of citizens. Such contribution becomes obvious when the change of pupils' discourse and attitude is observed and their interest in the themes generated by the Terrariums raises awareness of the importance of taking care of the environment for the balance of the planet. As the main result of this research we have that the levels of education influence the way that concept maps are constructed because each level of education presents different ways of approaching the contents in science.

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