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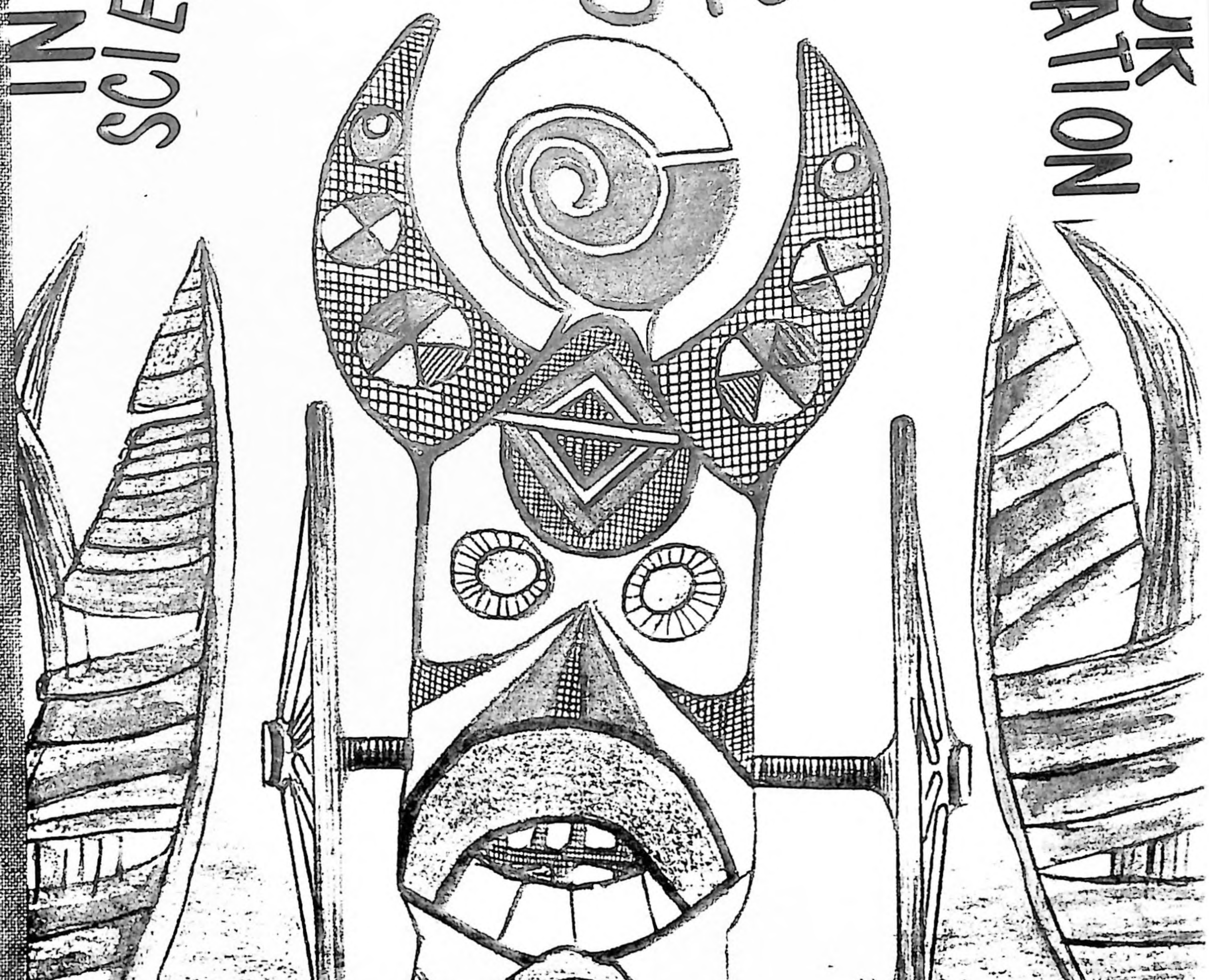

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PLANT NUTRITION IN A HISTORICAL AND EDUCATIONAL PERSPECTIVE

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ABSTRACT

This work presents the results of research done with students of primary schooling about their plant nutrition conceptions. Plant nutrition is an important curricular component developed in science teaching. Students view plant nutrition as one of the difficult areas in scientific study as it is a vital function in the plants, involving many aspects such as physiological, biochemical, ecological and of energy conversions aspects, demonstrating its enormous conceptual wealth. Besides, the processes involved in plant nutrition have a fundamental role in understanding many aspects of the living organisms and their relationship with the environment. Thus, students were interviewed to ascertain their understanding about plant nutrition by analysing the content of their ideas. Some aspects of the teaching-learning process were investigated, such as the text books and the science teacher's style of communication, to identify the students' conceptual models of plant nutrition.

Initially, current theoretical aspects of plant nutrition are presented, to compare them with students' conceptual models. Some of the previous ideas that culminated in the current theories were introduced; focusing mainly on different conceptual models that emerged during the conceptual development of these scientific theories. Thereafter, the results of the students' interviews are presented, comparing them with their respective scientific models. Comparisons with results of other studies are included. Starting from the analysis of the set of students ideas and of the way the students organize and structure them, inferences are made that take to the identification of the underlying conceptual models. The results of the analysis of the sciences didactic books and of the teachers' interviews, trying to identify some aspects of the teaching-learning process that influenced the conceptual models are presented. Final considerations are made, discussing the obtained results, including other influential factors in the students conceptual models, as the partner-cultural aspects, that could not be deepened in the research. The educational implications for the teaching of the topic "plant nutrition" into students' alternative conceptions context conclude the present work.

INTRODUCTION

The processes related to plant nutrition have a central role to understand many aspects of living organisms and their relationship with the environment. Among them, photosynthesis is one of the most important biochemical processes of the earth (Arnon 1982), acting as a bridge between non-living and living world. It transforms inorganic substances into sugars, which are initial organic substances for life manifestation. Also respiration, is as important as photosynthesis and produces the conversion of the energy stored in these sugars in forms that can be used by living organisms for the maintenance of their vital metabolic processes. Understanding photosynthesis and respiration processes is a prerequisite to the systematic understanding of ecology, since they are essential processes in the most basic of the substance cycles, the carbon cycle, and also in understanding energy flood through ecosystems.

However, the processes related to plant nutrition, such as photosynthesis and respiration, topics of great curricular importance in elementary education, are considered complex by students, configuring themselves in one of their most difficult areas of understanding (Finley, Stewart and Yarroch 1982; Johnstone and Mahmoud 1980). The majority of students demonstrate some knowledge in isolated aspects of these processes, but few can explain them, thus they are not able to understand the substance and energy transformations that occur in the plants in these processes, nor can they explain in what way these processes have a relationship with the environment (Leach, Driver, Scott and Wood-Robinson 1996). For example, in the selective process examination to be admitted to the University (undergraduate level in Brazil), a low percentage of students succeed in answering questions related to these topics. This fact shows that, after the conclusion of secondary school, these problems persist in students.

One of the purposes of science education is to develop the understanding of complex topics in students (Waheed and Lucas 1992). Consequently, it is important to investigate the students understanding about these subjects, identifying their specific ideas on related processes and how they interrelate these processes and concepts in a scientifically interconnected way. We investigated these aspects in relation to plant nutrition, in the context of science teaching in public and private elementary schools at the city of Ribeirão Preto, São Paulo State, Brazil. We also investigated the methodology used in science teaching to treat this topic, identifying the approaches given by textbooks and science teachers. These investigations intended to subsidize our knowledge on how students understand the processes related to plant nutrition. For according to studies on the extensions of misconceptions perpetuated by teachers and textbooks, it is undeniable the damages caused by these pedagogic materials and educators (Barrass 1984). A study of the development of plant nutrition ideas in a historical perspective was carried through aiming to know the evolution of the ideas in this field of knowledge.

BACKGROUND

According to a literature review, conducted by the author (1998), most works on students' conceptions in plant nutrition investigated isolated and disconnected ideas. These works either study concepts of the central processes in plant nutrition, such as photosynthesis and respiration concepts, or their conceptions of prerequisite concepts (for the understanding of the concepts of the central processes in plant nutrition), such as: osmosis, diffusion, half-permeable membrane properties, food, gases, energy, light, chlorophyll, ground, etc. Although 24.5% of the revised work present photosynthesis and respiration treated jointly, they are not treated in an integrated way with an exception made to topics relative to gaseous exchange (Anderson and Sheldon 1990; Barrass 1984; Bell 1985; Driver et al. 1984; Haslam and Treagust 1987; Johstone and Mahmoud 1980; Simpson and Arnold 1982 ab; Soyibo 1983; Stavy, Eisen and Yaakobi 1987; Treagust 1987 and Wandersee 1983). These works rarely search the students understanding of the integrated processes (Núñez and Banet 1997), being found only in one of revised works, from Waheed and Lucas (1992), that investigated the understanding of interrelated topics in photosynthesis. From this review it is possible to affirm that there is a great gap in the research context in students conceptions about plant vital processes treated as complex and interrelated topics.

The present study focuses mainly on the students understanding of processes related to plant nutrition in the elementary school, investigating their conceptions, from the following questions: "In what extension do students understand the fact that plants realize autotrophic nutrition?" and "In what extension do students understand plant nutrition as a complex and interrelated topic, in which physiological, biochemical, ecological aspects and energy conversions are involved?"

METHODOLOGY

The planning of this work adopted the basic principles that characterize the qualitative approaches of research (Bogdan and Biklen 1992; Lüdke and Andre 1986), since it included questions formulated with "what", with respect to the content of the students ideas as well as questions formulated with "how and why" these students revealed such ideas. We were concerned with the "meanings" students have of isolated aspects as well as of the set of the processes related to plant nutrition.

The research with students

The research with students was conducted in three elementary schools at Ribeirão Preto, São Paulo, Brazil, two of them being from the public sector and one from the private sector. Although the schools represented differentiated social contexts, the research did not intend to establish comparisons among different realities. Seventeen students from 5th to 8th grades, chosen at random, were interviewed in an average of 200 questions for student.

The data collection was made by in-depth-interviews (Russel, Longden and McGuigan 1993), which is a technique for the elicitation of ideas. This technique seeks to explain and to understand the students' ideas. At the same time, it instigates those interviewed to reflect and they reorganize their own conceptions during the interview. By paying attention to their own thoughts, this technique allows the students to rearticulate and reformulate their conceptions, emphasizing the important role of verbalization to the development of articulated ideas on the natural phenomena. The interviews lasted between 30 and 40 minutes. The interviewer ended the session when he understood thoroughly the student point of view. In order to maintain the coloquial speech of the students, all the interviews were recorded and transcribed with a minimum of edition.

Although pre-formulated questions did not exist, the interviews were semi-structured through the approaching strategy and a set of students' initial ideas. These ideas resulted from a pilot study conducted by Kawasaki (1995) and from previous works that had investigated similar processes.

The data analysis was developed throughout the process, through gradual theorizations in an interactive process in which the interpretation and the focus of the observation were regulating mutually. Data analysis was handled using the content analysis method. According to Bardin (1991), content analysis is a technique of qualitative research applied to the analysis of written texts or verbal, visual and gestual communication reduced to a text or document. The initial procedure for the data decoding was to choose among the large amount of information contained in the interviews, some particular features or conceptual categories that allowed the passage from the descriptive to the interpretative structure.

The research with science teachers

The research with teachers was conducted in the same schools where the students were interviewed. We interviewed two of their science teachers. However, the aim of this research was different from the research conducted with students, since this one investigated the pedagogical approach these science teachers give to the subject of plant nutrition. Hence, the data analysis focused basically on "how the teachers teach the subject" and "what pedagogical material they use to teach." Although the two teachers had two sufficiently different profiles with respect to scholarity, age and teaching time, these were not considered in the data analysis.

A methodological procedure similar to the one used with students' research was adopted to do the data survey and data analysis in this research. The interviews lasted between 35 and 40 minutes with approximately 70 questions per teacher.

Analysis of science textbooks

We also analysed science textbooks used by the interviewed students, verifying how these books treat plant nutrition, what kind of reading these books allow, and how these readings affect the students understanding.

Nine collections of science textbooks, from 1st to 8th grades were analyzed, in a total amount of 26 books. Despite the fact that the interviewed students belonged to 5th through 8th grades, we included the analysis of 1st through 4th grade books. The main reason is the fact that these books probably had some influences on the students' conceptions.

Content analysis allowed verifying the ideas and concepts contained in the texts, as well as pedagogical and methodological aspects, graphical representations and the use of the language that can influence in the final conceptions propagated by these books.

RESULTS

A. The topic "Plant Nutrition" in the Science Curriculum Context (Brazil)

Science teaching of 1st through 8th grades in the Brazilian curriculum consists of areas of natural sciences, such as Biology, Chemistry, Physics and Earth Sciences. A qualified professional in science teaching is one who majored in Short Licentiateship in Sciences or Full Licentiateship in one of the areas of natural sciences mentioned above. In the secondary phase, each one of these areas (but Earth Sciences, which is taught only on elementary school) represents one curricular discipline being taught by teachers of the specific areas, majored in courses of Full Licentiateship.

Two Science Curricula were elaborated by the State Secretariat of Education: "Guias Curriculares propostos para as Matérias do Núcleo Comum do Ensino do 1° grau - Ciências" (São Paulo/SE/CERHUPE, 1973) or the State Curricular Guides (1973) and the "Proposta Curricular para o Ensino de Ciências e Programas de Saúde - 1° grau" (São Paulo/SE/CENP, 1986) or the State Curricular Proposal (1986). They both are important references for the planning and the programming of science courses of state public schools. In the national context, the "Parâmetros Curriculares Nacionais - Ciências, Meio Ambiente e Saúde" (Brasil/MEC/SEF, 1997) or the National Curricular Parameters - Science, Environment and Health subsidizes the elaboration or curricular revision through States and Cities for 1st through 8th grades: "Although to present full curricular structure, the National Curricular Parameters are extensive and flexible, being possible to adjust curricula of different realities" (Brasil/MEC/SEF, 1997, 37). The National Curricular Parameters destinated to 5th to 8th grades of elementary and to 1st to 3rd grades of secondary are in an elaboration process.

Somehow, it is important to point out that, in Brazil, there is not a unified national curriculum in any level. According to the Secretariat of Fundamental Education (Ministery of Education and Culture), there is a set of curricular lines of direction consisting of orientations sufficiently flexible, since: "The National Curricular Parameters and the State Curricular Proposals must be seen as a starting point to subsidize the school in the construction of its educational proposal, in an interlocution process where they share and they explicit the values and aims that guide the educational work and develop a curriculum capable of taking care of the real necessities of the students" (Brasil/SEF/MEC, 1997, vol. 1, 38)

The two State Curricular Proposals of Sciences (São Paulo): the State Curricular Guides of Sciences (1973) and the State Curricular Proposal of Sciences and Health Program (1986) can be seen as two diametrically opposing proposals in their curriculum conceptions and in their science and science teaching conceptions. On the other hand, the State Curricular Proposal of Sciences and Health Program (1986) and the National Curricular Parameters of Sciences (1997) do not show divergences with respect to these conceptions, since the National Curricular Parameters (1997) represent a compilation of some curricular proposals of Brazilian States but possess differences in relation to the organization and approaching of the science contents.

Although the State Curricular Guides of Sciences (1973) have not been curricular references for science education since 1986, at least officially, their ideas remained deeply in the educational practice of science teachers and influenced science textbooks, since they had sought to propagate their ideas through content and methodology. According to Fracalanza (1987), despite the fact that science textbook tried to remain faithful to the State Curricular Guides of Sciences (1973), these textbooks diverged from their main lines and they could not translate the educational philosophy of their proposals. In any case, the content was organized around unifying subjects, the being emphasis in the experience of the scientific method for the pupil as much as the educational goal, as methodology of science education and the exclusion of the health contents, have been considered inheritances of the Curricular Guides of Sciences (1973) found in science textbooks. For many teachers, a good science education was and still is synonymous with good classes of laboratory work, where the student develops experimental activities through the scientific method and simulating to be a real scientist.

In the current situation of science education, the teacher searches to discuss, to elaborate and to implement the National Curricular Parameters (1997) and the State Curricular Proposal (1986) in the school context, but the teacher has a traditional practice. The use of science textbooks that carry the ideas of the State Curricular Guides of Sciences (1973) corroborate with the traditional practice in science teaching. It is in this context that we study the teaching of "Plant Nutrition", the central subject of this research.

In the State Curricular Guides of Sciences (1973), the content is presented in standard units and through a multidisciplinary approach (São Paulo/SE/CENP, 1986,9). That is, each unit deals with the content areas of different fields of knowledge separately, without establishing systematic connections among respective content areas: in the 5th grade it studies the geomorphologic aspects of the environment (emphasis on Earth Sciences), in the 6th grade it is studied the living beings (emphasis in Biological Sciences), in the 7th grade it studies the human body (emphasis in Biological Sciences) and in the 8th grade it is introduces the notions of Physics and Chemistry. This fragmented approach of these content areas happened since the beginning of elementary school. In this context, plant nutrition is introduced from the first grade, but only in units referring to the living beings, more specifically in Botany. Botany, in its turn, is organized around the great vegetal groups emphasizing descriptive and taxonomical aspects of these groups and the morphological features of the individuals of these groups, and the structure and functions. In this way, photosynthesis, which is a process of plant nutrition, is dealt alone, like a specific function of a determinate plant structure: the green leaf.

In the State Curricular Proposal of Sciences and Health Program (1986) and in the National Curricular Parameters of Sciences (1997), plant nutrition is also treated in the Botany context, but in this case it does interact with the environment. Thus plant nutrition is seen as an important vital function in plants, but its knowledge can not be restricted to fragmented knowledge areas. It has to be seen in their physical, chemical, biological, geological and ecological aspects.

B. Ideas about "Plant Nutrition" in a historical perspective: analogists X experimentalists

There exists two distinguished models of plant nutrition in the historical context studied: one that points out plant nutrition as an interaction EARTH-ROOTS and other that points out plant nutrition as an interaction AIR-LEAVES (Barker 1995). In the first model, the nutritional materials for the plants are found in the ground and these are absorbed by roots. In the second model, the alimentary or nutritional materials for the plants are not found ready in the external environment, but they must be produced internally from substances found in the atmosphere and absorbed by leaves.

The first explanations referring to EARTH-ROOTS model appeared in Aristotle's compared studies, where it searched anatomical analogies between plants and animals. Aristotle believed that the key for understanding plants could be found in the study of animals. Therefore, the understanding of the vital functions, such as plant nutrition, was inserted in this context, in the vision of the analogists. In Barker (1995), we can see an aristotelian idea of plant nutrition through a sufficiently suggestive phrase: "The plant is an animal standing on its head." In their compared studies, the roots of plants were analogous to the mouth of animals, both serving for the absorption of the food and the nutrition occurred by absorption, as well as occurred in the animals. The ground was analogous to the stomach of animals, where the materials were pre-digested before supplying the plant organism. Thus digestion occurred outside of the plant, not accepting any kind of internal transformation of foods. Therefore, the materials the plant was made of were found in the same way in the ground. In this model, there is a strong emphasis in the nutritional role of the roots and the ground was considered the single repository of the alimentary or nutritional materials to plants.

The search for analogies of aristotelian tradition remained in some authors, defying time and new ideas that had appeared with respect to this subject. Still in the 18th century, Tull (1751) equalled intestines with roots. Darwin, in 1800 affirmed that plants, as unmoving and fixed beings, removed from the ground its food ready and prepared. Darwin also propagated the idea that plants were, in real, an inferior order of animals, not presenting muscles, mouth, esophagus, stomach and intestines, but presenting many kinds of absorbent vases corresponding to the ones found in animals. Still in the century XIX, Davey, through his Humus Theory, affirmed that the gray amorphous material of the ground, humus, contained all the materials found in plants.

Beyond analogical thought the Aristotle comparative studies start from teleological observations of the nature. This way of thinking influenced Botany since its origin until century XIX. The teleological thought, in the physiological studies of Aristotle, established that it is necessary to understand the function of each part for the entire organism and to understand "how" each one of their aspects, phenomena or parts contribute for this function (Martins 1990). Thus all parts and the whole body of living organisms possess an innate heat when they live, and when they die they lose this heat. He observed that plants and animals grow by increment of material, but that it had some transformation involved. For how could the fact be explained that plants transform land, water and air in wood and leaves? In a time where Chemistry had still not developed, Aristotle attributed to the heat, the transformation of these materials absorbed by the plants into other materials. Thus, through teleological thought, Aristotle advanced in his compared studies convinced that it could have some kind of internal transformation of materials absorbed by the plant, without contradicting his idea that plant food must be pre-digested in the ground before being absorbed by the plant.

In opposition to analogists, it appeared that the first experimentalists, such as Van Helmont (1577-1644) and Boyle (1627-1691) affirmed that plants were capable of transmutation. That is, they became water in plant material. However, the idea of transformation still was in the Phlogistic Theory context, remaining obscure the way in which plants carried through this transmutation. In Sachs' conception (1892), an important physiologist of the time, despite the importance of the teleological thought in physiological studies, this represented a real stagnation in botanical scientific thought, through century XVIII to century XIX, because it hindered the observation of right facts that only the experimentation could lead.

It was from Hales (1677-1761), that the first theories had appeared on the interaction between plants and atmosphere, evidencing the AIR-LEAVES model in explanations on plant nutrition. Hales evidenced effectively that air contributes to the development of the plant and that it acts in the formation of solid plant substances. However, Hales could never give an immediate proof of the capacity of the leaves to take the nutritional substances from the atmosphere. Therefore, his idea of transformation was still in the Phlogistic Theory context.

Studies related to plant physiology made a new generation of botanists and physiologists that broke, definitively, with the teleological tradition of physiological studies. The precursors of the modern vision of plant nutrition, although they believed that there was a movement of chemical elements between the environment and the plants tissues, they were unaware of the nature of this interaction. It was necessary for the appearance of a new system of chemical elements, considered by Lavoisier (1789), to replace the old flogistic chemistry and to allow the discovery of the new laws of plant nutrition. The Priestley discovery (1774) that green plants release oxygen gas, even so in harmony with the Phlogistic Theory, allowed Lavoisier to establish the basic principles of his new system of chemical elements.

Ingenhousz and Senebier, during the interval from 1774 to 1804, had quantitatively determined that the green plant parts, the leaves, absorb and decompose one of the elements contained in air, and that they assimilate at the same time elements taken of the water amplifying their weight proportionally to the amount of absorbed substance.

C. Ideas about "Plant Nutrition" among students

In a general way, a lack of understanding of the fundamental aspects in plant nutrition is found among students, there are existing many alternative ideas in relation to the scientific thought. It means that the students do not understand that plants carry through autotrophic nutrition and they do not understand plant nutrition as a complex and integrated topic, where physiological, biochemical, ecological aspects and energy conversions are involved.

Contrary to the scientific idea that plants carry through autotrophic nutrition, the idea more disseminated among students is that plants get their food directly from the environment (86.5%), while the minority (13.5%) have the idea that plants manufacture their food internally. In addition, there is the idea that these substances are absorbed by roots, through simple absorption, carried passively by stem and thus being distributed throughout the plant. The growth of the plant, in this context, occurs by addition of substances. In reality, the students go to the school presenting some quotidian preconceptions of nutrition and feeding, these being sufficiently rooted and resistant and are different from the scientific ideas. In this context, the food is a substance found in the externally and can be immediately absorbed, used and integrated by the organism, suffering only mechanical transformations. With rare exceptions, the student conceives some kind of chemical transformation, only with respect to the action of enzymes about foods during the digestive process (in humans). Still with less probability, the student conceives some kind of internal production of organic substance similar to what occurs during photosynthesis. In general, the animal nutrition model, specifically the human model (antropomorphic approach) is the one adopted among the interviewed students in their explanations about nutrition.

On the other hand, the students possess a formal concept of photosynthesis learned in the school, that is defined generically as the internal process of food production by plants. However, when this student is requested to explain the functioning process of photosynthesis, he refers only to gaseous exchange (of oxygen gas and carbonic gas) that the plant carries through with the environment during photosynthesis and respiration. This fact demonstrates that the students do not understand the functioning of photosynthesis. Between a daily idea of plant nutrition, in which the nutritional substances are ready made in the environment and are incorporated passively in the organism and a formal idea of plant nutrition, in which the chemical elements are involved, undoubtedly, the first model (which is an easier idea to understand) predominates over the second model.

In conclusion, it is possible to affirm that the students do not possess a clear model of plant development. That is, not only they do not understand the functioning of plant nutrition, nor they understand other vital functions in plants.

D. The Science Teaching Approaching in relation to "Plant Nutrition"

D.1. By sciences teachers:

In general, the science teachers do not approach plant nutrition, as a complex and integrated topic but approach it through the idea that plant nutrition is a function of green leaves. Although, they had mentioned substance absorption from the external environment through the roots as well as through the leaves, the leaves possess one only purpose: the accomplishment of photosynthesis.

Two other ideas found in the science teachers concerning plant nutrition that is propagated in science education deserve to be observed. One of them refers to the idea that plant physiology occurs in a similar way as animal physiology, because the necessity of feeding is the same to both: animals and plants. The other idea refers to a physiological process that occurs in a determined structure of the plant. And so, photosynthesis and respiration are specific functions of leaves.

The first idea affirmed absolutely by one of the teachers, starts from the universal principle that all living beings breathe, feed, reproduce, etc. and that plants, as living organisms, not only carry out these same biological attributes, but also carry through these attributes in a similar way that animals do. The second idea, not explicated by teachers, presents the functioning of a vital process in a fragmented and linear way, where each structure has one unique objective, and they are independent of other structures. Such conceptual equivocal do not always arise from totally erroneous ideas, but many times from the ways knowledge are dealt with and organized in the science teaching process, in which the students' misconceptions are reinforced and perpetuated.

D.2. By science textbooks:
Some of the most serious misconceptions found in science textbooks, pointed out by the Ministry of Education and Culture (Brazil) evaluation, such as the idea that photosynthesis and respiration are opposing processes, through the affirmation that plants photosynthesize during the day and they breathe during the night, or the idea that plants die suffocated in closed environments, do not appear in an explicit way but they appear in an induced way among textbooks analyzed by this research. The fragmented way that sciences topics are approached, isolating the geological aspects (5th grade), biological aspects (6th grade), biological aspects/human body (7th grade) and physics and chemistry aspects (8th grade) results in an Environmental conception as a sum of the 5th, 6th and 8th grades contents, without the presence of the human being that is treated in the 7th grade. The same process is repeated along the former series (from 1st through 4th grade). This kind of approach does not allow the treatment of plant nutrition functioning in an integrated way and in its complexity.

The propagation of the idea that "plants feed," with emphasis in the nutritional role of the roots in textbooks of 1st through 3rd grades and the propagation of the idea that "plants produce their own food through photosynthesis", dislocating the emphasis in the photosynthetical role of the leaves in textbooks of 4th through 8th grades without any integration between these ideas, lead to the idea that the processes are totally distinct and the misunderstanding of all involved processes in plant nutrition. Moreover, there is the fact that students enter the school with daily preconceptions of food, feeding and nutrition that can influenciate the scientific conceptualization of the same ones. When it is affirmed that plants feed, probably, the picture that appears to the student is one of an animal feeding, and this picture is reinforced by the inadequate use of scientific terminology by textbooks.

The fragmented approach of the science content leads to a structuralist vision of nature and of living organisms, as if they were constituted by parts that possess unique functions (finalist character), independent from others, and that the sum of these parts assured the understanding of the whole. Into this structuralist vision, the mechanist metaphors are frequently used to help the understanding of the cells, organisms and systems functioning of the living world, leading to a belief that the human body is a perfect machine. The anthropomorphism of nature is another way used in the textbooks, mainly, in relation to the anatomical and physiological aspects, in which plants and animals are compared. The anthropocentric vision of the environment, that emphasizes the idea that environment exists at the service of the man and, at the same time, the idea that man must be treated outside the environment, are two visions that contribute for a distorted ecological vision and for an inadequate approach of environment questions in science education.

FINAL CONSIDERATIONS

The current research provided evidence of the existence of conceptions about plant nutrition in students, in textbooks and in science teachers that differ from the ones accepted by the scientific model of plant nutrition. It demonstrates that many of misconceptions related to this process and other processes related to plant nutrition result from some aspects of the science teaching process that propagate, stimulate and perpetuate these misconceptions. Moreover, several of these misconceptions are diffused in society, being found in diverse sectors of the media, meaning that these ideas may have arisen from cultural circumstances.

The results indicate the necessity of a deep reflection in relation to the traditional science methodology to approach this vital phenomenon - the plant nutrition, which is an important curricular component of sciences. Since consecrated didactic approaches have kept some beliefs that are not recognized as true. The absence of a global vision of the involved processes in plant nutrition hinders the understanding of its functioning, leading the students to the models based on analogies with phenomena close to their experiences, which are rarely appropriate. The generalization that plants, as living organisms, feed in a similar way that animals do, and the particularization of photosynthesis as a specific process of the plants and respiration as a specific process of the animals, due to the false opposition between photosynthesis and respiration, are some of the misconceptions that deserve special attention and must be replaced in plant nutrition teaching.

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