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Abstract: The present work stems from an interest in the systematization of concepts in the teaching of Chemistry at Secondary School level, given the presupposition that systematization helps the student to generalize these concepts, a fact which favors the development of theoretical thinking for which the chemical theme "Solutions" was chosen because it finds itself in a privileged position to treat of conceptual questions seen that the study of the dissolving phenomenon, as well as the characteristics of solutions formed by the process require a series of pre-requisite concepts. Solutions, so much a part of everyday life, are an example of how an empirical observation, even if generally yielding a broad range of knowledge, is seen to be insufficient in explaining the origin, development and internal bonds of that which is observed by the senses. Being that as it is, the study of the object of knowledge, in this case, solutions, must be carried out by means of analysis, an abstraction, in complex movement of the human thought process where it operates on a purely conceptual level.

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SYSTEMATIZATION AS A BASIC PROCEDURE FOR LEARNING THE CHEMICAL CONCEPT OF SOLUTION.

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INTRODUCTION

The present he systematization of concepts in the teaching of Chemistry at Secondary School level, given the presupposition that systematization helps the student to generalize these concepts, a fact which favors the development of theoretical thinking for which the chemical theme "Solutions" was chosen because it finds itself in a privileged position to treat of conceptual questions seen that the study of the dissolving phenomenon, as well as the characteristics of solutions formed by the process require a series of pre-requisite concepts. Solutions, so much a part of everyday life, are an example of how an empirical observation, even if generally yielding a broad range of knowledge, is seen to be insufficient in explaining the origin, development and internal bonds of that which is observed by the senses. Being that as it is, the study of the object of knowledge, in this case, solutions, must be carried out by means of analysis, an abstraction, in complex movement of the human thought process where it operates on a purely conceptual level.

If in the Chemistry Laboratory is insufficient for explaining the nature of the facts, what is the role of teaching in students' learning?

Chemistry is without doubt an experimental science which at the same time uses models a lot to explain facts. This shows the dynamic relationship of the empirical-theoretical dimensions in the process of learning. And this relation must certainly be considered by teachers at the moment of planning and organization of classes.

Taking the learning process to the classroom - and it is recognized that this does not happen exclusively at school-questions arise in respect of the concepts and the necessity of elucidating what are the fundamental characteristics of those concepts taught in classrooms, the so-called scientific concepts.

As regards scientific concepts, it can be said that the difference between them and the so-called spontaneous or intuitive (misconceptions) concepts is that the former are generally verbally introduced by the teacher and that they are part of a system of concepts. Spontaneous concepts, namely those concepts related to people's day to day, learned during the process of great social communication of the learner with adults, are anchored in everyday images, but in episodic form, outside of the organized idea system (Shif, 1935).

It has been said that the study of solutions constitutes a privileged place for the discussion of these questions. Illustrating briefly it can be said that for a student to understand the phenomenon of dissolving he will have to be referred to pre-requisites such as: chemical bonds, atomic structures, states of aggregation of substances, among others. And being thus, the teacher's function takes on primordial importance. He will have to work with models that, being a moment of theoretical thinking, don't have references in empirical observation. He will have to guide the students in the process of abstraction and generalization by means of adequate conceptual systematization. If he does not he runs the risk of his teaching becoming mere verbalism without any meaning for his students.

ANALYSIS OF THE DATA

In this study, in order to identify students' preconceived notions of solutions, as well as checking out how the theme was learned, written tests were given to First Year Secondary School students (17 students) who hadn't yet undergone the process of learning about solutions, as well as to Second Year Secondary School students (34 students) who has already completed this same study. This test aimed at identifying the students' ideas on solutions, both before and after the process of teaching of the theme.

The interest in identifying the students' prior-conceptions of solutions arose, as much from the consideration that they are important or any posteriore learning process as from the reading of other researchers such as Driver (1985), Longden et al. (1991) among others, who devoted themselves to the theme and concludes that prior conceptions of the conservation of substances, their physical states, the corpuscular structure of matter, all influence the understanding of the dissolving phenomenon. The studies of Longden et al. (1991) conclude that students have more facility in explaining the dissolving phenomenon at the microscopic level than through everyday ideas, a fact which is, without doubt, interesting for discussion and verification. Some researchers' on how and why students characterize the nature of phenomena as physical or chemical (Stavridou H. and Solominodou C. 1989), also incite interest in identifying students' prior conceptions.

The primary objective of the test was to identify, on the one hand, ideas on solutions of Secondary School Students who had studied general notions of solutions at the same time, it was considered that these same students, having completed the First Year Chemistry Programme would have acquired a set of concepts which would help them to solve the test. Because of this, in the drawing up of the questions chemical terms such as: homogeneous system, chemical phenomenon, ionic compound, covalent compound, covalent bonds and others, were not avoided. Even without avoiding the use of these terms, in two out of the six questions, the student is asked to explain, in his own words, how he understands solution and also to explain the phenomenon of the formation of juice from the mixing of a powder in water. In this, manner, it is hoped to obtain from the students the maximum of information coming from spontaneous ideas as well as from the knowledge acquired while learning.

With regard to Second Year Secondary School students, it was presupposed, that having completed both First and Second Year programs, they would be better able to solve the problems and their answers would have the possibility of verifying how the teaching of solutions had contributed to the development of new concepts.

It is appropriate to stress that, given the scope of the theme, solutions, which permeates a large part of the chemical content, the present study limited the field of research to the phenomenon of dissolving and to concepts related to it/or derived from it by considering the theme for its chemical importance, as it is related to the properties of solutions, as well as from the learning viewpoint, because it is fundamental in establishing conceptual relations.

The answers given to the test questions, for First Year as well as for Second Year, were organized into three groups according to the identification of general patterns of ideas: 1) what students understand by solutions, 2) how students understand the dissolving process and 3) what are the differences and similarities that students see between solution and misture and between solution and substance. This latter question aimed at finding out if managed to identify if a misture is like a solution in its variable composition but is different from its heterogeneous visual aspect, as in fact a substance is, as well as solution, macroscopically homogenous, at the same time as it is different in its composition, strictly defined for a substance and variable for a solution. This last question also seeks to verify if students see a fundamental characteristic of substances in the constancy of physical proprieties.

Tables 1 and 2 were constructed from the analysis of the answers given respectively by the First Year and Second Year groups. As the same student can give more than one idea in any one answer the final percentage can surpass the value of 100%

From the tables it can be observed that there are -as it was hoped- differences between the answers of First Year and Second Year students: there is a greater incidence of blanks among First Year students; among the Second Year students answers were ideas that the dissolving phenomenon can be physical, chemical or physic-chemical, while the great majority of First Year students responded that it was physical.

All of the students, both of First Year as well as in Second Year admitted interaction between solute and solvent. It's important to stress that expressions such as : "The salt is dissolved in the water" or "In the water the salt decomposes in ions" were interpreted as an admission on the part of students of a solute-solvent interaction. Nevertheless, it merits noting that 47% of Second Year students' answers present an attempt at explaining the phenomenon at the microscopic level. It was in the way that answers such as: "The water penetrates the empty spaces between the salt ions", or "The water involves the salt ions, separating them" were interpreted.

TABLE 1

PERCENTAGE OF FIRST YEAR STUDENTS BY GENERAL IDEAS ON SOLUTIONS, DISSOLVING AND DIFFERENCES AND SIMILARITIES BETWEEN SOLUTION AND SUBSTANCE

GENERAL IDEAS	PERCENTAGE OF STUDENTS (N = 17)
1) Solution	
* Solution is a mixture	59
* Blank	30
* Others	12
2) Dissolving	
*There is solute-solvent interaction	100
* It is a physical phenomenon	76
* There is no chemical reaction	41
* There are changes in the physical aspects of the components	24
* Others	10
3) Differences a similarities between solutions and substance	
* Blank	59
* Substances form solutions or, solutions have a solute and a solvent	24
* Others	12

However, the answers given to the question about the differences and similarities between solution and mixture and solution and substance, show by the high incidence of blanks (59% for First Year and 32% for Second Year), students' difficulties, in general, in developing discriminatory reasoning and generalization from the attributes and even from very definition of the concepts. Thus, among the students from First Year as well as from Second who answered this question expressions such as: "A substance participates in a solution", "A solution is a mixture of substances", "A solution contains solute and solvent, a substance is only a solvent", are frequently found. No student referred to the constancy of the physical properties as the fundamental attribute which characterizes substances.

From a careful reading of the answers it is also possible to conclude that, even if the Second Year Students had greater facility in using chemical terms, leading to more sophisticated discourse, this does not necessarily mean a real understanding of the phenomena. Within a social-historical perspective of the formation of concepts this fact could be analyzed as a process of *internalization* or internal reconstruction of concepts (Vigotsky, 1988).

TABLE 2

PERCENTAGE OF SECOND YEAR STUDENTS BY GENERAL IDEAS ON SOLUTION, DISSOLVING AND THE DIFFERENCES AND SIMILARITIES BETWEEN SOLUTION AND SUBSTANCE

GENERAL IDEAS	PERCENTAGE OF STUDENTS (N = 34)
1) Solutions	
* It is a mixture of two or more substances	76
* Others	15
*Blank	09
2) Dissolving	
* There is a solute-solvent interaction	100
* Solute-solvent interaction at the microscopic level	47
* There are changes in the physical aspects of the components	24
* There is no chemical reaction	20
* It is a physical phenomenon	59
* It is a chemical phenomenon	12
* It is a physic-chemical phenomenon	06
* Others	09
3) Differences and similarities between solution and substance	
* Solutions have a solute and a solvent, substances have only a solute or only a solvent	65
* Blank	32
* Others	04

Considering these theoretical principles and analyzing the students' answers it can be said that embarking on the initial learning of concepts, in this case dissolving, solute-solvent interaction and others, the story of these concepts is beginning for the students. In this process the differentials and generalizations will be established, permitting the subject to reframe the relations between concepts within a system. The recomposition of these conceptual relations will depend on the quality of the experiences that the teaching offers.

On the other hand, even though, as was mentioned, 47% of Second Year students give a microscopic explanation of the saltwater interaction, it is incomplete, as they say that the salt decomposes in ions but few students understand the role of the water of what happens to the water in the decomposition of the ions. A more adequate understanding of the dissolving phenomenon as a process of solute-solvent interaction certainly demands a movement of thought from the concrete to the abstract and vice versa mediated by mental reasoning. Teaching is presented as a fundamental component of this process since children and adolescents will hardly master this procedure alone.

Still on the nature of the dissolving phenomenon it is interesting to note that the idea generalized by students on the classification criterion of a phenomenon as physical or chemical is the reversibility or not of the process. In this way, it is interpreted that if the water from a solution evaporates it is possible once more to obtain salt, the phenomenon of the formation of a solution is physical without considering the chemical interactions between the components of a solution. It is possible to affirm that this is due to the direct influences of teaching already at Primary Level, when treating of the physical states of substances, "crystallize" in students' minds this type of classification of phenomena which becomes a hindrance at the moment in which the phenomena demand more complex reasoning. In these cases teaching also shows itself to be contradictory since, when studying Chemical Reactions, these are classified as reversible or irreversible. How then can one understand that a reversible Chemical Reaction can be a physical phenomenon?

From the analysis of the answers of these two groups of students it is concluded that teaching evidentically had an influence on those students who underwent the study of solution since, for the Second Year Students, for example, the incidence of blank answers is lower, the diversity of ideas in attempting to explain dissolving is greater, the use of chemical terms is more frequent. Nevertheless, the preponderance of approaching macroscopic aspects to the detriment of microscopic aspects can be noted.

This situation illustrates the answers given to the questions as to whetter these were changes in the initial components of solution. A reasonable percentage, 23% of the students, from First Year as well as from Second Year, talk about changes in the physical aspects of the components of solutions: "The water became salty", or "The powder turned into a liquid", etc. This certainly demonstrates a teaching approach limited to the empirical observation of the phenomena and an insufficient treatment of their theoretical aspects. The formation of a solution is a phenomenon whose explanation demands the use of pre-requisites such as, substance, mixture, chemical bonds, structure of matter, aggregation states of substances, etc. Which are part of these knowledges gaived through teaching, by means of the teacher, and which demand a more complex movement of ideas not always having a reference in the empirical practice of everyday.

The approach of Second Year students indicated that they tended to have difficulties in generalizing from the incorporated knowledges into solution to the new examples. This was due to an insufficient understanding of the dissolving process. In this way, it seems that teaching does not manage to treat this theme adequately, because it does not use it as an element of conceptual systematization.

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