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Teoría y práctica en el proceso de enseñanza-aprendizaje de la Química en la Educación Preuniversitaria
Theory and practice in the teaching-learning process of chemistry in pre-university education

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Resumen

En la práctica profesional pedagógica se manifiestan insuficiencias didácticas, presentes en el docente, matizados por: posiciones intuitivas, empirismo espontáneo, empleo de procedimientos mecanicista; que por supuesto, generan dificultades en el aprendizaje. Con el objetivo de superar estas y otras deficiencias, los autores, partiendo de un diagnóstico de la práctica pedagógica, seguido de una sistematización y análisis crítico de las concepciones más relevantes relacionadas con la problemática, propone un sistema de acciones didáctico-metodológicas, que permite además, un acercamiento entre teoría y práctica.

Palabras clave: Enseñanza problémica; Aprendizaje desarrollador; Aprendizaje significativo; Situación problémica

Abstract

In the professional pedagogical practice, didactic insufficiencies are manifested, present in the teacher, tinged by: intuitive positions, spontaneous empiricism, use of mechanistic procedures; which of course, generate difficulties in learning. With the objective of overcoming these and other deficiencies, the authors, starting from a diagnosis of the pedagogical practice, followed by a systematization and critical analysis of the most relevant conceptions related to the problem, propose a system of didactic-methodological actions, which also allows a rapprochement between theory and practice.

Keywords: Problematic teaching; Developmental learning; Meaningful learning; Problematic situation

Introduction

The progressive and continuous development of humanity, characterized by the rapidity with which changes occur in all spheres of society, has generated significant and ever-increasing needs for: consumption, resources, production of goods; a situation that has led to an accelerated development of science and technology, with their respective direct and unequal impact on each individual, city, country, and the environment of the planet.

The Cuban Revolution entrusts Education with the integral formation of the new generations and the elevation of the cultural level of the population in general. That through education, honest, patriotic, responsible, creative and investigative men and women are formed who are capable of facing the challenges that each context imposes and transforming reality for the benefit of society and nature. To promote the scientific-technological development of production and services, and with it the progressive improvement of the quality of life of the people.

Such an endeavor requires qualitatively superior preparation of the teacher, which should be achieved, in addition to the initial training process, in the teaching and methodological scientific work, in postgraduate studies. As a consequence, the progressive rapprochement between scientific theory and professional pedagogical practice.

Educational sciences continuously produce scientific knowledge, with ingenious and renovating proposals that should, proportionally, produce progressive changes; however, in the pedagogical professional practice, didactic-methodological insufficiencies are manifested in the teacher, both in the teacher in front of students and in those responsible for planning, directing, controlling and evaluating the teaching-learning process.

These and other inadequacies are qualified by intuitive positions, spontaneous empiricism, use of mechanistic procedures; which of course, generate difficulties in learning. With the objective of overcoming these and other deficiencies, starting from a diagnosis of the pedagogical practice, followed by a systematization and critical analysis of the most relevant conceptions related to the problem, it proposes a system of didactic-methodological actions, which also allows an approach between theory and practice.

In the authors' opinion, the conceptual change in the teaching of Chemistry requires a new conception of the teacher's role in the teaching-learning process, in this sense; they assume as theoretical foundations, the problémica teaching as a way to achieve a meaningful and developmental learning.

Development

Teaching means consciously involving the learner in a process of construction and reconstruction of knowledge, learning to learn, developing skills and learning strategies transferable to new and varied situations, learning to do, forming feelings, values and attitudes that determine a way of acting, learning to be, developing forms of behavior in different social environments, learning to relate to others. To teach science is to form ideas of the cognoscibility of the world and the phenomena that occur in it, a scientific conception of the world, to form feelings of respect, care and conservation for fauna, flora and nature in general, environmental education, and for their fellow human beings, humanistic training.

However, the diagnosis of chemistry teaching in pre-university reveals, as in other disciplines, that it is developed following the obsolete and mechanistic model of teaching-learning by transmission-reception, also recognized as traditional paradigm, Silvestre and Zilberstein, (2000), where the teacher's discourse with finished truths predominates.

In such dynamics, it is up to the student to listen attentively to the teacher's speech, take notes of the dictation that the teacher makes at a certain moment, or take some notes from the textbook, write in detail the steps that the teacher makes when demonstrating how to solve the problems that they will face in that area of Chemistry; in order to be prepared to solve typical problems, motivated students, basically, because the teacher has made them know, from his experience that this type of problems always comes out in partial and final evaluation.

Following the traditional dynamics, after transmitting the knowledge in question and demonstrating the algorithm of solving typical problems in this area of chemistry, it is up to the teacher to develop the class of exercises. In which he/she proposes typical exercises to his/her students, but before starting the student's activity, a review of the knowledge and the algorithm necessary to solve the exercises, which are generally tasks from the textbook, is carried out. Even in the Chemistry program itself, the teacher is recommended, Ministry of Education (MINED)

(2004), "To explain, according to the examples in the text, the algorithm for solving problems" (p. 18)

As a consequence, there is an accumulation of insufficiencies in learning, which increase from one educational level to another and are manifested in the limited performance of students in the appropriation and use of knowledge, which in general does not go beyond the reproductive level. Students do not learn how to learn. When looking for the causes of the limitations and insufficiencies of student learning in the discipline of chemistry, many teachers point to the lack of interest of the student in studying, the lack of resources in the institutions and the role of parents and their attitude of believing that their responsibility ends where the teacher's begins.

However, these issues are not causes of limitations and inadequacies; they are actually consequences and inadequacies present in teaching. And this question is interesting, because it is quite common to see and hear teachers at the end of a class, disgruntled and not at all satisfied with how incapable and disinterested their students are, because it is so clear and the repeated times he explained to them why the phenomenon occurs or how to solve the problem..., and they do not learn anything.

When the teacher understands that the art of teaching is such a complex craft, and that there will only be solid, meaningful and interesting learning for the learner, when he achieves solid, meaningful and interesting teaching. By then, his learners will cease to be incapable and disinterested, and failures and mistakes in learning will be seen by the teacher as failures and mistakes in his teaching.

Any attempt to transform the teaching-learning process must start from a correct understanding on the part of the teacher and the managers in charge of planning, guiding, controlling and evaluating this process, of the purpose of Education, of the objectives of the discipline in Pre-university Education, in them the aspirations in the formation of men and women capable of facing and solving the social demands for their continuous development are made concrete, in addition, this correct understanding allows to systematically evaluate the quality of the process, if the goal is not clear it is not possible to know how much progress has been made and how far we still have to go.

Consequently, the purpose of Pre-university Education in Cuba is to consolidate the development and integral formation of the adolescent's personality from their ways of feeling, thinking and acting, expressed in a deep scientific and research preparation for life, a higher level of creativity,

attitudes, convictions and civic behaviors that allow them to conceive their life project in favor of a conscious, protagonist and unconditional participation in the construction and defense of the Cuban Socialist System, and in function of efficiently accessing university studies.

And the mission of scientifically directing the development of the educational process and consolidating the general and integral formation of high school graduates, so that they can continue higher studies, in careers prioritized territorially.

Meanwhile, the teaching of chemistry in Cuba responds to the general objectives of the communist education of the new generations, through it, students are provided with the knowledge and skills necessary to contribute to the formation of the scientific conception of the world, it offers them possibilities for the development of the cognitive structure, the appropriation of knowledge, the formation of feelings and the development of skills.

All this, "means that the traditional ways of conceiving the teaching-learning process are increasingly surpassed, due to the weight of the demands of this historical reality" (Reinoso, Ballester, González, Torres and Ribot, 2013, p. 47)

This requires a new way of organizing teaching, which brings about the necessary change in learning, in short, a new conception of the teaching-learning process, in which the teaching and learning of problem solving plays a fundamental role. (p. 48)

In such an endeavor, there is much to unravel in the theoretical order about the teaching-learning process of Chemistry, of the existing relationship between the processes of Teaching and Learning so complex, which in turn complement each other and are structured in a dialectical unit, constituting a process, governed by philosophical, pedagogical, psychological laws, among others), which interact and mutually condition each other; laws that should be in the teacher's domain.

Likewise, it is necessary for managers and teachers to understand that each adolescent and young person who enters the educational institution does so from the perspective that it is a facet of life that he/she must go through, that he/she must receive the different programs and pass the corresponding evaluations in order to pass through the grades of each educational level. That is, taking into account that learning involves not only cognitive processes but also motivational, affective and relational ones.

Another of the actions for a change in the teaching-learning process of Chemistry, in addition to the correct understanding of the purpose of Pre-university Education and the objectives of the Chemistry discipline, is to assume advanced scientific theories, introduce results of scientific research and the sciences of Education.

In this line of thought, the author assumes the definition of Teaching proposed by Castellans, D., Castellans, M., Llivina and Silvery (2001):

The systemic process of transmission of culture in the school institution as a function of the social task, which is organized from the current and potential levels of development of the students, and leads the continuous transition to higher levels of development, in order to form an integral and self-determined personality, capable of transforming itself and its reality in a specific historical context. (p. 57)

In the same way, the definition of Learning, Castellans, D., et al (2001), is assumed as:

> The dialectical process of appropriation of contents and ways of knowing, doing, living and being constructed in the socio-historical experience, in which are produced, as a result of the individual's activity and interaction with other people, relatively lasting and generalizable changes, which allow him to adapt to reality, transform it and grow as a personality. (p. 28).

The definition is framed in the Cultural Historical Paradigm, since it is based on Vigotski concepts on the development of personality, it reflects the relationship of the learner with the objects and the mediation with other subjects with whom he exchanges ideas, successes and failures, and it is in this exchange where the modification and conformation of the new ideas learned takes place.

If we intend to transform the learning process, we must first transform the vision of what it is, this as a theoretical platform that supports a scientific understanding in the teacher about learning in contemporary conditions, and as an indispensable heuristic tool in the fulfillment of their professional functions, for the teacher to teach well, he must know well how the learner learns, recognize that there is a direct and dialectical relationship between these two processes, knowing that not all learning processes generate development, but only those that are located near the zone of proximal development; This is the virtuality of one of the two great principles that inspire all of Vigotski psychology (1982)

In the same way, learning has been typified according to conceptions, in addition to developmental learning, in meaningful learning, proposed and defended by Ausubel (1983):

> That occurs when the learner, in order to solve a new learning task, does so starting from his knowledge and experiences, from his attitudes, motivations, and previously formed interests, giving meaning to the new knowledge; this dynamic produces a distinctive approach and meaning to learning with superior efficiency and quality. (p. 59)

When the teacher proposes tasks that require the learner, for their solution, to resort to already acquired experiences, he/she propitiates the construction of new meanings that modify their cognitive structure, also attributing meaning to their learning, inserting in their scheme of intentions, purposes and expectations. New knowledge is not isolated, it is just one more concept, process or phenomenon, which exists or is produced concatenated to other concepts, processes or phenomena, and these must be precisely the starting point for the transfer of previous knowledge and the appropriation of new knowledge.

In meaningful learning, the search for what is new is essentially related to what is known; this is a process of transfer of knowledge and experiences, producing an interaction between the information already acquired and the pre-existing ideas of the cognitive structure. In the transfer, the learner's cognitive structure is shaped so that the experiences are used in subsequent learning.

In essence, the learner's cognitive structure contains relevant anchoring ideas, such as an image, an already meaningful symbol, a concept, or a proposition to which the new material can be related. The interaction between potentially new meanings and relevant ideas in the learner's cognitive structure gives rise to actual or psychological meanings. Symbolically expressed ideas are related in a non-arbitrary and substantial way to what the learner already knows.

How do you have evidence that learning has been meaningful? According to Ausubel (1983), independent problem solving is often the only feasible way to test whether students really understood meaningfully.

Accordingly, it is necessary for the teacher to recognize that the main purpose of learning chemistry is, in addition to expanding their knowledge related to this science, the development of their cognitive structure, the formation of feelings and modes of action; to understand that the integral development of the learner in the teaching-learning process is not a side effect, but a top

priority objective, because the continuity, the scientific-technical future and the very existence of the Revolution depend on it.

And finally, the author assumes the teaching-learning process from the developmental conception, Castellans, et al. (2001), as:

> That which constitutes the mediating way (the help of the other, of classmates, of the teacher, of the family, as well as of other members of the community) for the appropriation of knowledge, skills, habits and norms of relationship, of behavior and values, bequeathed by humanity, which are expressed in the content of teaching, in close connection with the rest of the teaching and extra-teaching activities carried out by the students and which propitiates the development of thought, the "spiral leap" from an achieved development to a potential one. (p. 57)

Development, as defined by Silvestre and Zilberstein (2000):

> Any essential and necessary change in time, as a type of movement with an upward trend, which implies the appearance of the new with a superior quality. The source of development lies in the permanent struggle of dialectical opposites that interact and at the same time maintain relative unity, in such a way that both (unity and struggle) must occur for development to take place. (p. 63)

In the teaching-learning process, Silvestre and Zilberstein (2000), state that:

The learner must perform all types of activity: practical, gnoseological, evaluative and communicative, since this process, like all human activity, has as components needs, motives, a purpose, conditions to obtain that purpose and components. (p. 71)

In the light of the previous discussion, if in the learning of chemistry the learner has not reached a certain level of competence, but can access it through the mediation of the teacher, other learners and the family, then such aids have been effective because the learner has achieved learning that surpasses the goals already achieved, in the zone of proximal development.

Assuming the psychological category zone of proximal development provided by Vigotski (1982) as:

The distance between the actual level of development determined by the ability to solve a problem and the level of potential development, determined through the resolution of a problem under the guidance of an adult or in collaboration with another more capable peer. (p.7)

It constitutes a trend in many researchers, proposing strategies and methodologies for the development of a problémica teaching, being its maximum representative Majmutov (1983). The essence of problem-solving teaching is based on the principles: unity of the logic of science with the logic of the educational teaching process and the relationship of the content of science with the teaching method.

Problem solving has a great educational significance because of its influence on students in terms of their formation in the scientific conception of the world, in their familiarization with the dissimilar ideas and points of view on the facts and phenomena manifested in nature, scientific discoveries and their application in technology.

In correspondence with the previous idea and in the authors' opinion, the most correct answer to the question: what is the best method for teaching science? Should be: the method of science itself. Precisely, this type of science teaching is based on the proposal of problémica learning tasks, containing problémica questions, problémica situations and problems, these tasks as ways of learning allow the teacher to talk less and the learner to work more. It is a learning process characterized by the student's cognitive independence and multilateral communication.

The problematic question does not deal with simple reproduction of knowledge or procedures; it demands reflection and creativity from the learner. For its part, the problem situation in chemistry represents the state of an object or chemical process with respect to the environment at a given time, characterized by certain variables; examples of chemical objects are: the substance, chemical reactions, among others. And finally, the task-problem or teaching problem, in the authors' opinion, is the most effective way to teach science and specifically chemistry.

For the analysis of the problem task the following definition of the problem category given by Majmutov (1983) is assumed:

> A reflection (form of manifestation) of the logical-psychological contradiction of the process of assimilation, which determines the sense of mental search, arouses interest towards the investigation (explanation) of the essence of the unknown and leads to the assimilation of a new concept or a new mode of action. (p. 132)

In the problem are manifested dialectical contradictions between the initial state of the object and the desired one, between the known and the unknown, between the level of development of the cognitive structure of the learner and the level of complexity of the problem, among others. These as sources of the learner's development. Problems fulfill instructive, educational, developmental, and control functions. The task of the school is to teach students to solve problems and not to get them to solve certain types of problems.

From the teaching of chemistry, Arietta (1989), the teacher must keep in mind that the proposal and resolution of problems is not a means but an end; to limit the proposal and resolution of problems to the application of previously acquired knowledge (exercises), means to dissociate it from the process of construction of concepts and theories. (p. 56).

Now, how to achieve that a problem-solving teaching generates a meaningful and developmental learning. The question is formulated in this way because student learning depends, among many other factors, on the professional performance of the teacher, as an influential determinant for the achievement of a qualitative leap in school management. In fact, today there is consensus on the idea that the failure or success of any educational system depends fundamentally on the quality of the teacher's performance.

Proposal

System of actions for the preparation of the teacher

- To study, to the point of understanding, the purpose of Pre-university Education, the model of the baccalaureate, the objectives of the Chemistry discipline in such Education.
- To raise the level of knowledge related to meaningful learning, developmental learning and problémica teaching.
- To study theses and scientific articles related to meaningful learning, developmental learning, problem-solving teaching, among others, applied to the discipline of Chemistry.

Action system for the planning of learning tasks

Plan task systems, as training, that meet the requirements of problem-based teaching, meaningful learning and developmental learning.

- As a tendency, the questions formulated should demand analysis and reflection from the learner. Instead of asking, for example: list the characteristics of a chemical reaction or a

process; propose: explain why a certain chemical reaction or process occurs as observed; questions that, in order to be answered, the learner should appeal precisely to the characteristics of the chemical reaction or process.

- The problem situations used for the formulation of questions and problems should be concrete, related to school life, family, community, production, services, science, environment, among others; all of them as close as possible to the experiences and environment of the learner.
- Propose tasks, questions, problems, projects that require the formulation of hypotheses, the search for information in different media, the development of experiments, logical thinking, creativity, perseverance. All this with the intention of achieving the transition to the zone of proximal development.
- To present problematic situations, as scientific enigmas, in which some errors or inconsistencies are intentionally introduced, so that they can be detected. In this way, it is intended that the learner appropriates experiences that persuade him/her of the tendency to immediate execution and develop a series of scientific attitudes, essential in the learning of chemistry.

Actions aimed at transforming the traditional dynamics of the class.

- In the assurance for the new subject, it is typical to propose questions that require only memory, because the intention is that, to remember what they are supposed to know. At this moment of the class, it is suggested to propose questions and problems that for their answer or solution must resort precisely to that previous knowledge and experience.
- In the introduction of the new subject, a problem is proposed that the student cannot solve. The idea is for the teacher to place the students in order to solve it together, at the same time that the objective of the class is oriented.
- Likewise, it is feasible to introduce the class with the proposal of a problem of which it is feasible for the learner to solve, based on his previous knowledge and experiences, one clause, but he cannot solve clauses b and c. With this task the teacher achieves the preparation and introduction of the new subject, as well as the orientation of the objective.
- For the learner to build his problem solving strategy, the teacher's mediation is necessary, an important way is the following proposal: the teacher suggests the learner to leave a

written memory of his actions in the problem solving process, which could be titled: How I solve problems, for whose organization he can structure the actions in four moments 1) Diagnosis of the situation. Here you will reflect the actions corresponding to the analysis and synthesis of the information. 2) Search for solutions. 3) Execution of the solution plan. 4) Verification of the solution.

- Una forma de motivarlos en tal sentido sería sugerirles que en un determinado momento se socialicen las estrategias de cada uno con el objetivo de construir una estrategia general proveniente de sus propias ideas, y de esta enriquecer la de cada uno. Una vez que se construye la estrategia general el trabajo debe continuar, tarea a la que el grupo pudiera denominar "perfeccionamiento de la estrategia de resolución de problemas", se continúa perfeccionando con los aportes individuales y la aprobación del grupo, esto en la medida que van enfrentándose a diferentes problemas.

Proponer problemas cualitativos que exijan, como vía de solución, el empleo de expresiones químicas cuantitativas, y proponer problemas cuantitativos que exijan, como vía de solución, el análisis y el razonamiento cualitativo y/o gráfico.

Conclusions

The actions proposed by the authors are the result of a process of systematization of the scientific theory, aimed at the transformation of the teacher, in order to move the teaching of Chemistry towards higher qualitative levels, for which the limitations observed some and diagnosed others in the pedagogical professional practice were taken as a starting point. The contrast between insufficiencies, new proposals and the results of their application show the need for their generalization in other subjects and in other educational institutions.

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