Original article

Epistemological characterization of the teaching-learning process of the Software Engineering I subject

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ABSTRACT

The process presents the scientific results obtained in the scientific tasks of the Project of Research And Development itself in the article Teaching learning in virtual environments in professors' formation. The objective was to accomplish the epistemological characterization of the process of teaching learning of the subject of study Software's Engineering I of the race Information Engineering making out of the determination the referent theoreticians and metodológicos that constitute the theoretic referential frame from where one understands, explain and interpret the referred process. The results allowed raising the quality of the process of investigation and the transformations desired in the educational levels.

Keywords: Epistemological characterization; Teaching-learning; Software Engineering; Theoretical references.

Introduction

The training process of computer engineers in the Computer Engineering career, at the University of Granma, demands a teaching that considers as an essential requirement its

contextualized character, a systemic and dynamic approach, and that assumes, as a curricular component, the professional problems to be solved by the future graduate. This reality imposes a challenge to the direction of the teaching-learning process of Computer Engineering and, therefore, to its main actors who are teachers and students.

The teaching-learning process of the subject Software Engineering I has been studied by different authors including Ciudad and Soto (2006), and Fergusson (2016), who define a set of principles for the development of didactic materials to support the teaching-learning process of Software Engineering and have provided valuable contributions that enrich pedagogy and didactics. However, there are no theoretical and methodological positions that characterize the treatment of methodologies for the software development life cycle, and that guide the teaching-learning process of the subject Software Engineering I of the Computer Engineering course at the University of Granma.

Software Engineering I is a fundamental subject within the study plan in the formation of the students of the Computer Engineering career of the University of Granma. The knowledge and skills to be developed through the learning of this subject contribute to the preparation of the student to face the exercise of his profession.

Software Engineering I can be considered as one of the fundamental subsystems of the teaching-learning process, since in its development the student is forming his personality while appropriating the teaching content under the guidance of the teacher and also contributes to the vertical and horizontal systematization of the contents, since it belongs to a discipline and is developed jointly with others in the academic year.

Therefore, the objective of the article is the epistemological characterization of the teaching-learning process of the subject Software Engineering I of the Computer Engineering career of the University of Granma, which is one of the scientific results obtained by the authors in a scientific task of the Research and Development Project "The teaching-learning process in virtual environments in teacher training", belonging to the Faculty of Secondary Education of the University of Granma.

In this epistemological characterization, it is assumed as a central axis of analysis and reflection the determination of the theoretical referents of philosophical, sociological, psychological and didactic character, which constitute the referential and contextual theoretical framework from where the referred process is understood, explained and interpreted.

Development

Theoretical references

The teaching-learning process has its theoretical-methodological basis in the Dialectical Materialist Philosophy; it is supported by the most general laws of the development of nature, society and thought, by revealing the relationship between the cognitive, evaluative and practical-transforming activity and with the Marxist-Leninist theory of knowledge developed by Lenin (1990).

In the teaching-learning process of the subject Software Engineering I of the Computer Engineering career at the University of Granma, Dialectical Materialism (Lenin, 1990) contributes to the scientific formation of the world in students by revealing: the objective existence of objects, phenomena and laws of nature; the material unity of the world, the role of modeling in the study of phenomena, the cognoscibility of the world through the study of magnitudes and laws as a reflection of the essential properties of objects; the role of experiment in scientific knowledge and the dialectical character of the process of knowledge; for which facts, hypotheses, models, laws and new facts have a transcendental character.

The dialectical-materialist method becomes fundamental for the search of scientific knowledge and in particular, the theory of knowledge, which according to Lenin (1990) passes: "(...) from living contemplation to abstract thought and from this to practice: such is the dialectical path of the knowledge of truth, of the knowledge of objective reality". (p. 165). This theory becomes evident when the student of the computer engineering career at the University of Granma interacts with the content of Software Engineering I, to elaborate his ideas and reach conclusions in a process of construction and appropriation of knowledge, skills and professional values, from the solution of problems related to the development of information management systems in the teaching-learning process of the subject Software Engineering I with an action of an investigative nature.

In this research the authors take into consideration the theory of the Sociology of Education of Blanco (2003), on the relationship between the general and social culture and its manifestation in the student's formation, through the activity and communication that is developed from the university substantive processes and its concretion in the academic, labor and investigative components of the professional formation in the teaching-learning process of the subject Software Engineering I.

In the teaching-learning process of the subject Software Engineering I, a system of social relations is established in the different contexts of action where the training process of the professional is developed (Blanco, 2003), which express the characteristics or features of today's society from the spiritual, material, intellectual and affective, constituting these features, the ways of life, performance, thought and value system in which the computer engineer is formed.

The consideration of the theory of the Sociology of Education of Durkheim (2005), on the sociological analysis of the socialization process and its agents, of the relations of the educational system with the other social systems; of the social functions of the education of an educational system, its active agents and internal social relations, with special attention to the relations between: student-group-teacher-society, as well as of the contradictions and reform processes that are developed in the educational system.

The consideration of the theory of Durkheim's Sociology of Education (2005), on the objectives of the educational process:

- Facilitating the student an analysis of the social dimensions of education.
- Understanding of the relationship between education and society.
- Knowledge of the social processes that take place in the framework of the professional's training process.

The teaching-learning process of the subject Software Engineering I of the Informatics Engineering course at the University of Granma is based on the mediational theories, which are based on the assumption that the characteristics of the internal psychic structure that mediate the action of external contingencies and determine diverse responses according to individual differences play a decisive role in learning. Within these theories, from the cognitivist paradigm, some conceptions of the genetic-dialectical psychology approaches of Vigotsky (1987), and of the genetic-cognitive psychology of Piaget (1969) and Ausubel, Novak and Hanesian (1978) are assumed.

In the teaching-learning process of the subject Software Engineering I, the relevant role attributed to the social environment and the types of interactions that the student carries

out with others must be taken into consideration, which for Vigotsky (1987), constitutes the general law of the formation and development of the human psyche, as well as the Social Situation of Development, taking into account the social position of the student due to the conditions of life and education and the internal position determined by the attitude adopted by the student before the previous requirement.

The teaching and educational processes that are developed in this subject Software Engineering I should be constituted in the development guide (Vigotsky, 1987), where the levels reached by the student will be mediated by the activity and the communication that he/she carries out as part of his/her learning, so they are constituted in the mediating agents between the student and the cultural experience that he/she is going to assimilate.

In order to achieve that the structuring of the teaching-learning process of the subject Software Engineering I enhances and expands the Zone of Proximal Development (Vigotsky, 1987), within the framework of cooperative learning, it is essential to take into account not only what has already been learned by the student, what he already knows, dominates and can face alone, but also what he is not yet able to face alone, but with the help of the teacher or a classmate he can solve; This expresses the potentialities of the student's future development and the relationship between teaching and development, where teaching acts as a conditioner of development.

In learning the contents of the subject Software Engineering I, the student must adopt an active position (Vigotsky, 1987), this implies inserting himself in the construction of knowledge, in its structuring and restructuring, contributing his criteria in the group, raising questions, different ways of solution, arguing his points of view, which will lead to the appropriation of new knowledge or to the restructuring of the existing ones.

From the constructivist approach: the Piagetian conception of cognitive conflict and Ausubel's theory of meaningful learning, from which we assume:

- The main hypothesis of the constructivist theory (Piaget, 1969) that knowledge is not simply acquired, nor is it received, nor is it a copy of reality, but is a construction of the student.
- The cognitive conflict that supposes the indissoluble relation between states of cognitive equilibrium and imbalance originated between the cognitive subject (active) and its object of study.
- The psychological paradigm of meaningful learning of Ausubel, Novak, and Hanesian (1978) on the importance given to the connection between the known and the unknown

by the student; the significant relationships in learning: conceptual, affective and experiential; and the dimensions of meaningfulness: logical and psychological of the content, as well as the positive attitude of the learner.

The research developed is theoretical, from a qualitative approach (Fuentes, 2010); in the epistemological characterization of the teaching-learning process of the subject Software Engineering I of the Computer Engineering career of the University of Granma, the analytical-synthetic methods were used in the construction of the research contributions for the determination of the theoretical assumptions, the dialectical hermeneutic to understand, explain and interpret the teaching-learning process of the subject Software Engineering I and as a data collection technique the study of documents.

The logic of the research is based on a dialectical-materialistic philosophical perspective, which favors the orientation of the research process and the enrichment of the methods and techniques used.

The teaching-learning process of the subject Software Engineering I of the Computer Engineering course at the University of Granma is understood, explained and interpreted from the Holistic Configurational Theory of Higher Education Didactics systematized by Fuentes, H. (2010).

Coinciding with Fuentes (2010), the principles and laws of the Didactics of Higher Education are assumed, so it is recognized as the first principle: "the epistemological and methodological systematization of the specific sociocultural contents", which starts from regulating that the development of the teaching-learning process is governed by the epistemological and methodological systematization of the specific sociocultural contents and not by other activities that blur the true intention of the process, which means that it is a requirement of great value in the Didactics of Higher Education to develop concretely that this specific intentionality is what allows directing from the specific didactic the teaching-learning process in the training of professionals.

This principle allows structuring the teaching-learning process of the subject Software Engineering I to achieve in the student the systematization of knowledge and methods of science and profession, making it possible to generate a constant transformation in their preparation to face the solution of problems related to the development of information management systems.

The second principle is "the systematizing orientation to the formative generalization", which allows to formalize directionally the construction, from the gnoseological, logical

and practical-methodological to the systematization of culture from the understanding of the dialectical relationships between the systematizing orientation and the formative generalization.

This principle allows understanding and interpreting the permanent character of the systematizing orientation and the formative generalization in the teaching-learning process of the subject Software Engineering I, which leads in its internal evolution to the sufficient and necessary structuring of the appropriation of knowledge in its relation with the logic of science and its consequent practical application in the solution of problems related to the development of information management systems.

It is essential to determine the didactic laws that will guide the theoretical-didactic work of teachers for their actions in the dynamics of the systematization of culture in the teaching-learning process of the subject Software Engineering I of the Computer Engineering career at the University of Granma.

The above presupposes recognizing the two fundamental didactic laws (Fuentes, 2010), the first law considered as: "the systematization of the advanced didactic-research activity", is connoted from revealing as essence that the advanced didactic-research systematization governs the whole formative process that favors the deepening of the content in the students involved in the development of the teaching-learning process. Therefore, systematization, both pedagogical and didactic, leads to reveal the structural relationships that promote new synthesis relationships reworked in the systematization process itself, where the appropriation of culture is linked to the process of scientific construction of knowledge.

The second is the "law of determination of the unity between the didactic and the qualitative of teachability and learnability", from the didactic point of view, is to express the constant and objective dynamics of the systematization of culture from the unity between teachability and learnability, since it expresses the form of the internal movement, the links and relations of the appropriation of culture and deepening of the content.

This law denotes the expressions of the relations and manifestations of the concrete conditions that are projected as an internal unity, a concatenation and a conditioning of the didactic with the qualities of teachability and learnability that will be put in correspondence with the teaching-learning process. Its unity, from these elements, is determined in the didactic by the relational character of the external and the internal.

The categories that allow characterizing the development of the teaching-learning process are considered of two types, in the first, those of a structural nature when components such as the academic, research and work are identified, or other more specific ones, which are well conceptualized in various texts of Didactics of Higher Education (Fuentes, 2010), the components make up a structure of systemic relationships, which interpreted from the consideration of the General Theory of Systems, allow to account for the relationships of the process with the environment and its relationships between the structure and the functions of the process, which although valid are not the object of this research.

On the other hand, from the application of the Holistic Configurational Theory to the development of the teaching-learning process, categories of a holistic and complex nature are identified, such as: configurations, dimensions and links.

The configurations of the teaching-learning process (Fuentes, 2010), constitute the subjective-objective expressions with which the students involved identify features and qualities, by characterizing the process and its movement, they identify with it: problem, objective, object, content, method and achievement.

The problem is the configuration that characterizes the teaching-learning process in its link with the social need and therefore, it is the objective situation that manifests itself in a process and is configured in the student in the subjective need to face it, which constitutes the starting point of the process. It is the situation that occurs in an object and creates in the student the need to solve it. It has an objective character as it is inherent to the object, but at the same time it has a subjective character, determined by the student for whom the situation becomes a need.

The problem of the teaching-learning process is manifested in the social need that demands the Model of the professional of the Computer Engineering career of the University of Granma related to the treatment of methodologies for the software development life cycle and its application to the solution of problems related to the elaboration of information management systems.

The object expresses that part of the professional culture linked to the problem in its support and solution, it constitutes the synthesis of the epistemological and methodological part of the culture that has to be systematized by the historical and social practice of humanity, which students must appropriate in the process, in order to achieve the objective.

The objective is the configuration of teleological character that expresses the achievement that is aspired to reach and when it is achieved, it satisfies social needs. It has an objective-subjective character, as it is elaborated by the students who develop the process.

The content is the configuration through which the knowledge, skills, values and valuations configured by the students in the dialectic relationship with the appropriation of culture are expressed. The content has in the development of the teaching-learning process an epistemological and methodological support, but of a professional nature.

The method is the expression of the logic of the process that is configured in the objective-subjective relationship adopted in the development of the process by the students. Thus the method is the most dynamic configuration of the process and has to express the contradictory unity between the objective dialectical logic and the subjective dialectical logic of the movement of the real object.

Achievement is the configuration that characterizes the final state in the transformation of the students in the process. It is configured as a dynamic synthesis of the previous ones, around the meanings that the process itself develops in the students; it is the concrete expression of the formative transformation of the process. It is not a moment of the process, but is configured throughout the process, both in space and in time. This category has its maximum significance and at the same time concreteness in the evaluation of the process.

The application of the Holistic Configurational Scientific Conception to the Didactics of Higher Education systematized by Fuentes (2010), allows identifying comprehension, interpretation, motivation and generalization, from the didactic configurations and understanding and interpreting this process, in order to develop it in the dynamics of training, that is, in the practice itself. Consequently, they are interpreted as dimensions of the dynamics of the process, namely: dimension of understanding; dimension of interpretation; dimension of motivation and dimension of generalization, which interact dialectically with each other, revealing the configurational nature of the dynamics of the teaching-learning process.

Motivation is where the need in training is developed. It has as a premise and necessary condition, although not sufficient, for the construction of any content, the relationship between the purely cognitive and the spiritual needs of students. This relationship takes place at the individual and social level, but transcends the context in which the training takes place, in which the communicative and valorative activity conditions and favors

the emergence of a space that promotes the student's disposition to the appropriation of culture, the deepening of socio-cultural contents, in the systematizing orientation and formative generalization.

Understanding is a complex process of appropriation of the objects of culture, a first approach to their meaning, and constitutes a totalizing image of the object studied. It is based on the recognition of the cultural reality, from the factual, historical-tendential information and the epistemological characterization of said object.

Interpretation constitutes the synthesis and realization of comprehension and explanation; it allows the reconstruction of the meaning of the object of culture from the student's point of view, which leads to the configuration of a different and qualitatively superior meaning of the content.

Generalization is the process through which the student integrates and generalizes the contents from the epistemological and methodological systematizations, as a product of the dialectical relationship between content and achievement, in which he reaches the application to the problems that exist in different contexts and with new factors that propitiate the formative generalization, and thus face challenges in which it is not enough to transfer, but to rethink the content structures themselves.

The modes of action respond to a logic that can be achieved independently of the objects and, therefore, of the procedures applied in each case, which means that there is a logical content that has to be taken to the professional formative process, where the logic of action of the professional is implicit, together with a set of ethical and aesthetic values that are inherent to the professional and constitute an invariant of ability.

The mode of action is a generalization of the professional's work method. In the Computer Engineering career at the University of Granma (Ministry of Higher Education, 2017), it is the one referred to "(...) the development of the processes of the life cycle of a computer system, the exploitation of systems and development tools and the performance of different roles in the development team and in knowledge management." (p. 8)

The spheres of action of the computer engineer in the Computer Engineering career at the University of Granma (Ministry of Higher Education, 2017), is the one referred to "(...) all those entities where computer systems are produced or exploited; this professional designs and develops computer solutions to problems of a very diverse nature in a wide spectrum of organizations." (p. 8)

The fields of action of the computer engineer in the Computer Engineering career at the University of Granma (Ministry of Higher Education, 2017), are related to.

(...) the conception, modeling, design, design, development, implementation, integration, maintenance and testing of computer systems... The multidisciplinary integration with specialists from various branches to conceive and develop the computer solution that provides an answer to the needs of the problem in question, being able to assimilate the models of the object of study. The selection and use of the equipment and the most effective techniques and methods for information processing and the problems presented in the basic link of the profession are solved by the computer engineer from the exercise of the main professional functions or essential roles classified in different levels (high, medium and basic) (p. 8).

The object of the profession (Ministry of Higher Education, 2017), manifests the dialectical relationship between the mode of action, as a generalized method, and the object of work, as a generalized object. This is concretized in the scenarios in which cooperative relationships are established between professionals in training, other students and different objects of diverse nature that enrich their human condition and favor the development of their transformative potentialities, in link with the problems related to the object of the profession.

The career of Informatics Engineering is posed as a social requirement to train competent professionals unconditionally committed to the work of the Revolution, expressing itself in modes of action that reflect the ethical essence of the revolutionary professional, whose function is to develop processes related to computer solutions and systems in organizations, which constitutes the object of the profession, with the purpose of obtaining an increase in the effectiveness and efficiency of these by applying techniques that allow him to analyze the environment to delimit the computational processes, the information to be processed and the corresponding interrelationships; as well as the management of computer projects with professionalism.

In this process, the logic of professional performance must be considered, which as Fuentes, Mestre and Repilado (1997) refer, expresses "(...) the generalization of professional skills, which taken to the content of the disciplines become the invariants of professional skill, taking into consideration the logical, didactic and psychological aspects that impose the logic of the profession" (p. 52). (p. 52)

The aforementioned authors consider it necessary to reveal in the professional formative process the relationship between the logic of action of the professional and the logic of

the profession, which is understood as "(...) the integration of knowledge, skills, motivations and values with a high level of generalization, has an essential character and operates through the disciplines of the career." (p. 48)

From the above, it is evident that in the professional training process the relationship between both logics is what leads to the conformation of the modes of professional performance, so this is realized through the integration of the academic, labor and research components, from the subjects of the teaching disciplines of the academic year.

The professional problems of the computer engineer (Ministry of Higher Education, 2017), are aimed at "(...) providing computer solutions to problems in organizations, efficiently and effectively exploiting the capabilities of available computer technologies and totally or partially modifying existing computer solutions, in order to improve the effectiveness and efficiency of an organization." (p. 8)

According to the Royal Spanish Academy (2020), an algorithm is a prescribed set of well-defined, ordered and finite instructions or rules that allows carrying out an activity through successive steps that do not generate doubts to the person who must perform the activity.

The logic of algorithmic action of the computer engineer for the development of information management systems is understood as the integration of knowledge, skills, and values with a high level of generalization, which makes it possible to use methodologies for the software development life cycle and to consciously reflect the solution of a problem related to the development of information management systems through an orderly, flexible and finite system of actions.

The skill invariant, according to Fuentes, Mestre and Repilado (1997), expresses, at the didactic level, the professional's mode of action, which includes, in addition to the generalized knowledge and skills that are specified in each discipline, the logic with which the professional acts; it is an essential generalization of skills that has its concreteness in each discipline. This invariant contributes to the formation of the professional's personality, through the formation of the values and motivations proper to the profession.

The epistemological characterization of the teaching-learning process of the subject Software Engineering I of the Computer Engineering career, has evidenced as a limitation that in the treatment of methodologies for the software development life cycle, follows a logic of algorithmic content appropriation, which does not allow to explain how to perform the software development and its application in the solution of

problems related to the development of information management systems, which as already explained, do not respond to the distinctive of the profession of Computer Engineer.

Conclusions

This study has made it possible to systematize the philosophical, sociological, psychological and didactic theory, as part of the referential and contextual theoretical framework of the research, which makes it possible to understand, explain and interpret the teaching-learning process of the subject Software Engineering I, of the Computer Engineering course.