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Methodology for the formulation of programming problems based on local development

Metodología para la formulación de problemas de programación en función del desarrollo local

Metodologia para formulação de problemas de programação com base no desenvolvimento local

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ABTRACT
Considering the social context in which Cuban society is currently developing, which has as its fundamental task the computerization of society and local development from the resources available in it the professionals graduated in Computing Education play an important role in the informatics formation of children, adolescents and youth, to solve problems using aids and computers resource that provided by technology of information and communications. Actually it is a need, to prepared this professionals for learn to solve problem, at once they learn to teach their student to solve it; for this reason the objective of this work is, to give a methodology for the formulation problems that are solution in Subject Language and programming techniques II; from theory and practices fundaments of that subject and local situations investigated by students in their community, that enable the acquisition of didactic proceed in this teaching and learning process directions. The use of the theoretical and empirical level methods were used, all under a general dialectical-materialistic methodological approach, it allowed as a result, a theoretical analysis of problem solving and its formulation, as well as to establish the methodology, which must be updated and socialized with the entities that contributed to the process, managing to further strengthen the university - company relationship both in the educational and productive spheres.

Keywords: local development; problem formulation; language and programming techniques; methodology; programming oriented to object.

RESUMEN
Teniendo en cuenta el contexto social en que se desarrolla la sociedad cubana en la actualidad, que tiene como tareas fundamentales su informatización y el desarrollo local a partir de los recursos disponibles en esta, los profesionales que egresan de la carrera de Licenciatura en Educación Informática desempeñan un papel importante en el cumplimiento de tales propósitos, ya que contribuyen a la formación informática de los niños, adolescentes y jóvenes, para resolver problemas utilizando medios y recursos que aportan las Tecnologías de la Información y las Comunicaciones. Preparar a estos profesionales para que aprendan a resolver problemas y a la vez aprendan a enseñar a

sus estudiantes a resolverlos, resulta una necesidad actual; es por ello que el presente trabajo tiene como objetivo: ofrecer una metodología para la formulación de problemas que se solucionan en la asignatura Lenguaje y Técnicas de Programación II, a partir de los fundamentos teóricos y prácticos que brinda la asignatura y situaciones locales investigadas por los estudiantes en su comunidad, que posibilitan la adquisición de procederes didácticos en la dirección de su proceso de enseñanza-aprendizaje. Se utilizaron métodos del nivel teórico y empírico, todos bajo un enfoque metodológico general dialéctico-materialista, cuyos resultados permitieron realizar un análisis teórico de la resolución de problemas y su formulación, así como establecer la metodología; los problemas y su solución deben ser actualizados y socializados con las entidades que contribuyeron con dicho proceso, lográndose fortalecer aún más la relación universidad-empresa, tanto en los ámbitos educativos como productivos.

Palabras claves: desarrollo local; formulación de problemas; lenguaje y técnicas de programación; metodología; programación orientada a objeto.

RESUMO

Tendo em vista o contexto social em que atualmente se desenvolve a sociedade cubana, que tem como atribuições fundamentais a informatização e o desenvolvimento local a partir dos recursos nela disponíveis, os profissionais que se formam no bacharelado em Educação em Informática desempenham um papel importante na concretização. de tais finalidades, uma vez que contribuem para a formação em informática de crianças, adolescentes e jovens, para a resolução de problemas por meio dos meios e recursos disponibilizados pelas Tecnologias da Informação e da Comunicação. Preparar esses profissionais para aprender a resolver problemas e ao mesmo tempo aprender a ensinar seus alunos a resolvê-los é uma necessidade atual; É por isso que o presente trabalho tem como objetivo: oferecer uma metodologia para a formulação de problemas que se resolvem na disciplina de Linguagem e Técnicas de Programação II, com base nos fundamentos teóricos e práticos fornecidos pela disciplina e em situações locais investigadas pelos alunos. comunidade, o que possibilita a aquisição de procedimentos didáticos na direção de seu processo de ensino-aprendizagem. Foram utilizados métodos de nível teórico e empírico, todos sob uma abordagem metodológica geral dialético-materialista, cujos resultados permitiram realizar uma análise teórica da resolução de problemas e sua formulação, bem como estabelecer a metodologia; Os problemas e sua solução devem ser atualizados e socializados com as entidades que contribuíram para esse processo, buscando um maior fortalecimento da relação universidade-empresa, tanto na área educacional quanto produtiva.

Palavras-chave: desenvolvimento local; formulação de problemas; linguagem e técnicas de programação; metodologia; programação orientada a objetos.

INTRODUCTION

The word "problem" is frequently used by people when referring to unresolved situations. In this regard, Majmutov (1983) states: "all human activity is directly related to the consecutive solution of problems" (p. 57).

Regarding problems in the computer context, Alea *et al.* (2019) define it by specifying the content of the problems, as an exercise that is formulated in a common language, requires computer resources and means for

its solution and has the following characteristics:

- Its content is part of a system of computer concepts and procedures typical of hardware or software, which makes it possible to find a model or algorithm to solve it.
- The data or information must be from a known context and related to the student's profile.
- The fundamental way to solve the contradiction must be created by the solver himself, since there is no algorithm or model in his memory that can give him a complete solution.
- The solver must feel the need and want to make the transformation, but with the resources he has, he cannot solve it, he must then be willing to look for them to give a solution (p.23).

For professionals who are trained as Graduates in Computer Education, it is of utmost importance that they learn to solve problems and at the same time learn to teach their students to solve them.

For Luza (2017), the biggest obstacle that students face is the lack of capacity and flexibility in solving problems.

According to Chezzi *et al.* (2017), the abstract level of the subject and the lack of connection with practical and significant problems show the need to achieve greater motivation and stimulation of the development of skills for solving problems. Hence the importance that must be given to the elaboration of problems in the Teaching-Learning Process (PEA) of programming.

The model of the professional of the Bachelor of Computer Education career, among its general objectives considers: to direct the PEA of Computer Science from the solution of problems within the framework of the individual, the group and the contextual, with a political-ideological, scientific and humanist approach that promotes the formation and development of knowledge, habits and abilities, values, attitudes and norms of behavior in the conditions and settings of the computerized Cuban society.

The disciplines of the specialized training area, including Language and Programming Techniques (LTP), of great importance in the computer training of these professionals, must contribute to the fulfillment of this objective. It is divided into four subjects: programming fundaments, LTP I, LTP II and LTP III.

The notion of programming is closely associated with solving problems using a programming language. In this area, programming refers to the action of creating programs or applications, through the development of a source code, which is based on the set of instructions that the computer follows to execute a program .

In the Teaching Process Plan (PPD), prepared for the Bachelor of Computer Education at the University of Pinar del Río "Hermanos Saíz Montes de Oca", it has been conceived that the LTP II subject focuses its study on solving problems using the paradigm of Object-Oriented Programming (OOP).

This paradigm is based on the management of objects. In solving a problem, entities that are closest to reality are used, where the data becomes primary. In addition, to solve it, the different objects that intervene in it must be determined and characterized; their properties and actions defined, as well as put them to interact with each other.

In the LTP II subject, the contents are taught from the resolution of problems of daily life, but it happens that in school practice the problem raised may be well elaborated, but not contextualized to the problems that occur at that time in the classroom society or town

where the student works; Furthermore, they are situations imposed by the teacher and do not constitute experiences of the students.

Despite the importance given to the formulation of problems for their solution, using a programming language and the need for them to respond to situations that arise in the community, the exploratory study carried out in the 2018-2019 academic year showed that, very often, the examples that are taken to introduce problem solving, taking into account an object-oriented design, do not reflect the reality of the locality where the students develop and lack updating, which influences the lack motivation for the study of this subject. Pedagogy has shown that it is necessary to bring educational processes closer to the social context every day, which facilitates learning and motivation for what is studied.

Considering the importance of all the aforementioned for professionals who are trained as Computer Education Graduates, this work was carried out, which aims to: offer a methodology for the formulation of problems that are solved in the LTP II subject, based on the theoretical and practical foundations provided by the subject and local situations investigated by students in their community, which enables the acquisition of didactic procedures in the direction of their PEA.

MATERIALS AND METHODS

The research began in the 2018-2019 academic year, constituting a task of the research project of the Bachelor's Degree in Computer Education "The initial training of the professional of the Bachelor's degree in Computer Science Education". As materials, various bibliographic sources of international and national authors were used who have dealt with the theoretical elements related to the formulation and resolution of problems, the particularities of the LTP II subject, of the LTP discipline of the Bachelor's Degree in Computer Science Education and the potentialities that provide the situations that are identified in the locality for the approach of the problems to be solved.

The present investigation had an explanatory character of the studied problem; it assumed an integral or dialectical approach. We worked with six professors who have taught the LTP II subject and 31 third-year students of the Computer Education Bachelor's degree where this subject is taught. The dialectical-materialist method predominated, which made it possible to operate with its laws, categories and principles. At the theoretical level, the following methods were used: analysis-synthesis, induction-deduction and modeling for information processing and to be able to offer theoretical considerations about the process of formulating problems that are solved in a programming language of the LTP II subject. , in addition to the interpretation of the results.

The empirical methods used were: survey, observation and document review.

RESULTS

In order to see the treatment that is given to the solution of problems in the LTP II subject, a review was made of the documents of its preparation. It was evident, in the methodological treatment to teach the contents, that in 71% of the problems the link between them with the educational contexts in which the students develop is not considered. It was found that 93% of the activities that guide the subject for work practice lack the solution and search for problems that are related to the community where they live, that can be solved using a programming language. In addition, an exercise booklet has not been organized

according to the logic of teaching the contents.

A survey was made of six teachers who have worked on the LTP II subject, with the aim of observing how the problems that are solved by means of a programming language are elaborated. In it, it was found that the logic for the teaching of the contents is always considered for its elaboration, but in 75% of them little importance is given to its connection with their school practice and very particularly with the local development.

The observation of seven practical classes of the LTP II signature was carried out to the group of 31 students of the third year of the career, with the objective of seeing the abilities that they had when solving problems using a programming language. The analysis of the results shows that 63% of the students have difficulties with understanding the problems and 89% do not know how to elaborate them based on the needs to teach the contents.

The use of empirical methods showed that it is necessary to update the problem bank available in the LTPII subject, so that it achieves the link with local development and greater motivation of students for programming.

As a result of the analysis carried out using the research methods, the following regularities were obtained in:

Students: have difficulties with understanding some problems, because they are not familiar with the social context from which they come and do not know how to elaborate a problem extracted from the social context in which they develop.

Teachers: most of the problems used to be solved through OOP are not linked to the different educational contexts, they lack a booklet of exercises organized according to the logic of the contents of the discipline and that their formulation considers the educational contexts, in particular what is related to local development and teaching tasks related to work practice; they do not include the elaboration or formulation of the problems by the students.

From the analysis of the results of the aforementioned regularities and supported by the theoretical foundations on the formulation and resolution of problems, we arrive at the approach of the educational need to solve, through the research project, the problem expressed as the " need to update the bank of problems available in the LTP II subject of the Bachelor's Degree in Computer Science Education, contextualizing these to local development ", which allows establishing as a problem how to contribute to the process of formulating problems based on local development, that are solved in a programming language and that respond to the demands and needs of the PEA of the LTP II subject.

From the problem identified, the object of study is specified: the process of formulating problems that are solved in a programming language of the LTP II subject.

Methodology for formulating problems based on local development, which are solved in a programming language

General objective

Manage the process of formulating computer problems related to OOP from the LTP II subject, based on a methodology based on theoretical and practical foundations, and local situations investigated by students in their community, which enables the acquisition of didactic procedures in the address of your PEA.

Rationale

According to Cruz *et al.* (2019), the concept of local development arises from the

combination of two controversial terms, which have been the subject of scientific discussion and have generated unequal positions. Various contributions have been made to provide a unanimous and accepted definition that has not yet been achieved.

Local development is based on the identification and use of the endogenous resources and potential of a community, characterized by its dimensions: economic, sociocultural and political-administrative, where local, public, socio-economic agents actively intervene in planning and execution, private companies and the population, led by the local government, which is in charge of legal processes and administrative management, with the aim of improving the population's living conditions and the most efficient and sustainable use of existing resources.

In addition, at the present time, in which the university is called to achieve an integration with local governments based on the development of science and technology in the locality, and as part of this process, university students must be linked to different state entities, it is that a methodology is provided for the contextualization of the formulation of the problems in the LTP II subject, where the students themselves are the protagonists, taking advantage of their work practice, contributing to achieve greater motivation for the study of the subject and preparing them so that in their future profession they contribute to local development.

Description of the methodology for formulating problems

An analysis in the scientific literature to the concept of methodology reveals that there are multiple definitions, which vary depending on the plane from which they are established: general, particular or specific, in any of which it is linked to the use of the method.

In this article, we assume what was stated by De Armas & Valle (2011) in that in a more specific plane "the methodology means a system of methods, procedures and techniques that, regulated by certain requirements, allow us to better organize our thinking and our mode of action to obtain certain cognitive purposes" (p.32).

Precisely, the developed methodology answers the following question:

How do you keep your computer problem bank up-to-date with local needs?

Taking into account that university students must be linked to a work center to develop their practices in the first years and, from the fourth year, the anticipated placement, it is a good task to teach them how to formulate a computer problem from the information that they collect as a result of their investigative work, contextualized to the center where they are located; then they are collectively analyzed under the teacher's direction and solved by them as part of the development of the teaching-educational process. This would allow the teacher to keep his bank of problems updated, which he can contextualize based on the content to be treated and achieve greater student motivation for the subject.

The methodology includes three stages: the preparation of the students, the management of the information and the formulation of the problem.

1 ra stage. The preparation of students

As a task of the labor and investigative component, students will be trained in the theoretical knowledge necessary for the formulation of a didactic problem, starting from the analysis and systematization of the meanings given by different national and international authors on the concept of problem and in particular of a computer problem.

- Establish a sequence of actions to consider when formulating a computer problem.

- The computer content according to the study program.

- Define the type of exercise to be formulated.

- Search for data and limitations provided by the client.

- Determination of the unknowns or desired variables and expected results.

2 gives stage. Information management

At this stage, the student is already in his employment relationship, having to carry out the following procedure to manage the information of a problem:

- Investigate in the direction of the location center the bank of problems to be solved and select one of them according to the type and content previously conceived.

- Analyze it and determine the data that will be offered to the user, taking care that they are real and what information should be processed and reported later.

3 ra Stage. Problem formulation

Write the problem text using the following order:

- Choose the format according to the type selected previously.

- Describe the place where the problem occurs.

- Make known the data and unknowns of the problem.

- Carefully review the wording, facilitating its interpretation.

- It is recommended that it be discussed with other colleagues to determine if adequate communication is achieved.

- Present the task in the workshops that are planned in the subject for such purposes.

- Subsequently, it is suggested that it be solved by the student who prepared it as a stimulus to the work done.

- Socialize, both the writing of the problem and its solution to the entity of the locality from where it was stolen.

DISCUSSION

The results obtained with the application of the exposed methods and the bibliographic search on the subject show the need to deepen it, due to the contribution to the mastery of the students of the contents of their basic professional training for the management of the PEA of programming, to starting from the linking of the university in function of local development.

The teaching of programming is closely associated with solving problems through a programming language. Many are the investigations that are related in how to solve the problems in programming. Some have developed strategies to solve them, which are based on Poyla's (1976) process to solve problems. Supported by this same process, others offer a series of steps or phases to solve them using a programming language.

The formulation, writing or approach of a problem has been an aspect to which mathematicians have been paying attention due to the relationship it has with its resolution.

Penalva *et al.* (2010), based on a systematization carried out of the positions

on the posing of problems of a group of researchers, they suggest that it is generally applied to three different forms of mathematical cognitive activity:

- Pre-solution approach. Original problems are generated from a presented stimulus-situation.
- Approach in solution. A problem is reformulated based on the resolution made.
- Post-solution approach. The objectives or the conditions of a problem already solved are modified to generate new problems.

According to Duardo *et al.* (2020), the problem statement must have data (known information), conditions (related to the solution strategy) and requirement (solution from the data and given conditions). For Domínguez *et al.* (2017) it is very important for the formulation of the problem the environment where the student develops. Cutiño *et al.* (2017) consider that the person who develops the problem must have knowledge of its structure and the elements of other sciences that are part of its context.

On the term formulation of problems in the field of computing, what was raised by Stoyanova (1998) it is contextualized, considering it as the process in which, on the basis of specific situations, problems are written for their solution using computer media and resources. In addition, the three forms of cognitive activity that is applied in the approach of the problems, raised by Penalva *et al.* (2010).

There is little research on the formulation of the problems to be used in the programming PEA. Here we can mention Alea *et al.* (2019), who assume the three forms of cognitive activity that are applied in the approach of the problems, raised by Penalva *et al.* (2010).

Others, such as Fonseca (2020), are of the criterion of formulating various types of exercises that allow a better development of the ability to solve problems by students.

The methodology proposed in this article takes into account the three forms of cognitive activity that are applied in posing the problems, expressed by Penalva et al. (2010) and assumed by Alea *et al.* (2019), all the criteria exposed by Duardo *et al.* (2020), Domínguez *et al.* (2017) and Cutiño *et al*. (2017), in relation to the formulation of problems and ensures, in addition, that: the problems are formulated taking into account the content that is taught, the educational context in which the students develop, where they do their work practice, and that they are the students themselves who formulate and solve them. These last three elements are what distinguish this research from the others.

It was analyzed in the pedagogical group of the career and as a result it was obtained that in the subject Language and Programming Techniques II the problems for the treatment of the contents of the subject were reviewed, based on the contextualization that was obtained annually as a result of the application of the proposal.

In summary, the methodology described in this work allows: compliance with the didactic principle of linking theory with practice, linking the university based on local development, updating scientific knowledge at the university, motivating students for the programming and contribution to the computerization of society from the student labor component.

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Conflict of interest:

Authors declare not to have any conflicts of interest.

Authors´ Contribution:

The authors have participated in the writing of the work and analysis of the documents.