

METHODS OF TRAINING OF PROGRAMMING FOR FUTURE INFORMATION SCIENCE TEACHERS VIA DISTANCE LEARNING

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***Abstract:** The article describes the main classifications of learning methods from the viewpoint of their application in distance learning of programming. From there, the following classifications are considered: classification by the methods of training material presenting, classification by the main types of didactic problems, and classification by the kinds of cognitive activity of students. Also, the article characterizes the level of skills and ability needed to solve programming training tasks: reproductive, meaningful, probative, and creative programming. The following didactic particularities of approaches to learning of programming are defined: focusing on material covering, algorithms, and on hardware.*

Key words: distance learning, programming, learning methods, teaching methods.

INTRODUCTION

The current state of the national higher education development is characterized by modernization and reforming targeted to joining to Bologna process with purpose of entering to European education and research area.

Bologna declaration (1999) and other Bologna process documents initiated a series of reforms needed for harmonization of the architecture of European higher education system, increase of compatibility, comparability and competitiveness of European higher education, and for increase of its attractiveness for European citizens as well as for other country researchers.

Traditionally, the different types of Ukrainian educational institutions have the following modes of study: full-time education, part-time education, and non-residence education. In recent decades, online study mode (distance learning) has been developing, because of socioeconomic needs and development of new teaching means in the world education system.

Under these conditions, the following trends are spreading: usage of interactive forms and methods of students' work under the guidance of teachers (tutors) and application of individual (self-dependent) work in laboratories, reading rooms, facilities of future professional activity that is especially important for distance learning system.

Internet network is already serves as a model of using technologies to attract students to actively participate in the learning process. Until now, we simultaneously have traditional and distance learning.

Distance learning is the technology which provides for possible usage of the best traditional and innovative means as well as types of learning based on computer and telecommunication technologies (Smyrnova-Trybulska 2007).

Distance learning system of certain higher educational institution includes the following support:

1. Methodical ware.
2. Software
3. Hardware.
4. Infoware.
5. Orgware.

The key person in the distance learning system is a tutor who is responsible for class hours. Analyzing the foreign universities experience, it is possible to notice that (in most cases) the course developer and tutor is the same person.

1. GENERAL CHARACTERIC OF TEACHING METHODS

A lot of experienced professors prefer (during conducting class hours for students of full-time education) usage of distance learning methods. First of all, it provides for revision, addition and selection of appropriate teaching methods.

Teaching (learning) methods in higher educational institution mean types of interconnection professor-student activity targeted to achieve learning objectives within certain discipline. Learning methods is realized due to the training activity means.

Peculiarities of teaching methods classification is considered in the viewpoint of traditional approaches: by the sources of knowledge acquisition, the nature of cognitive logic, and by the level of individual mental activity.

The most popular and understandable division (classification) of **teaching methods by knowledge sources** is division according to their external form appearance. Based on this, three groups of teaching methods are defined: verbal, visual, and practical (Maksymyuk 2009).

Then we provide description of the **teaching methods by the nature of cognitive logic**. It is obviously to use logic methods (such as analysis, synthesis, induction, deduction, and traduction) in the learning process. These methods also can be effective being in certain interrelation.

Analytical method provides for mental or practical dividing integral (complete) unit into the parts in order to learning of important characteristics.

For understanding integrity of phenomenon, process, concept essence, it is necessary to consider synthesis as the following logic operation. Synthesis is based on mental and practical combining of different elements or characteristics into integral unit. Synthesis is natural continuation of analysis and can be constructed only on its basis.

Logic methods, induction, deduction, and traduction can also be used in the learning process. Inductive method is a way for learning of objects and phenomena (from singular to general). As a result of understanding of characteristics and properties of singular objects and phenomena, we can consider essential, typical conformity or properties of singular (separate) objects and phenomena.

In contrast to the abovementioned, deductive method is based on learning of material from general to separate (singular). Students start to learn general conformity or concept, and then based on this, they characterize other phenomena and objects. Inductive and deductive methods are in dialectical connection.

Traductive method provides for findings from separate to separate, from partial to partial, and from general to general.

Training effectiveness is caused by the methods for organization of thinking. According to the **level of mental activity of students, teaching methods** are divided into problem (problem-information), partly search and research instructing.

Problem instructing provides for creation of problem situation (by professor), assistance in defining of problem issue, usage of verbal methods (lectures, explanations) to enhance mental students' activity aimed to satisfy cognitive interest due to getting of new information.

Partly search method attracts students to participate in the search of ways, means for solving cognitive tasks. To ensure the effectiveness of this method, it is necessary to create problem situation and encourage students to understand and "accept" the cognitive task; to control the course of research mental activity of students (using the system of logically motivated questions); to stimulate cognitive activity of students in the task solving process; and to analyze achievements, mistakes, and difficulties.

Research method is targeted to attract students to individual (self-dependent) solving of cognitive tasks with using of necessary equipment. For the method effectiveness, the following requirements should be met: creation of problem situation, students guidance during cognitive task definition; encouraging of students to search of hypothesis (and check of its reliability); assistance in search of effective methods and knowledge reserve needed for solving problems; bring students' focus on

research conduction and results systematization; and attracting students to individual (self-dependent) analysis of the course and results of the work performed.

2. METHODS OF LEARNING PROGRAMMING VIA DISTANCE LEARNING

We consider learning (teaching) methods in the viewpoint of their application during learning of programming via distance learning.

According to the training material delivery, verbal methods (discussion, explanation, narration, and lecture) combined with visual and demonstration methods (illustration, demonstration) can be used for teleconference organization with using proper equipment. Together with the lecture videotranslation, lectures can use additional materials in the form of slides and media files. Concerning visual methods, the main role belongs to demonstration and visualization of data structures (by the professor) and their processing algorithms that allow dynamically show (in the visual form) the course of the program mean performance.

One of academicians (Honcharenko 1997) gives (in “Ukrainian Pedagogical Dictionary”) the following definition of a lecture: “A lecture is a systematic and consistent presentation of learning materials, any scientific issues, topics, items, subjects and methods”.

Requirements to academic lectures are the following: modern scientific level and deep informativity, persuasive arguments, understandable language, emotionality, clear structure and logic, presence of stunning examples, scientific evidence, justification, and facts.

Practical methods are used for training tasks solving and laboratory (or practical) work performance. Applying these methods, students get knowledge as well as new practical skills.

As a rule, while learning of programming, the practical works content is consistent of different exercises for theoretical material learning. So under the distance learning conditions, check of performing exercises can be realized by review of the performance protocol, or by computer-aided evaluation of test task performance. The laboratory works content consists of tasks, performance of which provides for skills in making algorithms for the computer-aided solving of problems and in the algorithms realization by the use of programming language. In the latter case, before sending (for professors) results of laboratory work performance, students can check correctness of task performance not only by using local computer, but also using server (with the help of the proper resource).

According to the main didactic problems (for solving within class hours), it is possible to define the following methods: knowledge acquisition, methods for skills development, knowledge application methods, methods of creative activity, and competence check methods.

Analysis of general didactic learning methods shows that training activity very often is like iterative and incremental process. Considering iteration as step by step going for the certain purpose, it is possible to use iterative approach for training material presenting as well as for process of laboratory works performance. All the more so that specific character of laboratory tasks fully corresponds to iterative and incremental process which is related to construction of models (besides, the each next model is specification or development of the previous one). Laboratory works should consist of the following parts: tasks for individual (self-dependent) work; theoretical material; task solving examples; general learning tasks; and self-control test tasks. Constructing of the final model is like the iterative process; certain additions and specifications appear at each stage of this process. This allows using iterative and incremental approach in the process of learning programming.

Task approach is the most popular at the current stage of learning programming. Modern psychology and didactics consider tasks as the most important factor to stimulate and enhance cognitive and practical human activity. Student thinking development happens due to the problem solving process. The initial stage of this process is a problem situation, because usually people start to think when thinking need occurs.

Programming skills in creating of programming tools (software) are formed directly in the problem (task) solving process on the basis of the theoretical knowledge application.

Task solving method (in programming) is considered as a set of techniques of mental activity or logic actions and operations, which helps to solve lots of problems (tasks); in this case, the method of problem solving is a set of techniques of mental activity or logic actions and operations for solving a separate (special) task. In programming, practically all the tasks have several solving methods (algorithms).

The particular characteristic of solving of programming tasks is the fact that task solution, usually, provides for data structure definition, finding of the necessary processing algorithm, and its realization by means of programming language that needs students' knowledge of proper language instructions as well as skills to work in certain programming environment.

Solving of programming tasks can consist of the following stages: constructing of task information model, searching and constructing algorithms for its solving, and the algorithm realization by means of programming language. The most essential stages of the task approach are the first two. Therefore, it is possible to notice that the programming language is the tool which can be reasonably chosen due to the task character definition.

The experience of learning programming shows that four stages of students' abilities and skills in problem solving can be defined: reproductive, meaningful, probative, and creative programming.

Knowledge, received as a result of explanation and illustration method, does not form skills and abilities to use the knowledge. For this purpose, the professor (with the help of task system) organizes student activity basing on repeated reproduction of presented and showed actions methods. Reproduction and repetition of programming problems solving according to the professor's tasks is the main characteristic of the reproductive programming stage.

At the stage of meaningful programming students shall have more knowledge than at the reproductive programming stage; because it is necessary for the students (with no outside help) to determine types of data needed for the task solving, to have skills in the algorithm constructing, to understand constructions of programming language for preparing of the program text, and to test the program. However, at this learning stage of training, students often still see only one algorithm for the problem solving (this algorithm is not always reasonable).

The idea of the probative programming belongs to one of the academics, Yershov (1977). This idea provides for the creation of programs with the proving of their correctness. Constructing and proving the correctness of algorithms and programs faces the following difficulties. For concluding about the algorithm or program mistakes, it is enough to indicate the tests, while performing of which the fail or incorrect result happens. For proving the program correctness, it is necessary to prove that the correct answer is received for the whole of the valid input data. Such assertions can be proved only by an in-depth analysis of results of the program performance in the case of any valid data.

Creative programming is characterized by the novelty of its result for students, the peculiarity of the process of getting the result, and by the essential effect on the mental development. Students, being at the creative programming level, can ensure self-dependent solving of new (unacquainted) problems, deep learning, rapid pace of gaining new knowledge, width of the knowledge transferring to the relatively new conditions, ability to self-dependently form tasks, and use training, scientific or periodic programming literature for new knowledge search. Creative programming shows intellectual abilities of students and their creative potential. Such approach helps to attract students to learning, make them more self-confident, which triggers off their cognitive activity and stimulates the training activity. At the same time, task solving according to the algorithm prepared by the professor does not need individual thinking of the students. Problem solving skills also can be gained only due to the individual work.

In the process of learning programming, it is reasonable to consider the "pair programming" method, when two students simultaneously use one computer for performing tasks. In this case, one of the students does computer work, and, mainly considers coding in detail. Another student considers the task in general and persistently observes the code put by the first student. So, these two students continuously have a dialog concerning the training task and realize interactive

learning and control. Change of roles for these students is one of the obligatory conditions of the approach.

In most cases, modern programming is collective, and contribution of each programmer in the general project effects on the team success. It is necessary to understand importance of forming such characters as skills of collective work and cooperation with other teams (e.g., with teachers and resource specialists). The team participants work in order to solve the common (general) task. The participant is individually responsible for the program code, and he/she can assert the best solutions to the problem. Such type of training activity encourages students for individual creative work and deep learning of the programming course.

Considering introductory course of programming, it is possible to define the following learning approaches: approach of maximum material covering, algorithm-oriented approach, and hardware-oriented approach.

Approach of maximum material covering provides for consideration of amount of the training material without its deep learning. Application of this approach helps students to entirely understand the course, give them ideas of important themes, instead of focusing on only one problem in detail. So, the students gain a more complex vision of programming that allows them to confidently learn other computer courses. The disadvantage of this approach is the fact that consideration of a wide range of theoretical programming issues (at the early stages of learning) makes difficulties in learning materials by the students of freshman classes.

The Algorithm-oriented approach (while learning of the main concepts) provides for the usage of the pseudocode, instead of the real programming language. Application of this approach minimizes students' efforts for learning specific syntactical construction of specific programming language; but students should prove and explain the created algorithms. This allows students to work with a wide range of data types and basic structures. After learning of the main data types and the processing algorithms, students can start to use one of the programming languages. Due to the exception (from the study program) of the time for learning syntax and details of certain programming environment, it is possible to include additional theoretical material. As a result, students start to learn the theory aspects since the first days of studying.

Hardware-oriented approach provides for learning of computer fundamentals and, in particular, programming fundamentals starting with the hardware-logic level. It is noticed that (in this way) students can learn informatics more deeply and consistently. Transferring to learning of programming of high level is performed only after developing students' understanding of structural peculiarities of hardware, machine logic, and mathematics. From the viewpoint of developers, such approach is more attractive for students who want to understand the process of computer functioning in detail.

CONCLUSION

However, hardware-oriented approach is not fully consistent with the modern trends of continuing improvement of virtual machine that disengage the programming process from the hardware environment. This approach can be used for preparing computer engineering specialists, when it is necessary to introduce information on computing hardware.

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