The Model of Use of Mobile Information and Communication Technologies in Learning Computer Sciences to Future Professionals in Engineering Pedagogy

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Abstract. *Research goal*: the research is aimed at developing a model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy. *Object of research* is the model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy. *Results of the research*: the developed model of use of mobile ICT as tools of learning Computer Sciences to future professionals in Engineering Pedagogy is based on the competency-based, person-centered and systemic approaches considering principles of vocational education, general didactic principles, principles of Computer Science learning, and principles of mobile learning. It also takes into account current conditions and trends of mobile ICT development. The model comprises four blocks: the purpose-oriented block, the content-technological block, the diagnostic block and the result-oriented block. According to the model, the learning content of Computer Sciences consists of 5 main units: 1) Fundamentals of Computer Science; 2) Architecture of Modern Computers; 3) Fundamentals of Algorithmization and Programming; 4) Software of Computing Systems; 5) Computer Technologies in the Professional Activity of Engineer-pedagogues.

Keywords: model of use, mobile ICT, Computer Science, future professionals in Engineering Pedagogy.

1 Introduction

In the previous works of the author based on a comprehensive analysis of technological conditions for the implementation of mobile learning [1] based on the statistical analysis of the results of the expert survey were highlighted general professional and ICT competencies of the future professionals in Engineering Pedagogy, which can become a core of corresponding competency-based standard of training in Ukraine [2]. There are ICT competencies of future Engineer-pedagogues in computer technology, the advantages of use of competency matrices to diagnose their level of formation, the specific criteria for assessing each ICT competence (cognitive, operational-technological, value-motivational), three their levels (low, medium, high), the influence of the criteria

on the level of formation of each ICT competence which is determined by the expert evaluation method in the article [3]. The problem of formation of ICT competencies of future Engineers-pedagogues in the learning of Computer Sciences remains open. Its solution requires the construction of a methodic of use of mobile ICT as a learning tools of Computer Sciences to future professionals in Engineering Pedagogy.

In particular, a problem of determining the content and the structure of the method of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy. The solution of this problem involves determining of systemic relations between the components of the method and the components of the ICT-based environment, implementation of educational studies and the construction of a suitable model.

2 The model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy

In order to develop a model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy, according to [4, p. 55] offered some general principles of model construction, such as the definition of the purpose and specific modeling tasks; collection and systematization of the data related to the formulated tasks; distinguishing the main factors that influence the change of trends and patterns of investigated object or phenomenon; construction of a model based on tasks, the solution of which is the main model's orientation.

In Fig. 1 there is a structural and functional model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy based on the above-mentioned principles and aimed to the formation of their ICT competencies.

Based on these factors, two main groups contributing to changes in training future professionals in Engineering Pedagogy (Computer Technology) were distinguished. First, as a result of development of the society (modernization of higher education system, demand in professional education for vocational training system, informatization of society and education, the change of the educational paradigm to competency based) and second, as a result of technology's development (e.g., mobile ICT). Taking into account the results of the first group of factors, the system of ICT competencies of engineers-pedagogues in computer technologies was created. The second group's factors have enabled to specify the goal: the formation of the ICT competencies of the future engineers-pedagogues in computer technology in learning of Computer Science using mobile ICT. Together, the above-mentioned components form the purpose-oriented block of the model.

Mobile ICT, methodological approaches (competency-based, person-centered and systemic) and principles (principles of vocational education, general didactic principles, principles of Computer Science learning, and principles of mobile learning expert, person-centered and systemic), underlain to the development of the model are distinguished because they affect all the blocks of the model.

Achievement of the set purpose is in the content-technological block, which structurally corresponds to four of the five components of the methodical system of learning: content and technologies (organization forms, methods and tools) of Computer Science learning. The Computer Sciences learning content consists of five general units: "Fundamentals of Computer Science", "Architecture of Modern Computers", "Fundamentals of Algorithmization and Programming", "Software of Computing Systems", "Computer Technologies in Professional Activity of Engineers-pedagogues". Mobile ICT tools in learning Computer Sciences include mobile learning management systems, mobile simulation and programming environments, mobile database management systems, mobile multimedia development tools, mobile test systems etc. The leading hardware mobile ICT tools in learning Computer Sciences are mobile Internet-devices, mobile projectors, and mobile electronic textbooks.

Tools of monitoring and diagnosing ICT competencies formation in diagnostic block are represented by two groups: general diagnostic tools (tests, interviews) and specific (competency matrices, mobile ICT tools of monitoring ICT competence maturity of future professionals in Engineering Pedagogy (Computer Technology)). The model components are corrected according to the results of diagnostics.

Forecast result (increasing the maturity level of ICT competencies of Engineers-pedagogues in computer technologies) represented in the result-oriented block is achieved through applying expedient method of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy.

All four blocks of the model are connected with each other both directly and through their components.

Thus, among the methodological approaches, the main influence on the components of the purpose-oriented block is provided by the competency-based (on the higher education modernization and common goal) and systematic approaches (on the structuring of ICT competencies of Engineers-pedagogues in computer technologies). Mobile ICT, in turn, influence on the informatization of society and education and the procedural goal component.

In the content-technological block, mobile ICT: (1) are reflected in the learning content; (2) are distinguished directly at the tools of Computer Sciences learning; (3) are distinguished indirectly at the organization forms and learning methods. According to the competency-based approach, the requirements for preliminary students' training and to the results of Computer Sciences learning are formulated in terms of competencies. According to the person-centered approach, the methods of Computer Sciences learning, forms of organization of educational activities of students and mobile learning tools are selected. In accordance with the principles of the system approach, the components of the block form a subsystem of the methodical system of learning Computer Sciences, which is a part of the training of Engineers-pedagogues in computer technologies. This, in turn, requires taking into account the principles of vocational education, general and specific learning principles (in particular, the principles of mobile learning and the principles of Computer Science learning).

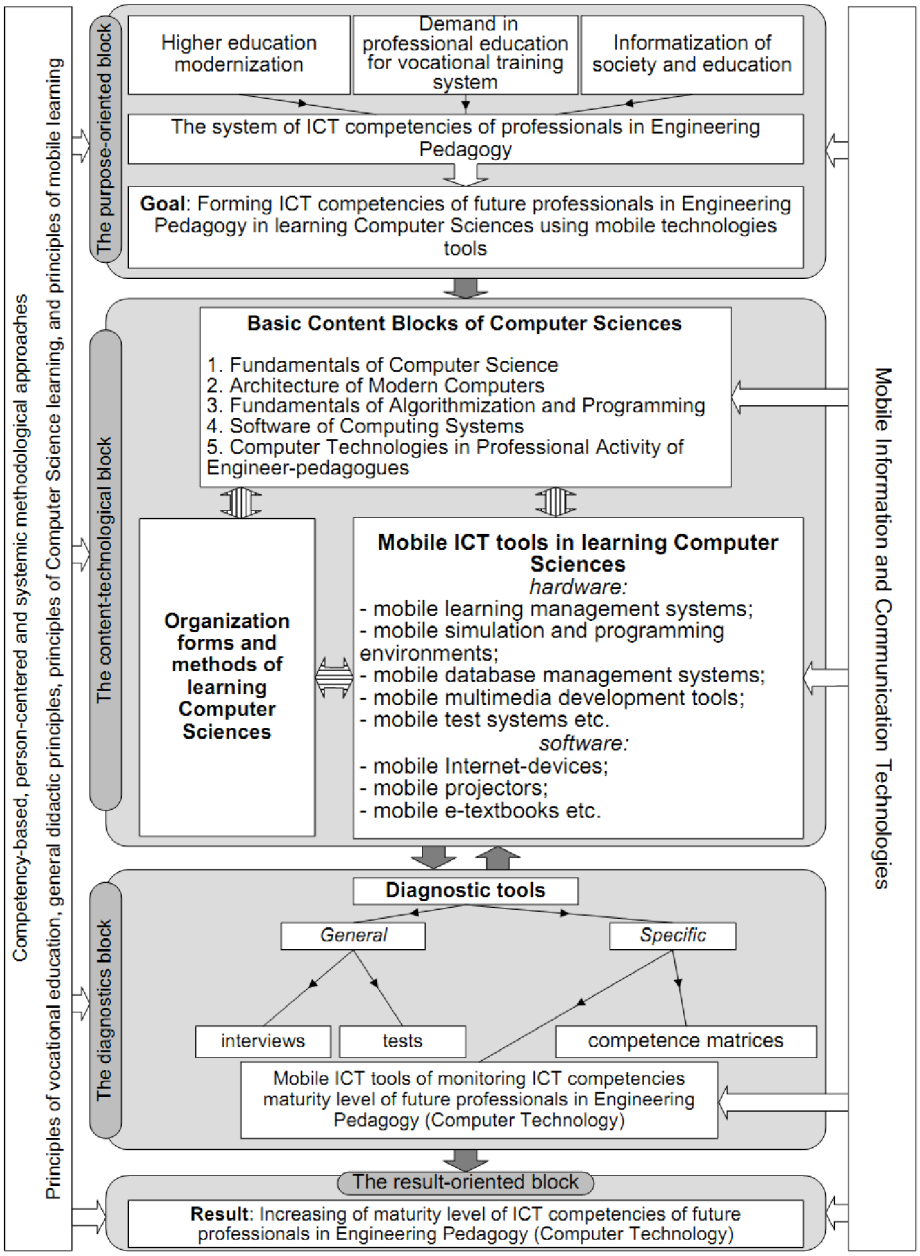

Fig. 1. Model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy

The diagnostic block has not only direct connection, but also feedback with the content-technological block: being structurally isolated, it is procedurally implemented with it

– monitoring and diagnostics of the level maturity of ICT competencies of future Engineers-pedagogues in computer technology is necessary for correction of technological components of learning during the implementation of learning content. The competency-based approach and mobile ICT have a special influence to this block. Both, they determine the leading diagnostic tools of the level of ICT competencies formation – competence matrices for monitoring students' educational activities.

The result-oriented block is totally influenced by all the methodological approaches, principles and technologies shown on the model.

3 Objectives and content of learning Computer Sciences to future professionals in Engineering Pedagogy

The objectives of Computer Science education are determined by the specifics of its contribution in solving the main tasks of the general education of the person: the formation of the foundations of the scientific ideology, which lies in understanding of the modern world, changes of nature and content of human activity in accordance with the development of new information technologies; students' thinking development, in particular theoretical, creative and a new type of thinking (operational) while learning Computer Science using of computer technology; the students' training in practical activity and life-long learning. Since it is the study of Computer Science that influences the formation of computer literacy and information culture, which makes it possible for a person to exist in the modern information society [5, p. 268].

Thus, the general purpose of teaching Computer Sciences to future professionals in Engineering Pedagogy is to form their professional ICT competencies, which specify the requirements for knowledge and skills determining the learning content as pedagogically grounded, logically arranged and textually recorded in the curriculum scientific information on the material to be studied. They are presented in a summarized form and determine the content of educational activities of teachers and cognitive activity of students aiming at mastering of all components of the learning content on the relevant level.

The learning content includes:

- theoretical (fundamental) learning elements, which is a set of basic concepts of a specific subject area of knowledge and it's interconnections;
- problems, which are determined in accordance with the theoretical material and are intended to the development of specific skills and competencies for the relevant knowledge area;
- inter-subject and intra-subject interrelationships between educational elements [5, p. 156].

According to the model, the learning content of Computer Sciences consists of 5 main units:

1. *Fundamentals of Computer Science* are represented in courses:

- "Industrial training" (modules "Information: forms of data representation", "Solving systems of linear algebraic equations using the Jordan-Gauss method in the spreadsheet environment", "Matrix manipulation functions in spreadsheets", "Analysis of data and parameters selection in spreadsheets", "Development of the infological model and creation of the structure of the relational database");
- "Discrete programming" (modules "Sets", "Functions", "Combinatorics", "Propositional calculus", "Logic algebra", "Graphs");
- "Operations research" ("Optimization tasks: fundamental methods and algorithms. Convex optimization", "Linear programming", "Dynamic, discrete programming, maximum principle");
- "Data security in computer networks" (modules "Analysis of computer systems of data processing", "Symmetric cryptographic algorithms", "Cryptosystems");
- "Informatics and computer workshop" (modules "Informatics, information and information technologies", "Arithmetic basics of computing", "Logical fundamentals of computing");
- "Computer logic" ("Functions of the logic algebra: basic laws of the Boolean algebra, Boolean functions minimization, "Synthesis of combinational schemes in a given basis", "Abstract and structural synthesis of digital machines", "Synthesis of control devices", "Computer arithmetic");
- "Computer design, multimedia and Web-programming" (module "Mathematical fundamentals of computer graphics");
- "Database management systems" (module "The fundamentals of databases and knowledge bases");
- "Theory of automatic control" (modules "General characteristics of the concepts of the theory of automatic control", "Stability and quality of continuous linear automatic systems", "Correction of automatic systems", "Stability and quality of linear pulsed systems", "Stability and quality of nonlinear systems").

2. *Architecture of Modern Computers* is represented in:

- "Industrial training" (modules "Computer system building", "Computer architecture and principles of functioning", "Basic input/output system");
- "Computer elements and devices" (modules "Basic system devices of personal computers", "I/O devices, information storage", "Computer peripherals");
- "Data security in computer networks" (modules "Data backup devices");
- "Informatics and computer workshop" (module "PC hardware");
- "Computer networks" (modules "Basic information about computer networks and data transmission", "Standardization of networks and data transmission protocols", "Standard technologies and structural organization of networks");
- "Microprocessors and microprocessor systems" (modules "General concepts of microprocessor technology", "Types and structure of modern microprocessors", "Accompanying devices in microprocessor systems");
- "PC repair and modernization" (modules "PC components", "Peripheral devices, PC upgrades and repairs").

3. *Fundamentals of Algorithmization and Programming* are represented in courses:

- “Algorithmic programming” (modules “Introduction to algorithms development and coding in C ++”, “Windows programming”);
- “Informatics and computer workshop” (module “Algorithmization and programming fundamentals”);
- “Computer design and multimedia” (module “Visual programming in ActionScript”);
- “Microprocessors and microprocessor systems” (module “Basics of programming in Assembler”);
- “Applied and Web-programming” (modules “Applied programming in C++”, “Web-programming in JavaScript and PHP”);
- “Programming technologies” (modules “Methods and technology of data organization”, “Object-oriented programming”, “Software testing”, “Software design”, “Software documentation”).

4. *Software of Computing Systems* is represented in courses:

- “Automated organizational management systems” (module “The fundamentals of project management”);
- “Industrial training” (modules “Operating system concept”, “Shells”, “Applied software”, “Computer viruses and network defense”, “Text processing basics”, “Linguistic software”, “Spreadsheets basics”, “Presentations basics”, “Database management systems”, “Internet technologies”);
- “Computer elements and devices” (module “System and specific software”);
- “Data security in computer networks” (modules “Defense of computer systems for data processing”, “Data backup”, “Computer virus defense”, “Information security systems in computer networks”, “Defense methods for network traffic”, “Tools of distributing access to information resources”);
- “Engineering and computer graphics” (module “Graphics editor”);
- “Internet technologies” (modules “Internet fundamentals”, “Internet services”);
- “Informatics and computer workshop” (module “Operating systems”, “PC software”);
- “Computer documentation management” (module “Documentation management systems”);
- “Computer design and multimedia” (modules “Raster graphics editors”, “Vector graphics editors”, “Creation of typical graphic elements for website design”, “Creation of realistic animated 3D-objects”);
- “Computer design, multimedia and Web-programming” (modules “Graphic software”, “Publishing software”);
- “Fundamentals of complex systems automated design” (modules “Fundamentals of software design”, “Diagram technology”, “Design methodologies and technologies”);
- “Applied and Web-programming” (module “Database development based MySQL server”);
- “Database management systems” (module “Relational database design”);
- “System programming” (modules “Introduction to system programming”, “Computer resources management”).

5. *Computer Technologies in the Professional Activity of Engineer-pedagogues* are represented in courses:

- "Automated organizational management systems" (module "Management of pedagogical projects");
- "Production training" (modules "Keyboard simulators");
- "IT ergonomics" (modules "Fundamentals of human-machine systems ergonomic", "IT influence on human health");
- "Engineering and computer graphics" (module "Professional work in 2D- and 3D-graphics systems");
- "Computer documentation management" (module "Electronic educational resources development");
- "Computer design and multimedia" (module "Computer games development with Unity");
- "Computer design, multimedia and Web-programming" (modules "Computer graphics in the art and business", "Computer graphics in the science and industry");
- "Computer technologies in education" (modules "Theoretical fundamentals of ICT of learning", "ICT implementation at learning", "Methodical fundamentals of ICT of learning", "Prospects for the development of the ICT tools use in the education");
- "Technical learning tools" (modules "Psychological and pedagogical basis of use of technical learning tools", "Modern technical learning tools", "Methodic of technical learning tools application");
- "Educational internship" (modules "Modern methods and organization forms of future professional activity", "Scientific and organizational work in the team and adaptation to the specialty");
- "Technological internship" (modules "Hardware and system software", "Applied software", "Data processing in information systems", "Design of text documents using modern word processors", "Operations of data processing technological process".

4 Conclusions

The developed model of use of mobile ICT in learning Computer Sciences to future professionals in Engineering Pedagogy comprises four blocks:

- the purpose-oriented block includes factors of changes in learning computer technologies to professionals in Engineering Pedagogy (higher education modernization, the demand in professional education for vocational training system, informatization of society and education). They determines the system of ICT competencies of professionals in Engineering Pedagogy, which is aimed at forming ICT competencies of future professionals in Engineering Pedagogy while learning Computer Sciences using mobile ICT;
- the content-technological block determines interrelated content blocks of Computer Sciences ("Fundamentals of Computer Science", "Architecture of Modern Comput-

ers", "Fundamentals of Algorithmization and Programming", "Software of Computing Systems", "Computer Technologies in Professional Activity of Engineer-pedagogues"), mobile ICT tools in learning Computer Sciences (hardware and software), organization forms and methods of learning Computer Sciences;

- the diagnostics block determines general (interviews, tests) and specific tools (competence matrices, mobile ICT tools of monitoring ICT competencies maturity of future professionals in Engineering Pedagogy (Computer Technology)) of monitoring and diagnosing ICT competencies formation;
- the result-oriented block determines the forecasting result of the model realization implying the increased maturity level of Engineer-pedagogues' ICT competencies. All blocks of the model are connected with each other both directly and through their components.

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