

# III. THEORETICAL, METHODOLOGICAL AND PRACTICAL ASPECTS OF DISTANCE LEARNING

## FORMATION OF ICT COMPETENCES THROUGH THE SYSTEM OF COMPETENCY TASKS: FROM IDEA TO PRACTICAL IMPLEMENTATION

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***Abstract.** The approaches to the organization of the educational process aimed at the formation of the ICT competence and development of life competencies at different levels of education - from primary school to the first year at the universities are discovered in the article. As an example of instrument for the proposed approach the system of competency task that provides content, technological, structural, active and instrumental component is proposed. The results of approbation of the proposed system show a positive trend of forming students' soft skills.*

**Keywords:** ICT competence, competency tasks, level of competency tasks, model of competency task.

## INTRODUCTION

Social and technological changes are a sign of the 21st century; they are causing a change of paradigms (Kuhn 1962), including in the field of education. Today the paradigm of “education for life” has changed to “lifelong learning”, and accordingly the main elements of the education system have also changed.

Modern requirements to a specialist (Future Work Skills 2011) formed under the influence of the situation on the labour market, accelerating the pace of development of society and the widespread of information, cause replacement of authoritarian and reproductive education oriented at obtaining knowledge by the system of productive collaboration and communication, including networks, for development and production of new (objective or subjective) knowledge.

Competence-based approach is interpreted as one that not only affects the structure of knowledge, but also the quality of education in general (Korzhova 2012). Taking into account the fact that the quality of specialist training largely depends on the ability and willingness to use ICT to obtain the necessary knowledge and producing new knowledge, ICT competence is regarded by scientists as a key (Golovan 2007). International organizations that are currently working in the field of education, in recent decades have been studying the problems associated with the emergence of a competence-based education; among them are UNESCO (UNESCO Recommendation 2013), UNICEF, UNDP, Council of Europe, European Commission, Organization for Economic Cooperation and Development (OECD), the International Standards Department and others. The issues of implementation of the competence-based approach in the education system and the formation of information competencies (Zymnaya 2012, Morze 2008, Morze 2011, Ovcharuk 2013, Ovcharuk 2015, Pometun 2004, Smyrnova-Trybulska 2007, Spirin 2009, Khutorskyi 2005, Hansen 2015 and others) are discovered in a significant number of scientific publications.

However, the need to develop a system to support a process of acquiring ICT competences by the subjects of educational process (pupils, students, teachers, coaches), including forming a system of competency tasks and methods of their use in the learning process, does not lose the relevance.

*The purpose* of this article is to analyze the approaches to the development of ICT competence through competency tasks and to propose an example of their implementation in the process of comprehensive study of computer science.

## 1. ICT COMPETENCE AND APPROACHES TO CREATION OF COMPETENCY TASKS.

Scientists distinguish substantive and key ICT competence. Key information and communication competence is an ability to use effectively ICT in teaching, research and daily activities for solving information and professional problems. Subject ICT competence is determined as an ability of a pupil (student) to apply in a particular life, educational and research situation, including problematic, acquired knowledge, abilities, skills, ways of working for selection of appropriate ICT and their usage for searching the necessary data, analysis, organization, conversion, storage, transmission of ethical and legal norms and solving problems in subject area.

Formation of ICT competencies involves the development of universal critical thinking skills, including the ability to observe and make logical conclusions, using information models, to analyze the situation, to understand the overall content of the message and its hidden meaning. These competencies include the following components (skills and abilities):

- the ability to search, collect, create, organize electronic data, systematize received data and concepts, the ability to distinguish subjective from objective, real from virtual, relevant from irrelevant;
- to use the appropriate means (presentations, graphs, charts, maps, knowledge, social networks) for a comprehensive understanding and presentation of data;
- to search and find needed websites and to use Internet services like forums and e-mail, and services based on Web 2.0 technologies;
- to use information technology for critical reflection of what is happening, innovation in different contexts at home, at work (school, college) and leisure.

ICT competencies also include the following attitudes to ICT: habit to use ICT independently and while working in a team, the ability to determine the value of certain data and information; positive attitude to the rules of safe and responsible online experience, including personal issues and understanding of cultural differences between people; interest to expand the horizons of using ICT by participating in various communities, including cultural, social, etc. (Defining Key 21st Century Skills 2012).

In a process of learning computer science at school or disciplines of IT cycle at the university ICT competence is considered both as a subject and as a key.

General characteristics of the educational competence-based and authors' proposals for its support are given in Table 1.

**Table 1.****Scientific and technological matrix of support of a learning competence-based process**

<b>No</b>	<b>Technological component</b>	<b>Indicators</b>	<b>Scientific basis</b>
1.	Description of signs and the expected (target) level of competence in a determined subject area	Availability of educational standards, including standards for ICT competence, curriculum of the new model	Structure of the ICT Competency of teachers. (UNESCO Recommendation 2013)
2.	Determining the necessary and sufficient set of learning tasks, situations, the sequence of which is built according to the growth of completeness, problematic, specificity, innovation, vitality, practicality, creativity, reflection and self-examination, examination and decisions approval, necessity of combining fundamental and applied knowledge	System of competency tasks, availability of bank of tasks from various subject areas	System of training tasks D. Tolingerovoi (Tolingerova 1970)
3.	Technology of process, including the sequence of presenting s to students task and situations of different types and levels	Developed methodology of application of competency tasks in teaching a particular subject or integrated courses, practical training, organization of research activities, etc.	Taxonomy of educational objectives by B. Bloom
4.	Algorithms and heuristic schemes that organize pupils' (students') activities to overcome difficult situations	Developed criteria of evaluation both as the intended result, and the activities of its receipt; instructions on how to perform certain stages; examples and templates	The strategy of solving IT problems "big seven" (Burmakina 2007)
5.	Technology of guidance, counseling and support for pupils (students) in the process of performing a system tasks	Developed online system for support tasks performing and communication of subjects of educational process: students, teachers, external consultants	The concept of zone of proximal development (ZPD) by L.S. Vygotsky (Makarova 2012) Formation situation of success by Ermakov (Ermakov 2006)

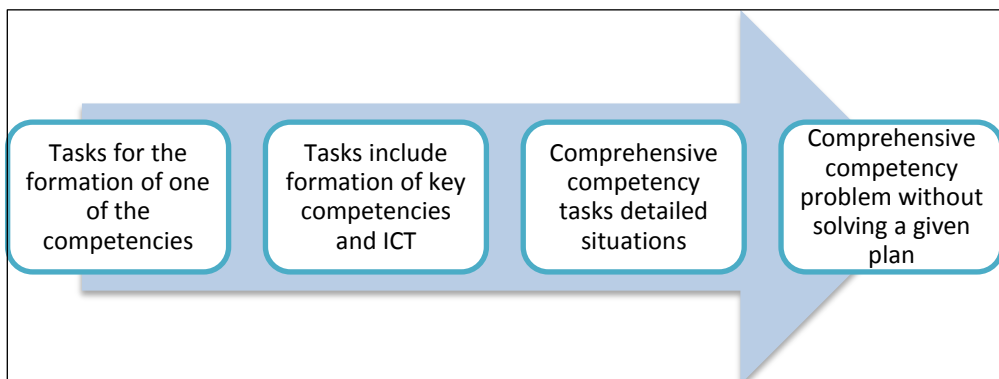
6. Technology of monitoring, evaluation and adjustment of the educational process	Developed checklists, control tasks, tools for evaluation and discussion, etc.	Information literacy indicators. UNESCO (Catts R & Lau J (2008))
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*Source: Own work*

Educational activities aimed at building ICT competence involves the development and use of competency problems for which it is mandatory to use modern ICT as a mean of solving, providing multi-level assistance and evaluation criteria both as a final result, and ways of its receiving (Kuzminska 2011). In general, the approach “from general to specific”, meaning from the formation of generalized patterns of intellectual activity to their usage in a specific subject matter, is a ground of a system of development competency tasks and in implemented in practice by applying project method, appropriate selected tasks, taxonomy of educational tasks based on theory of stage formation of mental actions (Morze, Kuzminska 2008).

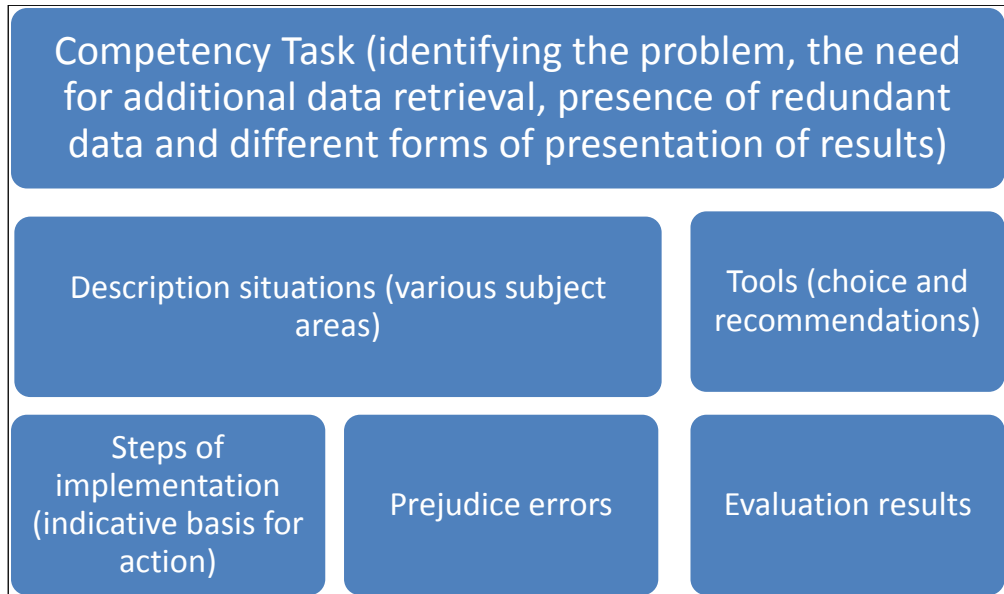
To form skills for solving competency tasks in the classroom it is useful to use the following tasks at various levels, from simple to complex, from the tasks aimed at the development of one of the competencies to integrated problems without a given plan of solving a problem (Figure 1).

Creation of integrated competency tasks that combine knowledge and activity components should include the following steps: description of the content of the problem situation based on previously learned knowledge or personal experience of students; formulation of requirements to determine initial and boundary conditions of the flow of learning activities; development of performance criteria for implementation of phases of the assignment and the resulting products of the students’ activities; development of assistance in the form of questions, tasks or exercises aimed at the specification of the content of the situation, specification of formulated requirements, updating of basic knowledge and intensification of the association and causal connections needed to find ways to solve the problem; development guidelines for quality performance of certain tasks (Figure 2).



**Figure 1. Usage of competency tasks to form competencies**

*Source: Own work*



**Figure 2. Model integrated competency task**

*Source: Own work*

In problems of this type direct product is a conscious assimilation of knowledge and skills to form a strategy for solving competency tasks, plan the process of solving, monitor its accuracy and efficiency, detect and correct errors. Depending on the degree of generalization these tasks can be divided into substantive, group (that provide pair or group interaction of students), interdisciplinary, fundamental. In these conditions pupils (students) exhibit intellectual activity and independence both in the process of solving, and evaluation (self-evaluation, mutual evaluation) of intellectual tasks and demonstrate the ability for goal-setting, evaluation, effective action and reflection.

To prepare pupils (students) for solving such tasks it is useful to use appropriate taxonomy of educational objectives by B. Bloom, implemented by means of selected learning tasks according to 6 categories of educational goals: knowledge, comprehension, application, analysis, synthesis, evaluation; organization of pupils' (students') activity; use of ICT (Figure 3).

To determine the semantic component we can use a system of learning tasks by D. Tolingerova (Tolingerova 1970) containing learning objectives in five categories, ranked in increasing cognitive complexity and operating values (Morze, Kuzminska 2011).

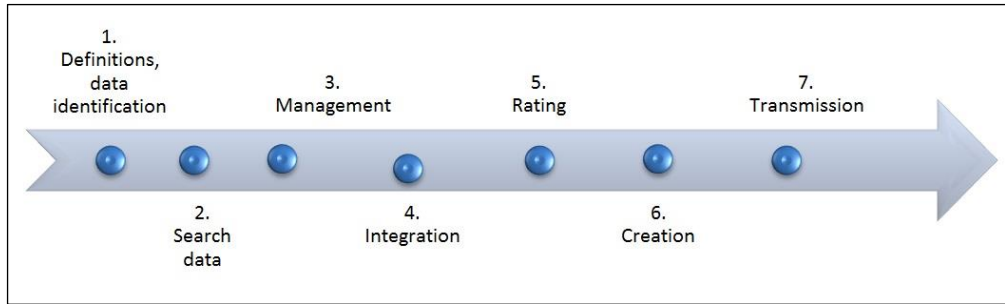


**Figure 3. Taxonomy of educational objectives by B. Bloom: setting activities and ICT-support**

Source: [online] at

<https://bloomstechtaxonomy.wikispaces.com/Bloom%27s+Digital+Taxonomy>

At the stage of designing the process of solving by pupils (students) of integrated competency tasks and formulating learning situations and guidelines, it is appropriate to discover a strategy for solving IT problems “big seven” (Burmakina 2007). This is a strategy of integration in systematic process focused on solving a wide range of practical tasks of universal skills of search and data processing by the means of modern ICT (Figure 4).



**Figure 4. Stages solving competency tasks**

*Source: Own work based on Ermakov 2006*

At the stage of monitoring the formation of competences in the process of creating and using competency tasks in the learning process it is also should be taken into account that in addition to the subject and ICT competence it is important to form life competencies that include: technology, communication, willingness to use information resources, self-study, problem solving and social interaction (Ermakov 2006).

## **2. COMPETENCE TASKS IN COMPUTER SCIENCE: PRACTICAL IMPLEMENTATION**

It is logical to anticipate that a significant role in the formation of a person as intelligent, mobile and competent subject is given to such educational discipline as computer science, as ICT competence today is invariant component: knowledge, skills and abilities relating to information and communication technology in everyday life do not depend on the content of the specialist's future professional activity. An exceptional role is played by science and education to prepare pupils (students) to continue their education and professional self-determination in terms of increasing demands for continual process and results of work in the information society.

However, data of monitoring study (the study was conducted in 2010 and included 1,200 students from all regions of Ukraine (Morze 2011)) on forming graduates' of secondary schools skills in using information and communication technologies (ICT) in practice showed that more than 50% of students do not have a formed ICT competence, relating to:

- *access to data and information*: they cannot exclude inappropriate and irrelevant information (53%);

- *evaluating the data*: they cannot correctly determine in the task incoming and outgoing data and its quantity (53, 5%); can't explain the criteria for selection of results (67.78%);



- *creation of data and information*: they cannot justify the selection of the form for presenting results (63, 39%); they do not know how to choose the right means of data for solving problem (79.61%); they do not understand the purpose of different types of diagrams, they cannot consciously choose the type of chart and argue their choice (60, 14%);

- *data management*: they are not able to submit data in visual form to perform comparisons (64.90%); they cannot take into account the features of the final destination of the document (56.93%);

- *notification of data and information*: they cannot summarize correctly and logically express conclusions on the results obtained (71.53%); they cannot substantiate its findings (62.41%); they do not know how to structure a document created in order to enhance the credibility of findings (66.41%); they are not able to issue their opinion correctly, to build sentences properly (59.12%);

- *integration of data*: they do not have developed critical thinking (68.03%).

In connection to this in 2010-2015 the authors have conducted a study of the effectiveness of the competency approach in teaching computer science in schools of Ukraine and in cycle of disciplines in higher educational institutions, including “Methods of teaching science” (<http://elr.tnpu.edu.ua/>) (Ternopil National Pedagogical University); “Information technologies” (<http://elearn.nubip.edu.ua/course/view.php?id=232>), “Methods of teaching disciplines of IT cycle, <http://human.nauu.kiev.ua/course/view.php?id=242>” (NUBiP Ukraine), “Information education technology” (Borys Grinchenko Kyiv University).

Experiment distribution on higher educational institutions was caused by the survey (conducted by the authors in 2012-2014) of the first year students of these universities (the survey covered 350 students from different fields: computer science, social pedagogy, informatics), namely: DPA in computer science at school made up less than 5% (in Ukraine this examination is selective), competency tasks at computer science lessons were solved no more than by 3% of students, feel the practical significance of learning outcomes of teaching computer science at school - 34%. The results of the input testing of teaching disciplines of IT cycle that was based on the tasks of a state final certification, do not significantly differ from the results of the monitoring on forming the graduates’ of secondary schools skills in using information and communication technologies (ICT) in practice.

As a result of the research a system of competency tasks to implement comprehensive study of computer science and a teaching support were created:

- Textbooks on computer science (publishing house *Osvita*);
- Copybooks to test competencies (publishing house *Osvita*);
- Blogs of methodological support (eg <http://inf5-m.blogspot.com/>)
- Collections for the state final certification in computer science (Center of educational literature 2014);

• E-learning courses to support teaching disciplines of IT cycle and methods of their teaching in universities (e.g. <http://elearn.nubip.edu.ua/course/view.php?id=232>).

The special features of formulation of various levels of competency tasks include the following:

• Computer science (3-6 grades): *aim*: formation of ICT competencies (propaedeutics); *instruments*: proposed by the program learning environment; *assistance*: tips and examples of implementation;

• Computer science (7-9 grades): *aim*: formation of ICT competencies; *instruments*: multiple, base - proposed by the program learning environment; *assistance*: different options, tips, suggestions to justify the choice;

• Computer science (State final examination, 9, 11 grades): *aim*: measurement the level of ICT competencies; *instruments*: student chooses the environment; *assistance*: evaluation criteria;

• Information technology (the subjects are taught in high schools): *aim*: creation and measurement of the level of ICT competence as a subject and key; *instruments*: student chooses the environment, the use of a wide range of tools for starting cooperation, communication and dissemination of the results; *assistance*: motivational articles, videos, etc. that encourage to develop new technologies and tools, evaluation criteria, experts examination.

In a current program in computer science (<http://www.mon.gov.ua/activity/education/zagalna-serednya/navchalni-programy.html>) the school provides a solution to problems of competence, ranging from the 7<sup>th</sup> grade. Thus a teacher can choose one of two approaches:

1) competency tasks are solved with one block at the end of the course in Computer science for 7 grade;

2) while training in computer science the additional lesson for generalization and systematization of each topic where students solve competency tasks appears.

However, it is recommended to use propaedeutics of solving competency tasks from 3-6 grades. For this purpose the following models of their usage are proposed:

- at the lesson as a comprehensive task over a series of lessons
- at the reserve lessons as a lesson of generalization and systematization;
- as integrated practical task for domestic implementation with the current discussion and consulting by a teacher;
- as a task to organize practical training, summer camps, extracurricular activities.

Specificity of disciplines of information technology cycle (for example, <http://elearn.nubip.edu.ua/course/view.php?id=232> ) involves

determining of ICT competence as a subject and a key. The level of a subject competence is determined by testing students and laboratory work according to the curriculum. As a key ICT competence is the ability to use effectively ICT in teaching, research, professional and daily activities, to assess the level usage of competency tasks (individual work) and educational projects (group work). In addition, competency tasks are used to organize practice and independent work of students (Morze, Kuzminska 2013).

The structure of competence tasks is also different. Solving of competency tasks offered to pupils of the 3-7 grades, is based on the method of selected tasks. In accordance to this method, the task is divided into subtasks-situations that specify the principal, giving a pupil the plan for solving the problem and pointing to the development of pupil's readiness to apply the acquired knowledge and skills in a new situation close to normal living environment. Each of the proposed situations revealed in tasks that serve as the oriented basis of actions, tips to direct a pupil to the area of actual performance. For this we can offer both tests to choose one correct answer, multiple choice answers, sequencing, matching, classification etc. and tasks designed to use various computer applications and information technology.

For example, when teaching computer science in the 5th grade in a chapter "Computer Basics" we offer such a task: "Lena is a 5<sup>th</sup> grade pupil. Her grandmother decided to buy a computer and learn to work with it. Help her to do this" and details:

*Situation 1.* In a store grandmother saw various devices and now wants to determine what computers are and which one she should choose. Help her to understand what devices are computers and how they are called.

*Situation 2.* Grandmother decided to choose a stationary computer, but does not know what input and output devices will be necessary for work. She plans to store favorite recipes in the computer, view photos and videos, listen to audio books, communicate with her relatives and is not going to play computer games. Help her to choose the required input and output devices.

*Situation 3.* After buying the computer grandmother turned it on and saw various objects on the desktop. Lena explained to her that many programs have been installed. Without programs you cannot do anything on your computer and for downloading the needed program you can use the main menu or program icons on the desktop. Grandmother wants to use the calculator to calculate the cost of purchases. Help her.

*Situation 4.* Lena created on the desktop of her grandmother's computer folder Photos where she saved in different folders photos from the first ball, the New Year and birthday party. Help grandmother to learn how to view the contents of folders that contain pictures.

*Situation 5.* For a long time grandmother is looking at the keyboard trying to find needed letters and numbers when writing a text. Advise her how to learn to enter quickly any characters from the keyboard.

In tasks proposed for use in state final certification in computer science at school and in training the relevant disciplines in universities the detailed tasks are absent, but they would enhance the semantic direction of the formation of professional competencies, self-conscious and social interaction.

For example, the task *“Choice of profession”*. After reading the study of labour market of IT professionals (e.g., according to LuxoftPersonnel), you decide to make a spreadsheet to track changes in the market of IT professionals with time. Develop a table structure independently. Analyze the dynamics of vacancies in information technology, particularly in Ukraine, determine which programming languages you need to know to be a competitive software developer and look for proposals (sites of training agencies and centers) of training in the field of a web developer and developer of Java Net projects. Express assumptions about the prospects for certain IT fields. Post your results in a convenient form for analysis and comments.

As in the study of the concept of competence much attention is paid to the readiness for entry into individual components and involvement in the formation process (Ermakov 2006), in addition to evaluation of the graduates’ ICT competences (according to the requirements of the curriculum) and students’ (in accordance to developed universities standards on ICT competence, for example, <http://moodle.nauu.kiev.ua/mod/lesson/view.php?id=421>), students of various disciplines were offered tools for self-assessment of their acquisition of life competencies by Ermakov.

Reflections after the course “Information Technology”, during which the students were offered competency tasks and methods of their solving, showed a significant increase of students’ skills classified as «soft skills»:

- the ability to manage their time, set goals, prioritize - 35%;
- to use modern IT technology to solve problems and solving tasks - 39%;
- communication skills, teamwork - 27%;
- leadership - by 23%;
- the ability to present their ideas and results - 32%;
- skills to manage the project - 25%;
- cognitive skills, creative thinking - by 32%.

## CONCLUSIONS

The received results allow for making a conclusion about a need to include a module of solving competency tasks in a cycle of training of future teachers in order to develop their ICT and life competencies that are needed for a specialist today.

However, analysis of educational training programs revealed insufficient attention to the formation of the ICT competency of teachers - usually teachers attend in-service

courses for increasing the level of subject competence. Development of curriculums, training and technical support of the formation of the ICT competence and development of soft skills is a subject of further authors' research.

The specifics of computer science as a science and spheres of human activity is that it provides with its methods, tools, technologies other branches of knowledge, cognitive and practical human activity. Skills and abilities that are formed while learning science at school and subjects of information technology cycle at the university, in modern conditions are generally academic, general intellectual and can be transferred to the study of other subjects in order to create integrated information space of knowledge of pupils (students) and the formation of key competencies according to the social order of the information society.

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