

Continuous Development of Information and Communication Competence of a Biology Teacher as an Improvement Factor of Overall Professional Competence

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Abstract: This study deals with the concept of information and communication competency of a biology teacher that is connected with the introduction methods and means of Information and Communication Technologies (ICT) into the education system. We have considered prerequisites essential for improvement of quality of continuing professional pedagogical education with the ICT implementation. We determined those competences a biology teacher must possess in a modern education system. Since, an effective and efficient form of developing the ICT competence in future teachers of biology is the study of special disciplines, this study deals with the program of educational discipline “Application of information and communication technologies in the teaching of biology” which is designed to train future teachers of biology and to improve skills of present ones.

Key words: Professional standard for teachers, ICT competence of a biology teacher, information and communication technology of education

INTRODUCTION

The concept of the professional standard for teachers, adopted by the Order of the Ministry of Labor of Russia No 544n of October 18, 2013 “On approval of the professional standard “Teacher (pedagogical activity in preschool, primary general, basic general and secondary education), (tutor, teacher)” specifies the following: “Teacher is a key figure in the education reforming. “Nothing can be improved in overall training and education if leaving out the teachers” (Ushinskii). The main professional quality a teacher must constantly demonstrate to students in our rapidly changing, open world is the ability to study. Willingness to changes, mobility, the ability to unconventional labor actions, responsibility and independence in the decision-making are characteristics of successful professional activities fully applicable to a teacher. It turns to be impossible to acquire these valuable qualities without expanding a space for pedagogical creativity”.

Important but fragmentary elements of the ICT competence of a teacher are a part of the qualification

requirements adopted at the end of the 2000s. The Russian school in general has rapidly developed in the computerization of all processes, becoming digital.

Most teachers use computers for text writing and cell phones to send short messages. Teachers use multimedia projector in their speeches, task their students to find information in the internet, send out information to parents via E-mail, etc.

Many regions of Russia have allowed or specified using electronic journals and school diaries that help the educational process to immerse partially into the Information Environment (IE). Deeper immersion (implying the hosting of basic information of the educational process in the IE) provides additional educational opportunities; having these opportunities is the basic element of pedagogical ICT competence, along with the ability to type professionally the text and to formulate a request for searching on the internet.

Federal state educational standards for all levels of Russian education involve ICT professional competence of a teacher in particular, IE operating skills as the requirement for the educational process. Experience in

training the biology teachers for working under the implementation of the federal state educational standards for general education shows the reality of formation of professional ICT competence in the absolute majority of teachers. The professional ICT competence of a teacher means in this case the expert use of ICT tools, common for this professional field in the developed countries in solving professional problems (Iamburg, 2014). The professional ICT competence involves:

- All-user ICT competence
- All-pedagogical ICT competence
- Subject-pedagogical ICT competence (reflecting the professional ICT competence of the corresponding area of human activity)

Each of these components includes ICT qualification consisting in the corresponding ability to use ICT resources (Table 1).

Whereas the graduates of pedagogical universities must meet the requirements of professional teaching standards, the system of higher pedagogical education should meet its requirements at all levels starting from the fundamental (technical, first of all) training, going through special professional training towards the continuing professional pedagogic education throughout all life.

Analysis of recent research and publications has shown that the training of highly skilled teachers of biology requires changing methodology of teaching,

namely to implement innovative information and communication technology in addition to the means of education organization and support. Scientists of international organizations such as UNESCO, UNO, European Union, Council of Europe, etc. continuously study the ways of developing and implementing the ICT in the education system (Anonymous, 2008). This problem is discussed in the researches by S. Papert, M. Reznik (USA); E. Patarakin, E. Polat, A. Khutorskoi, B. Iarmakhov, O. Iastrebtsev (Russia); V. Bykov, M. Zhaldak, M. Zgurovskii, V. Kukharensko, V. Lapinskii, N. Morze, A. Pilipchuk, S. Rakovai, S. Semerikov, E. Slovak, A. Striuk, M. Shishkina (Ukraine) and researchers from other countries. The problem of implementing the ICT in the process of studying the fundamental disciplines was studied by K. Vlasenko, V. Shred, T. Krylova, T. Maximova, I. Reutova, N. Rashevskaya, Iu. Trius and other domestic researchers. At the same time, the problem of continuous development of information and communication competence of biology teachers remains understudied.

Given the above stated, the objective of this paper is to analyze the component of ICT competence of the graduates in pedagogy and the present teachers of biology under the implementation of the professional teaching standard as well as the rationale for choosing any technologies for the continuous development of the ICT competence of the teacher of biology.

Table 1: Components of ICT competence of a biology teacher

All-user component	All-pedagogical component	Subject-pedagogical component
Using methods and complying with the rules of starting, suspending, continuing and completing the work with ICT, troubleshooting, providing the consumables as well as the rules of ergonomics, safety rules and other issues included in the results of ICT mastering at primary schools	Educational activity in the Information Environment (IE) and its constant representation in the IE in line with the tasks of planning and objective analysis of the educational process	Evaluation of the quality of digital educational resources in relation to the specified educational objectives of their use
Complying with ethical and legal norms of the use of ICT (including the impermissibility of unauthorized use and intrusion of information)	Arrangement of educational process: giving tasks to pupils, checking their tasks before the next lesson; reviewing and fixing the intermediate and final results; drafting and annotating the personal and pupils' portfolio; remotely consulting the pupils in the performance of tasks; supporting the interaction between the pupils and their tutors	Consideration of public information space in particular the youth one
Audio and video registration of the processes occurring in the world and in the education.	Preparation and carrying out of various presentations, discussions, consultations with electronic support, including the telecommunication environment	Support for the development and use of all-user component in the learning process of pupils
Keyboard typing	Arrangement and carrying out of the group (including interschool) activity in the telecommunication environment	Arrangement of health monitoring process by the pupils
Audio, video and text communication (intercommunication, conference, instant and delayed messages, automated text correction and language translation)	The use of the activity design tools (including group activities), visualization of roles and events	Arrangement and conducting of experiments in virtual labs at the biology lessons
Skills in searching on the internet and databases	Visual communication-the use of visual objects, including conceptual, organizational, etc. (diagrams, video editing) in the communication process	Acquisition of an array of numeric data by means of automatic reading of the video image map from the digital measuring devices (sensors), subsequent measurements and accumulation of experimental data
The systematic use of existing skills in everyday life and professional context.	Prediction, design and relative evaluation of individual progress of each pupil based on the current state, personal characteristics, history and previously collected statistical information on different pupils	Processing of numerical data using the electronic statistics and visualization instruments
		Identification of objects on the maps and satellite images, setting of maps and images
		The use and updating of digital identifiers
		Knowledge of qualitative sources of information in Biology
		Teacher's assistance in the implementation of all elements of the subject-pedagogical component of Biology in the learning process of the pupils

MATERIALS AND METHODS

Technique: Writing this study, we applied theoretical and empirical methods of studying and analyzing the psycho-pedagogical and methodological literature, theoretical sources considering the implementation of ICT in the learning process; studying the regulatory and methodological documentation and the educational experience; observing the learning process; testing; and surveying.

RESULTS AND DISCUSSION

Results of the study conducted by Barber and Mourshed (2008) show that ICT competence of a teacher is one of the key components of qualitative education.

According to leading domestic and foreign scientists (A.A. Kuznetsov, V.V. Kraevskii, O.E. Lebedev, J. Raven, A.L. Semenov, etc.), it leads to an increase in the significance of the ICT competence of teachers carrying out their professional activity amid extensive implementation of information and communication technologies in the educational environment of the school. The future of the whole world society depends, largely, on how well the teaching staff will be trained and how fluently they will apply the means of information and communication technologies in the educational process (Peksheva, 2008).

The scientific literature has quite a lot of definitions of the term “information competence”. Each of them, depending on the field of scientific knowledge, accentuates a certain aspect of this type of competence. In particular, the study by Zaitseva (2002) explains information competence as a complex, individually psychological education based on the integration of theoretical knowledge and practical skills in the field of innovative technologies and the specific set of personality traits. Semenov (2000) defines information competence as a new literacy which includes the ability to perform active and independent human information processing, to make fundamentally new solutions in emergencies using different technological tools. Peksheva (2008) defines information competence as “a set of skills in obtaining and processing information”. Trishina (2005) considers information competence as “an integrative quality of a personality which is the reflection of processes of selection, assimilation and processing of information and its generation and transformation into a particular type of subject-specific knowledge which allows to develop, make, predict and implement the optimum solutions in various activities”. Gritskov *et al.* (2008) believe that the information competence is a

“possession of new information technologies, understanding of the range of their application in the educational process, as well as a critical attitude towards the distributed information”.

Many international organizations have already identified their aims of integrating the ICTs in the educational process as well as developed norms and standards for teachers to use the appropriate tools. Currently, there is an interaction of several factors which, therefore, greatly requires from teachers to have practical ICT skills specified by UNESCO and the International Society for Technologies in Education (ISTE). These factors include the growing need in mastering new skills related to information, technological and visual literacy, the understanding of that the students have changed, while the educational practices haven't as well as the awareness of current worldwide demand for students who can eventually become qualified specialists and successfully integrate into the economic system.

The existence of norms and standards for ICT competence of teachers itself is inadequate to effect the necessary changes. The most important element in the transformation of schools and the effective use of ICT is the training and continuous professional development of teachers.

Numerous studies in this field clearly indicate that a high-quality advanced training of teachers which unfortunately is neglected in the context of efforts made to reform the education system, plays a crucial role, among other factors. Meanwhile, it is the lack of effective professional development of pedagogical staff that is often considered the main reason for the gap between what students can potentially achieve and the reality they usually face in their learning process all over the world.

Ensuring professional training of teachers prior to the implementation of ICTs at schools is an important element of the systematic approach. Teachers not confident in their ability to effectively use computers in the work with their students will try to avoid using them. There are many examples when portable classrooms gather dust in school cabinets. The challenge of modern educational systems is to give confidence to teachers in using modern equipment at schools rather than to change their mentality. Modern society is centered on the use of information and knowledge. Today, ignoring the ubiquitousness of media, various forms of information and communication technologies and their impact on our private, economic, political and social life is impossible. Therefore, active and successful participation in the information society requires new types of competencies (knowledge, skills and attitudes).

It is impossible to overestimate the importance of skills in counting, reading and writing, however, the inclusion of information competence into the set of key professional competencies of teachers means that both a teacher and a student today have to understand the functions of media and other information providers (for example, libraries which media resources are the books) to be able to seek, evaluate, use and generate information to achieve their personal, social, occupational and educational goals. Research in information competence of modern pupils have shown that students have difficulties in assessing the data reliability even in the educational environment, although, it is believed that young people usually have the technological skills and consequently, the media and information literacy better developed than the older generation.

Mastering the information competence opens to teachers and students a wide range of possibilities that enrich the educational environment and make the teaching-learning process more dynamic.

According to the researchers of the UNESCO Institute for Information Technologies in Education, information competence is a set of competencies required to obtain, understand, assess, adapt, generate, store and present the information used for problem analysis and decision-making. People with information competence have the following basic skills: critical thinking, the ability to analyze information and use it for self-expression, aptitude for independent learning and information generation, willingness to be an aware citizen and professional to participate in government activities and democratic processes in the society.

One of the main trends that determine the requirements for the level of ICT competence of the modern teacher is a shift focus from the technological aspects of problems (relating to practical skills in using specific tools and specific program products) to the pedagogical ones. In addition to the basic values and

concepts of the system, the Federal State Educational Standard of general education (FSES) determines the key objectives that ensure the formation of universal learning activities meeting the requirements of this standard to the educational results. These include also the FSES specified requirements for the qualification of teachers. Schools have taken responsibility for the implementation of these FSES requirements for both the formation of information and educational environment of schools and the organization of training the teachers to actively use the resources of this environment. Information educational environment must include electronic educational resources, electronic diary and journal, school site, an environment for electronic portfolios of pupils and teachers, etc.

ICT competence system of the future teacher of biology is based on the requirements of the program of "ICT application in Biology teaching process" designed for undergraduates of pedagogical education with a degree in Biology and Chemistry. This program defines the content, scope and level of professional training. Purpose of the discipline is to form a competence of modern biology teacher in providing an information basis of activity. Features of mastering this discipline, specification and detailing should be based on the specifics of the professional activity of the future graduates. Therefore, it is better identify the required training level of ICT competence of the biology teacher through the prism of his/her professional activity. For this purpose, we have analyzed the content of the required ICT training of the future biology teacher in terms of the professional standard, appropriate labor actions and functions and knowledge which mastering promotes teachers of biology to use information technologies (Table 2).

The feature of studying this discipline is that its importance is integrative, since it is based on knowledge gained by students upon studying other disciplines of

Table 2: Trainee's competences developed upon mastering a discipline
As a result of mastering the discipline "ICTs Application in teaching Biology"

The student must be able to	The student must have skills in
Use the ICTs to improve educational process at schools	Using an interactive whiteboard at the lessons in Biology
Organize a professional diagnosis of students with the use of computers	Electronic educational technologies and their use in the learning process
Organize the project and research activity of students with the use of ICTs	Preparing the didactic materials and working papers which will help to schedule and organize the integrated use of ICT at the biology lessons and integrated courses
Design a lesson in the information educational environment	Modern methods and techniques of equipping the educational process
Organize educational computer simulations of students	Using several different mobile computers at the biology lessons
Choose training tools for the implementation of new learning activities (electronic educational resources, educational online resources, computer equipment such as interactive whiteboard, interactive tablets, telecommunication facilities, etc.)	
Use interactive models, virtual laboratories, integrated environment for frontal, individual and group work with pupils	
Use remote resources for doing a homework	
Prepare tasks and tests in electronic form or with the use of IE tools	

professional training; at the same time, there is a further update of this knowledge, a promotion of a stable relation between the knowledge acquired from different subjects.

According to the studies of self-assessment of ICT competence of future biology teachers which involved the undergraduates of Kazan (Volga region) Federal University as well as 1776 teachers in biology from 54 regions of the Russian Federation, the teachers realize more and more the benefits of a competent and effective use of modern information and communication technologies in general education. Total 79% of the respondents apply systematically their present ICT skills in everyday life and professional context. However, only 50% of the respondents both carry out their pedagogic activity and display it constantly in the information environment. Unfortunately, we have to admit the fact that the respondents understand the ICT-based organization of educational process in quite different manner.

By the organization of ICT-based educational process, the respondents mean (Fig. 1):

- Developing the tasks for students/pupils and using them during the lesson (Idea 1)
- Checking the tasks done by students/pupils (Idea 2)
- Consolidating the intermediate and final results (Idea 3)
- Preparing an annotated electronic portfolio of a student (Idea 4)
- Preparing an own annotated electronic portfolio (Idea 5)
- Remote counselling (Idea 6)

According to our respondents, the following factors ensure teachers to achieve their ICT competence (Fig. 2):

- Factor 1; the availability of a sufficient technological base
- Factor 2; the availability of broadband internet
- Factor 3; anytime access to a mobile computer
- Factor 4; tools of information environment installed in the educational organization
- Factor 5; the teacher's need to improve his/her ICT competence
- Factor 6; instruction set by the administration of an educational organization
- Factor 7; the adoption of local regulations on the work of an educational organization in the IE
- Factor 8; initial introduction of a teacher into the basic ICT competence in the advanced training system

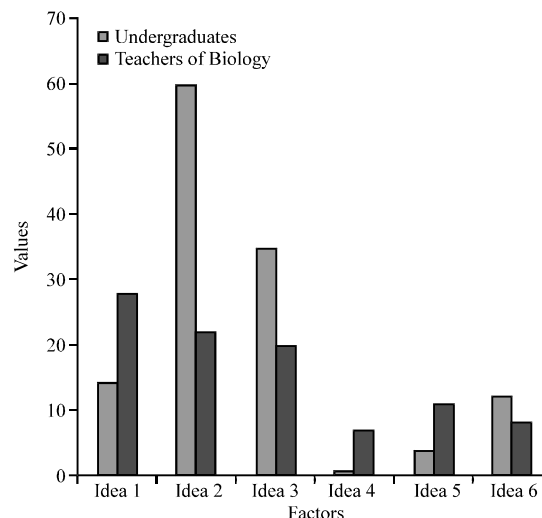


Fig. 1: Analysis of ideas about the organization of ICT-based educational process

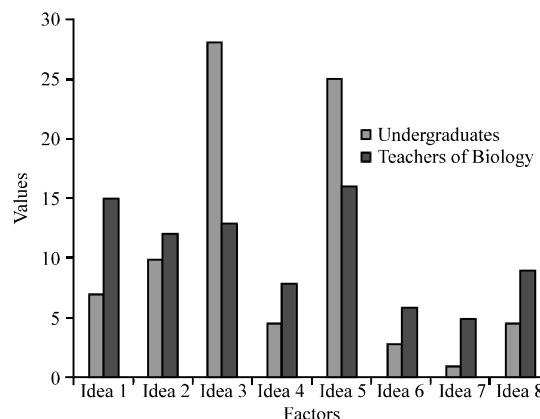


Fig. 2: Analysis of the factors ensuring the achievement of the professional ICT competence by a Biology teacher

We should note a change in the motivation of the biology teachers for using ICTs. Today, a teacher tries to look less archaic as compared with the student wants to be more mobile and interesting to a student. This follows from the answers of the teachers surveyed:

- We must be aware of the innovations, move with the time to be interesting to students
- Teachers must be the best for their students, they must be good psychologists, not to stand with a rag and chalk at the blackboard but to be near the interactive whiteboard, use the Internet and digital resources
- I can operate with larger amount of information, talk one language with children

Table 3: Estimate of ICT competence of a teacher by the pupils

Estimate of ICT competence of a teacher	Response rate
-1.6	0
-1.4	0
-1.2	0
1.0	18%
1.2	32%
1.4	24%
1.6	26%

- ICTs help me to become more mobile
- A teacher is changing!

We have tried to estimate the change in the level of activity of a biology teacher associated with the use of ICTs at the lesson. First, we asked the students to evaluate the degree of ICT competence of their teachers, who apply information technologies at his/her classes, using marks from -2 to 2. The obtained estimate was above the average which may indicate both the changes in the teachers' understanding of the educational potential of information and communication technologies and explicit prerequisites to the change in the level of work (Table 3).

Today, many teachers of biology tend to use more often the ICTs at their lessons and in extracurricular activities, demonstrating thereby the change in their attitude to the computer. At the same time, both teachers and their students use electronic learning tools at the lessons which previously was not observed. This may indicate the change from the "teacher-centered" educational process to a "student-centered" one.

Once the motivation of a biology teacher changed and a teacher began to construe the computer as a powerful multifunctional learning tool, the changes began to inevitably occur in the teaching methods, new practices have been used at the lessons and in extracurricular activities, the working conditions of the teacher and student have been also changed.

Along with the process of increasing the use of ICT by the biology teachers at the lessons, we should also note that some teachers have to stew in their own juice having no targeted methodological and partnership support from the municipal and regional methodological support services and their fellow subject teachers. Teachers need a system of ICT advanced training slightly different in the form and content as well as new forms of organization of professional training courses such as on-the-job training, organized and provided in their schools (Fig. 3).

Summary: A significant part of the biology teachers are interested in and professionally demonstrate their achievements in using the ICTs at their lessons and in extracurricular activities and confidently formulate their needs. The vast majority of teachers understand the possibilities of using the computer in the educational

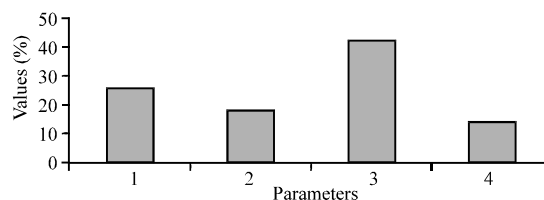


Fig. 3: The use of electronic learning tools by teachers and students during the lessons (1; only a teacher uses the electronic learning tools at the lessons 2; a teacher uses the electronic learning tools at the lessons more often than his/her students 3; both teacher and students equally use the electronic learning tools at the lessons 4; students use the electronic learning tools at the lessons more often than their teacher)

process. Total 88% of the respondents give positive answers to a question on their attitude to the use of ICTs in the educational process and only 12% say them being forced by external circumstances, regulations, etc. to use the ICTs at their lessons.

CONCLUSION

Introducing ICTs into the classes requires from the biology teachers to master a completely different approach to teaching, namely to change a role of the teacher from lecturer to developer because the teacher has to develop electronic materials for lessons and apply them at his/her classes, to use entirely new ways of teaching and learning based on ICTs. Studying the ways of designing and developing the ICT-based learning environments prior to their application at the lessons requires much more time than the traditional advanced training courses provide as well as much more specialized assistance. It is necessary to provide teachers with a lot of time for the development of their ideas, skills and research works.

Since, it is difficult and perhaps even ineffective to involve simultaneously all teachers in the innovation process, it would be better to apply a gradual strategy, involving first those who introduces or tackles the innovation by him/herself. These usually are the tutors ready to take efforts to ensure the implementation of innovative practices. The process of creating a community of tutor teachers includes a number of measures, such as:

- Determining the legal status of the tutors (for example, providing more opportunities for activities such as the development of learning sessions, support for other teachers; raising wages; providing personal advanced ICT devices and free Internet access, etc.)

- Identifying the tutors in the regional education system
- Creating a support system for this community
- Developing the initiatives on professional development in order to attract the tutors
- Creating virtual learning communities of tutors with the help of a suitable ICT platform and online educators
- Establishing the tutors' communities

Mastering the necessary skills implies using such methods of thinking as:

- Vision of the problem
- Formulation of hypotheses
- Anticipation
- Determination of principal points
- Analysis, evaluation, interpretation and recording of ideas
- Flexibility of approaches
- The use of heuristics
- Understanding of the complex relationships
- The use of common models
- Application of the existing remedies in solving new problems

One should select the content and methods of teaching that contribute to the formation of personality traits such as:

- Independence
- Discipline
- Consistency
- Intrinsic motivation
- Reflection
- Flexibility
- Proactiveness

ICT competence improving program must be developed with the use of following didactic principles:

- The real context
- Realistic tasks
- Avoidance of repetitive tasks
- Continuous monitoring
- Logical segmentation of the material
- Integration of knowledge and skills
- Creativity of a teacher
- Collectivism
- The spirit of innovation (Anonymous, 2013)

Schools need to identify the institutional strategy that will recognize the importance of preparing the academic disciplines by the teacher. In accordance with this strategy, there is a need to develop a system of

encouraging those teachers, who develop and adapt training materials, including such form as providing them time for the development of such materials. Teachers involved in the development of content should be provided with best equipment and free Internet access. Any activity of teachers aimed at professional development in the field of content should be encouraged. Tutors should take part in training courses to learn how to develop high-quality digital content.

The use of ICT in the school calls for teamwork and teachers with different qualifications should work together, forming temporary or permanent teams, contributing their knowledge in various subjects and their personal qualities to the common cause. Pedagogical communities can be created by means of E-learning courses based on virtual learning communities. At schools, teachers can create production groups for the development, adaptation and evaluation of digital content. Equal cooperation and collegiality make significant contribution by helping teachers to work in accordance with the new teaching methods. According to their new role, they need more time for project activities; therefore, one should revise the balance between working time spent by the teacher on the lesson itself and its preparation.

Results of the study of professional activity of modern teachers in terms of self-assessment of ICT competence allow us to conclude that:

- ICT competence of modern biology teacher is one of the most important indicators of his/her successful activity and a prerequisite for the further improvement of his/her professional competence that determines the significance of the development of advanced training system for a modern teacher focused on the systematic use of ICTs
- Current models of advanced training help to solve some problems of improving ICT competence of modern biology teachers, however have a number of drawbacks and cannot fully solve the problem of the active use of ICT by a teacher in his/her professional activity. This suggests the need to develop an advanced training model for teachers based on the idea of integration of existing models and the personalized demands of the modern teacher

ACKNOWLEDGEMENT

The research is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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