УДК 378.147:519.72
DOI: 10.25559/SITITO.15.201904.805-814

Introduction to Informatics as Part of the University-Wide General Education Curriculum

E. K. Khenner
Perm State National Research University, Perm, Russia
15 Bukireva Str., Perm 414990, Russia
ehenner@psu.ru

Abstract

This article deals with the problem of studying the elements of Informatics (Computing) in the framework of general education curriculum by university students who do not major in computing. The expediency of this approach is connected with the role that computing plays in all spheres of life and professional activity. The courses of Digital Literacy or Information Literacy traditionally included by many universities in general education curriculum, are recommended to be replaced or supplemented by the course conditionally called "Introduction to Informatics" since the computing became a supra-disciplinary phenomenon in the modern society. The article describes the experience of implementing the overview course on the fundamentals of Informatics. The course contributes to the understanding of the important role of Computer Science and Information Technologies in the modern world, training of information technology skills necessary to continue university education, and formation of ICT-competence and computational thinking.

Keywords: Computing, curriculum design, educational policy, purposes of higher education.

For citation: Khenner E.K. Introduction to Informatics as Part of the University-Wide General Education Curriculum. *Sovremennye informacionnye tehnologii i IT-obrazovanie* = Modern Information Technologies and IT-Education. 2019; 15(4):805-814. DOI: 10.25559/SITITO.15.201904.805-814

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Введение в информатику как часть общеуниверситетской общеобразовательной программы

Е. К. Хеннер
Пермский государственный национальный исследовательский университет, г. Пермь, Россия
614990, Россия, г. Пермь, ул. Букирева, д. 15
ehenner@psu.ru

Аннотация

Рассматривается проблема изучения информатики в вузах в рамках общеобразовательной составляющей учебной программы студентами, которые не специализируются в области компьютерных наук. При этом термин «информатика» понимается в широком смысле, охватывающем всю область компьютерных и информационных наук и использования компьютерных и информационных технологий. Целесообразность такого изучения связана с той ролью, которую играет информатика и информационные технологии во всех сферах жизни и профессиональной деятельности. Несмотря на это, в настоящее время, при отсутствии регламентации содержания образования на уровне ФГОС и формирования образовательных программ на основе расплывчатых формулировок компетенций и практико-ориентированных профессиональных стандартов, в российском университетском образовании наблюдается снижение значимости общеобразовательной составляющей и, в частности, тенденция исключения курса информатики из образовательных программ. В работе показано, что эта тенденция не соответствует задачам формирования информационной культуры, информационно-коммуникационной компетентности и вычислительного мышления современного выпускника университета, и противоречит образовательной политике многих ведущих университетов мира. Описан опыт проведения вводного курса основ информатики, адресованного студентам многих направлений и специальностей, который способствует формированию понимания её важной роли в современном мире, навыков владения информационными технологиями, необходимыми для овладения профессиональными компонентами различных направлений университетского образования, формированию ИКТ-компетентности и вычислительного мышления.

Ключевые слова: информатика, разработка учебных программ, образовательная политика, цели высшего образования.

Для цитирования: *Хеннер Е. К.* Введение в информатику как часть общеуниверситетской общеобразовательной программы // Современные информационные технологии и ИТ-образование. 2019. Т. 15, № 4. С. 805-814. DOI: 10.25559/SITITO.15.201904.805-814

Introduction: problem statement

Below we use the term “Informatics” in the broadest sense, meaning by it both computer science and information science, and the whole area related to the use of computers and information technologies. This interpretation of the term “Informatics” is used in Russian-language scientific literature along with other approaches [1]. With this approach, the term “Informatics” is almost identical to the term “Computing” [2], understood in accordance with the series of reports “Computing Curricula”, made under the auspices of ACM and IEEE.

Computing became a supra-disciplinary phenomenon in the modern society a long time ago. It relies on humanities, technical and mathematical sciences and creates tools for development of these and other sciences, as well as for numerous applications of high practical importance. Much of the methods and achievements in computing are used in many types of professional activities and can be applied to almost everyone, but as to higher education, this circumstance has not yet been adequately reflected.

The following list of top ten reasons for studying computing has been developed[1]:

1. Computing is part of everything we do!
2. Expertise in computing enables you to solve complex, challenging problems.
3. Computing enables you to make a positive difference in the world.
4. Computing offers many types of lucrative careers.
5. Computing jobs are here to stay, regardless of where you are located.
6. Expertise in computing helps even if your primary career is something else.
7. Computing offers great opportunities for true creativity and innovativeness.
8. Computing has space for both collaborative work and individual effort.
9. Computing is an essential part of the well-rounded academic preparation.
10. Future opportunities in computing are without boundaries.

These reasons ACM addresses first of all to those who intend to receive professional education in computing. Let us note that among the 10 reasons mentioned above a significant part does not belong to a professional career in the field of computing, but is addressed to representatives of an indefinitely wide range of professions. The following statement confirms the above: “An argument can be made that computer science is becoming one of the core disciplines of a 21st century education, that is, something that any educated individual must possess some level of proficiency and understanding” [3].

A similar view on IT education raises a question whether it is adequately represented in university curricula. We believe that the introduction to Computer Science and Information Technologies (CS & IT) i.e. those components of computing which have the greatest general educational potential, are to be included into the basic part of university education, which is meant for all students regardless of their fields of study. Introduction to CS & IT would be a useful part of higher education for all students.

This article describes the experience of designing and implementing the CS & IT introductory course at the Perm State University (Russia). The course is called “Informatics” in the original but is noted above this term in Russian is polysemantic and does not quite correspond to appropriate term in English.

General education and study of elements of Informatics

General education in higher education

In the process of undergraduate education, the universities of many countries include to curriculum a set of general education subjects, in addition to the disciplines of professional training.

In the US, this part of education is called General Education Curriculum (GEC). In this respect, the position of the Association of American Colleges and Universities is quite indicative: “AAC&U general education initiatives aim to ensure that every undergraduate student experiences a relevant and challenging general education curriculum… AAC&U initiatives address strengthening general education for transfer students, embedding high expectations and meaningful assessment of student learning, and general education as essential for enhancing curricula and pedagogy”[?]. 85% of AAC&U member institutions have in 2015 a common set of intended learning outcomes for all undergraduate students.

Many US universities emphasize the importance of general education in the undergraduate programs. For example, American Public University System considers GEC in a broader context: “The University’s general education curriculum provides a broad-based, integrative, and practical learning experience meant to prepare students for responsible civic and cultural engagement in a global context. By completing general education coursework, you will have gained skills and knowledge in arts, humanities, literature, communication, civics, political science, social science, mathematics and applied reasoning, and natural sciences. This level of knowledge and skill helps our students to become effective leaders, creative thinkers, responsible citizens, and ethical decision makers”[?].

The quotes given above reflect the position of most US universities. So we can conclude that general education is considered by them as an integral part of higher education.

Many leading universities in Asian countries also have common core requirements (mandatory for all the students) which are specially segmented to form all-round education. National University of Singapore (which is the first in the top 10 Asian universities and the 22nd in the 2018 Times Higher Education World University Rankings) requires students to take general education courses during the first two years of study[?]. A similar educational policy is pursued by the leading universities of China, such as universities of Hong Kong [4], Tsinghua University[1] and many other universities.

Some European universities also include general education in their curricula (e.g. Manchester University[2]). However, this kind of approach is not typical for modern universities in Western Europe where education is mainly focused on the disciplines related to the

[1] Top 10 Reasons to Major in Computing. Association for Computing Machinery [Electronic resource]. Available at: https://www.acm.org/binaries/content/assets/education/top-10-reasons-to-major-in-computing.pdf (accessed 01.07.2019). (In Eng.)

[2] Association of American Colleges & Universities. General Education [Electronic resource]. Available at: https://www.aacu.org/resources/general-education (accessed 01.07.2019). (In Eng.)

future profession. Many studies are devoted to the analysis of the causes and effects of this phenomenon (e.g. [5-7]). Anyway, in European universities students usually are offered an extensive set of elective courses including not only profession-oriented ones.

In Russian universities, within the framework of national educational standards, which were in force through 2012, the corresponding GEC set of disciplines was divided into two blocks: "General Humanities and Socio-Economic Disciplines" and "General Mathematical and Natural Science Disciplines". 1800 hours were allocated to studying the disciplines of the first block for all fields of study (approximately a half of them was accompanied by a teacher in the classroom). The block contained three sections: a federal component (1200 hours), disciplines established by the university and compulsory for students (400 hours) and elective disciplines (200 hours). The first section included compulsory subjects: physical training, domestic history, culturology, political science, jurisprudence, psychology and pedagogy, Russian language and speech culture, sociology, philosophy, economics, foreign language. The block called "General mathematical and natural science disciplines" has the same structure, but its total labor intensity varies for different fields of study within the range of 400 to 1400 hours. Informatics was the part of this block. However, new generation of national educational standards changed situation in this sphere not for the better.

Elements of Informatics as component of GEC

In the context of the present article, it is important to note that many colleges and universities include elements of digital literacy (and/or information literacy) in general education curriculum.

According to American Library Association, "Digital Literacy is the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills"[3]. A broader view on digital literacy (ICT-literacy) is "ability to use and create technology-based content, including finding and sharing information, answering questions, interacting with other people and computer programming"[4].

Participants of the Symposium in Digital Literacy in Higher Education [8] used the approach formulated by Sharpe and Beetham [9]. They divided a variety of intellectual processes associated with digital literacy into three categories: (a) locating and consuming digital content, (b) creating digital content, and (c) communicating digital content.

By 2015, the share of colleges and universities in the US putting information literacy skills on the list of compulsory learning outcomes was 76%[5]. In the GEC framework, many universities offer their students special courses on digital literacy or information literacy.

The situation is similar in the universities of other countries where general education is part of undergraduate program. For example, the Chinese University of Hong Kong offers a short course of fundamentals of information technology as compulsory: "The required one-unit IT Foundation course provides students with basic knowledge of information technology and develops their capability in handling and using digital information. It will be of tremendous significance to life-long learning and to coping with the demands of the workplace"[6]. Note that this course is not much different from the digital literacy courses.

In our opinion, for all the importance of the skills formed in the course of studying digital literacy or information literacy, university education at 21 century can and has to give a broader ideas of information processing principles and information technologies. At present, these ideas can be formulated as requirements for the development of such personal qualities as ICT competence and computational thinking, which qualitatively exceed digital literacy.

In support of this statement let's note that the European Commission includes ICT Competence (Digital Competence) in the list of "Key Competences for LifeLong Learning"[7]. It is necessary to mention that many authors relate definition of ICT-competency with concrete contexts and with the ability to act in this context (e.g. [10-13]). Anyway, ICT Competence includes both a set of knowledge and skills in the field of computer science and information technologies, as well as a *personality characteristics necessary* for a motivated use of the whole set and variety of computer tools and technologies in different kinds of activities *[11].*

These personality characteristics largely overlap with the characteristics generated by computational thinking, the shortest definition of which is as follows: "CT is an approach to solving problems in a way that can be implemented with a computer" [14]. The same article gives a more detailed operational definition: "Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following characteristics:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analyzing data.
- Representing data through abstractions such as models and simulations.
- Automating solutions through algorithmic thinking (a series of ordered steps).
- Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.
- Generalizing and transferring this problem solving process to a wide variety of problems"

According to many authors formation of computational thinking is an important component of university education (e.g. [8, 15]).

[3] American Public University System. General Education. Philosophy of General Education [Electronic resource]. Available at: https://catalog.apus.edu/undergraduate/academic-programs/general-education/ (accessed 01.07.2019). (In Eng.)

[4] National University of Singapore. General Education [Electronic resource]. Available at: http://www.nus.edu.sg/registrar/academic-information-policies/undergraduate-students/general-education (accessed 01.07.2019). (In Eng.)

[5] Tsinghua SEM Undergraduate General Education Curriculum. Tsinghua University. January 12, 2012. [Electronic resource]. Available at: http://www.sem.tsinghua.edu.cn/en/semnucen/TZ_49919.html (accessed 01.07.2019). (In Eng.)

[6] The Manchester Core: A Program in the Liberal Arts. Manchester University [Electronic resource]. Available at: https://www.manchester.edu/academics/AcademicandStudentAffairs/the-manchester-core (accessed 01.07.2019). (In Eng.)

[7] Digital Literacy, Libraries, and Public Policy. Report of the office for Information Technology policy's Digital Literacy Task Force. American Library Association, 2013. [Electronic resource]. Available at: http://www.districtdispatch.org/wp-content/uploads/2013/01/2012_OITP_digilitreport_1_22_13.pdf (accessed 01.07.2019). (In Eng.)

From the above we can conclude that such courses as Digital Literacy, Information Literacy make a relatively small contribution to the formation of ICT competence and computational thinking. A much greater contribution to the solution of this problem can be made by the course, conventionally called "Introduction to Computer Science", or somewhat more broadly, "Introduction to Computing". Such a course will help to generate key ICT competencies and develop computational thinking skills.

Note that the arguments about the need to study the elements of computing in the framework of the general curriculum at universities and colleges are given also in some other works [16-18].

In Russian universities Informatics during many years was a compulsory discipline in almost all educational programs – either as an independent discipline called "Informatics", or as part of "Mathematics and Informatics" (mostly for humanities). The course of Informatics took from 100 to 300 hours (including time for self-study), depending on the field of education. Current national educational standards significantly expand the rights of universities to form their educational programs. The list of compulsory disciplines is reduced to philosophy, history, foreign language, life safety, physical training. The standards exclude the requirements for learning outcomes, expressed in the knowledge-skills terms. This reform leads to a reduction in education related to General Education, and, in particular, to a decrease in the level of study of informatics in the part of universities.

In recent years, due to the expansion of university rights to form their curricula, the status (obligatory or elective) and the level of CS & IT study in Russian universities became significantly different. The content and scope of CS & IT ("Informatics") courses differ significantly not only in different universities but also within one university for different educational programs ranging from a small course of computer literacy to a course focusing on application of information technology in future professional activities. This situation reflects the curriculum developers' conception of the importance of education in IT, as well as the average level of computer science preparedness of those who enter universities, which is significantly different in different universities.

The expediency of studying the CS & IT introductory course at the university follows both from the above-mentioned role of computing in the modern world and from the fact that most of those who enter universities do not have the knowledge to the extent necessary for university education, basics of Computer Science and skills of using Information Technologies in cognitive and educational activities. This is in particular due to the shortcomings of school education, which does not always solve the problems described above at a sufficiently high level.

The lack of knowledge and skills of university students in the field of CS & IT is also affected by the great number of schools leavers entering universities. Percentage of age cohort entering universities in Russia nowadays is about 76% (approximately as in the USA and more than in many European countries). Such a circumstance cannot but negatively affect the level of general preparedness of students for higher education – at least in disciplines that are not major for their field of study. Another factor, negative for regional universities, is the outflow of the best high school graduates from regions to the capital, to metropolitan universities; this phenomenon became a factor of negative selection for regional universities (this factor arose relatively recently in Russia due to introduction of the Unified National Examination similar to SAT and ACT in the USA). As far as the author can judge, this problem is also present in other countries.

Introduction University course of Informatics

Aims and basic principles

The main purpose of the course is to form ICT-competence and Computational Thinking at the level indispensable to life and professional activities in modern society.

The course solves next tasks:

1. Formation of ideas about computing, its place in the modern world.
2. Deepening views on information as a fundamental concept, its basic properties, measurement and encoding.
3. Deepening views on basic information processes, such as storage, transmission and processing of information, principles of presentation in a computer.
4. Deepening the skills of general-purpose information technologies (creating and processing text, table, graphic and multimedia objects, and search for information in networks).
5. Formation of ideas about social impacts of informatization.
6. Leveling of students' knowledge and skills in the field of CS & IT and creation on their basis of theoretical and technological base for familiarization with professionally oriented information technologies.

Let's focus on the latter point. As a rule, the introductory CS & IT course precedes special courses aimed at building up special knowledge and skills of applying information technologies in a future profession. Examples of such courses taught in PSU are given in Table 1.

Table 1. Examples of IT-oriented courses in PSU

Bachelor's degree program	IT oriented courses
Chemistry	IT in chemistry
Biology	Bioinformatics
Law	IT in legal activities
Philology Philosophy	IT in humanitarian researches
Economy	IT in management
Psychology Sociology,	IT in in the social sphere
History Political science	IT in historical and political research
Geography	Geo-information technologies, IT in geography
Geology	IT in geology
Education	IT in education

When planning the content of the course, we proceeded from the need to give students an idea of the fundamentals of CS & IT. Of course, not all components of CS & IT are reflected in the described course; when planning it, the developers performed an analysis of expediency and practical possibility of including into the course various sections of CS & IT from the positions of

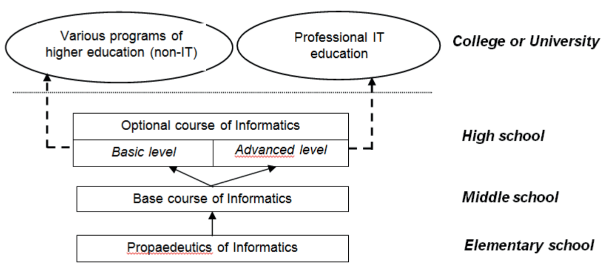
- importance for the general outlook and development of students;
- importance for theoretical and technological equipment of students, required for the subsequent studying of special disciplines;
- level of education in computer science, previously received by students at school.

In determining the level of requirements for the results of the course, we proceeded from the following circumstances:

- this is a review course which primarily aims at the formation of general ideas of the subject in students not specializing in computing;
- the course should combine the level determined by its university status with accessibility for students (taking into account their real preparedness in the field of computing);
- the course should solve the tasks stated above.

School course "Informatics" as a base of the university course

In order to explain the place and content of the mentioned course in the university education, it is useful to explain briefly the system of study in informatics in Russian schools [19,20] and its relation to the subsequent education and professional activities. In Fig.1, the study of informatics in school is matched with the most common choice of fields of study and types of professional activity made by school leavers.



F i g. 1. Informatics in school education in Russia

The study of the subject named "Informatics" (in fact, it includes a combination of elements of Computer Science and Information Technologies) in modern Russian school is compulsory only in the middle school (grades 7-9). However, taking into account the popularity of the subject, most high schools (grades 10-11) include informatics in their program. Most students who entered the university continued to study informatics in high school at the so-called basic level; those students who study informatics at an advanced level, as a rule, plan to continue their education in the field of computer science and IT.

In elementary school (grades 1-4), informatics may or may not be a separate subject (at the discretion of the school). If informatics is not taught as a separate subject, then such compulsory elements of education as formation of fundamentals of logical and algorithmic thinking, ability to act in accordance with an algorithm and construct a simple algorithm, acquisition of the initial idea of computer literacy are realized within the framework of traditional subjects.

Learning outcomes in computer science of a high school graduate who enters a university to study programs not related to IT professions, include the following (for more details, see [19,20]):

1. Knowledge of basic concepts: information, algorithm, model, and their properties.
2. Knowledge of basic algorithmic structures and principles of programming.
3. Knowledge of concept of computer modellings.
4. Knowledge of concept of databases and elementary skills to work with them.
5. Knowledge of the principles of the Internet and skills to work with it.
6. Basic skills of operating computer equipment and operation systems.
7. Basic skills of formalization and structuring of information, ability to choose how to present data in accordance with the task – tables, charts, graphs, diagrams.
8. Skills of safe behavior when working with computers.

The level of this knowledge and skills corresponds to the initial stage of formation of ICT competence and computational thinking and is, in our opinion, insufficient for a university graduate.

Example of realization of university course

Taking into account the real content of the course described below, its most adequate English title sounds like "Introduction to Computing". Over the past 5 years, this course (in the original named "Informatics") is compulsory in the Perm State University for students of 10 faculties of 12. These are humanities – philological, modern foreign languages and literature, philosophical and sociological faculties, faculty of historical and political science; socio-economic faculties – law, economic and geographical; natural science faculties – geological, chemical and biological. This course is not studied at the faculty of Mechanics and Mathematics and at the faculty of Physics because their educational programs include courses of informatics (computer science) and information technologies at the professional level. Annually, more than 2,000 first-year students study the CS & IT introductory course within the framework of more than 40 undergraduate educational programs. The course is unified; the specificity of the field of study is reflected only in the selection of part of the tasks for the practical work.

The course in question is constructed in a subject-based conventional teaching paradigm. Other variants of constructing an introductory CS & IT course are possible in the problem-based education paradigm, when basic ideas and methods of informatics unfold in the process of discussing approaches to solving some specific problems. In the article [21], the problem approach is implemented within the traditional structure of the course called "Introduction to programming", "Introduction to Computer Science". The authors of the article [22] based the courses they developed on the principle of "Topic based introductory courses". This approach implies that each section of the course is devoted to a specific topic: social media, bioinformatics, business analytics, etc. For all its attractiveness such an approach requires a much higher motivation of students to acquire general education than currently existing in our conditions.

Table 2 presents the result of this selection supplemented by the academic work planning for the introductory course of Informatics implemented in PSU. It is to be explained that in Russian universities the complexity of subjects in the curriculum is measured in credit units and in hours. Each credit is equal to 36 academic hours (hours of study) of so-called *total labor intensity* including hours of class work with a teacher and self-preparation. Estimation of time spent by students for self-preparation is used by teachers for making home assignments in order to harmonize the total workload of students within the curriculum.

Table 2. Course planning

Modules	Lectures	Labs	Self-study
1. CS and IT (basic concepts)	4	-	6
2. Information modeling	2	-	4
3. Computer hardware	2	-	4
4. Operation systems	2	4	4
5. Office suite software	6	12	18
6. Databases and information systems	2	6	10
7. Algorithmization and programming	4	6	16
8. Computer networks and Internet	4	4	8
9. Information Security	2	-	4
10. Social impacts of informatization	4	-	6
In total	32	32	80

Comparing the content of the modules described above with requirements for the results of acquisition of the school course of informatics, we can see that the introductory university course continues the education received at school. However, the level of complexity and scientific character of the university course is, of course, higher than that of the school course, and the acquired skills are more profound. Practice in basic information technologies included into the university course completes the formation of digital literacy, and numerous examples of applications of information technology in various human activities contribute to the development of computational thinking and ICT competency.

It should be noted that programming is given little attention in this course. Contrary to popular belief, we do not consider programming to be a more significant component of general education, including high school, than other components of computing. The idea of programming as a necessary skill “for all students” was formed in those times when a specialist who faced the need to solve professional tasks with the help of a computer often had to create a program himself. Since then, the situation has radically changed – currently most professionals have access to powerful software systems for solving their professional problems. Nowadays, knowledge of operating principles of modern information and communication technologies in the professional sphere and the skill to use existing software systems and services is far more significant universal professional quality, rather than programming.

Elimination of the programming barrier allowed many specialists in the natural science, engineering, humanities and social science to use a computer in their work, and millions of people in their everyday life. The necessary skill “for all people” is not programming (i.e., coding of algorithms in formal languages), but algorithmic thinking which is the basis of computational thinking and informational and communicative competence.

Let us estimate to what extent the above-described course gives students an idea of CS & IT. Here we are to proceed from the structure of body of knowledge of these computing sections [3, 23]. The components of these bodies of knowledge are given in Table 3; it should be noted that the left column of Table 3 does not include the sections which are considered unnecessary by the developers of mentioned above Computer Science Curricula 2013, even when preparing bachelors of Computer Science. The sections are sorted alphabetically; the sections of bodies that are included in both curricula are highlighted in Table 3 (italics).

Table 3. Computer Science and Information Technologies: Components of bodies of knowledge

Computer Science Body of Knowledge	**Information Technology Body of Knowledge**
AL. Algorithms and Complexity	*HCI. Human Computer Interaction*
AR. Architecture and Organization	ITF. Information Technology Fundamentals
DS. Discrete Structures	IAS. Information Assurance and Security
GV. Graphics and Visual Computing	*IM. Information Management*
HCI. Human-Computer Interaction	IPT. Integrative Programming&Technologies
IM. Information Management	MS. Math and Statistics for IT
IS. Intelligent Systems	NET. Networking
NC. Net-Centric Computing	*PF. Programming Fundamentals*
OC. Operating Systems	PT. Platform Technologies
PF. Programming Fundamentals	SA. System Administration and Maintenance
PL. Programming Languages	SIA. System Integration and Architecture
SDF. Software Development Fundamentals	*SP. Social and Professional Issues*
SE. Software Engineering	WS. Web Systems and Technologies
SP. Social and Professional Issues	

On formal grounds, without touching upon the issue of the depth of reflection of CS & IT sections in the introductory course under discussion, it can be stated that most of these sections are reflected in this course.

The sections listed in Table 3 and not considered in this course include Net-Centric Computing, Software Development Fundamentals, Software Engineering, Integrative Programming & Technologies, Math and Statistics for IT, Platform Technologies, System Administration and Maintenance. These sections do not carry significant general-educational potentials and are too complicated for the introductory course.

Of course, we are talking only about the formation of common ideas of CS & IT problems and about expanding the skills of working with information technologies used irrespectively of professional interests of users. If we estimate the results of studying the course basing on three possible levels of mastery, defined as [3]

- Familiarity: It provides an answer to the question “What do you know about this?”
- Usage: It provides an answer to the question “What do you know how to do?”
- Assessment: It provides an answer to the question “Why would you do that?”

then the results of studying Modules 1-4, 8-10 correspond to the *Familiarity* level, and Modules 5-7 to both *Familiarity* and *Usage*. The *Assesment* level mostly is beyond the range of goals and capabilities of this course.

Experience of implementing the course

All teaching materials for this course, as well as current and final results of its acquisition, are posted in the university information system, protected from external access. In addition, lecturers are able to download a part of teaching materials as open access or conditionally-open (i.e. accessible only to their students) access options in a cloud storage. These materials include (at the discretion of a lecturers):

- lecture scripts;
- presentations for each lecture;
- video of lectures performed by the instructors, most competent on corresponding topics, so that a student can compare them with the current lectures given by his or her lecturer;
- workbooks on disciplines;
- instructions for laboratory work, variants of tasks and exercises;
- video instructions for completing these tasks;
- topical collections of Internet resources.

We prepared and published the textbook and the collection of practical tasks on the introductory CS & IT university course. These books cover a bit wider content than the one described above, and allow students and lecturers to organize the study of the course at different levels of complexity.

The university system of computer testing is used to control the acquisition of the theoretical part of this course. The test base generates tests automatically, and is unified for all training areas. The system is configured for a particular date and time (the beginning and end of testing), a group of students, a tested topic; the test results are supposed to be given to the students and their lecturers' immediately after completion and are stored in the result database until the end of the semester. Individual passwords for logging into the system are generated directly before each session to increase the degree of protection of the procedure and the reliability of the results obtained. Each student has to take the test according to the schedule planned by the lecturer.

The control over all the courses studied at the university including the course described above is based on the modular-rating system. There are 8 checkpoints and approximate dates set for the course, each checkpoint is to be passed by a certain assigned date. In order to receive a positive mark, a student has to pass all checkpoints with a score not lower than the minimum for each of the tests, after that the system estimates the student's results according to a 100-point scale. The final score is formed on the base of the results of the four topical and one final tests and five laboratory works. The contribution of the final test to the overall estimation is 30%, and it covers the entire content of the course.

The experience of studying the introductory CS & IT course leads to the following conclusions:

- The complexity degree of the course is accessible to most students; about 95% of students pass successfully all the sections of the course at the first try, without getting into the situation of failed tests.
- According to the surveys, the course is interesting to students.
- The course promotes familiarization of students with scientific ideas of information, its collection, classification, storage, retrieval, and dissemination of knowledge treated both as a pure and as an applied science.
- Most students experience a significant increase of their technological skills obtained during the course; for example, the basic skills of using a word processor, which most students have at the beginning of the course, become enhanced by the skills of advanced text editing, use of styles, etc. Work with spreadsheets creates the skills of using logical and statistical functions, and work with databases forms the skills of creating reports and processing queries, and so on.

Conclusions

We believe that the benefits of studying Computer Science and Information Technologies remain underestimated in universities. Many developers of higher educational curricula consider education this sphere at best only in the technological paradigm, and a huge general-education potential of computing is almost not used. In computing, there are many things, which should be included in education of each graduate of the university, regardless of his or her field of study, majoring or the future specialty.

The experience gained over 5 years of implementation of the introductory CS & IT course for the very different categories of students supports this approach. It successfully solves the tasks of formation of students' ideas about computing, significantly increases the level of digital literacy, and really contributes to formation of computational thinking.

We hope that this experience can be used in other universities. Of course, a specific version of the course may differ from the one described above. It essentially depends on the content and level of informatics skills of applicants entering the university, on the content of the university courses included in the General Education Curricula, and other factors. The content of the course and the level of requirements for its results in different universities can be different even within the same country. For example, the course described above may be too simple for the leading universities of Russia, where students with a high initial level of training are flocking from all over the country. However, in any case, in one form or another, the introduction to computing is worthy of being included in university education.

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Submitted 01.07.2019; revised 25.09.2019; published online 23.12.2019.

About the author:

Evgeniy K. Khenner, Professor of Department of Information Technologies, Perm State National Research University (15 Bukireva Str., Perm 414990, Russia), Dr. Sci. (Phys.-Math.), Professor, Corresponding Member of the Russian Academy of Education, ORCID: http://orcid.org/0000-0002-6397-4465, ehenner@psu.ru

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Поступила 01.07.2019; принята к публикации 25.10.2019; опубликована онлайн 23.12.2019.

Об авторе:

Хеннер Евгений Карлович, профессор кафедры информационных технологий, Пермский государственный национальный исследовательский университет (614990, Россия, г. Пермь, ул. Букирева, д. 15), доктор физико-математических наук, профессор, член-корреспондент Российской академии образования, ORCID: http://orcid.org/0000-0002-6397-4465, ehenner@psu.ru

Автор прочитал и одобрил окончательный вариант рукописи.