Organization of Independent Studying of Future Bachelors in Computer Science within Higher Education Institutions of Ukraine

Svitlana L. Proskura [0000-0002-9536-176X] and Svitlana G. Lytvynova [0000-0002-5450-6635]

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Prosp. Peremohy 37, 03056 Kyiv, Ukraine,
slproskura@gmail.com
Institute of information technologies and learning tools, M. Berlynskogo St 9, 04060 Kyiv, Ukraine
s_litvinova@i.ua

Abstract. Market demand for computer sciences experts and software developers is increasing day by day in Ukraine. Therefore, the requirements to the professional competence of technical universities graduates are increasing, which in its turn needs improvement of training forms and teaching methods aimed at creating a coherent system of education.

Success in the training of information technology specialists depends on many factors, one of which is self-studying. Independent work skills and self-studying abilities make the most important point in continuous education. This strongly applies to programming students who have to see it as a basis for their education.

This article features basic points of independent work organization of future bachelors of computer science taking into account current condition of Ukrainian universities development level.

Increasing importance of independent work of future bachelors of computer science in technical universities requires improvement in organization of educational process, modernization of teaching and methodological documentation aimed at both effective independent work of programming students, and implementing new forms and methods of control and self-control.

Types of independent studying as well as conditions for effective implementation of informational support of students' educational process for self-studies are determined.

Emphasis is placed on students' motivation for independent studying activities and organization of development of a positive attitude towards non-auditing work, especially for first year students

Keywords: independent work, the role of self-studying, independence, independent studying management

1 Introduction

Professional standard "Information Systems Specialist" describes the need in country's economy for specialists who obtain a wide range of modern information technologies, designing skills, programming and system support knowledge, profound understanding of automated business processes, and organizational management tasks (accounting, analysis, planning, control, implementation, etc.), as well as methods of project management [1, p.4]. Therefore, the requirements to the professional competence of future professionals in computer science are increasing. This, in turn, requires improvement of the forms and methods aimed at creating a coherent system of continuing education. There are many ways for such improvements. One of them lies in the proper organization of future bachelor's degree in computer science independent studying process.

Strengthening of the role of students' independent studies means a fundamental review of educational process organization in higher education institutions. The process should be structured in such a way that allows teachers to develop in their students the ability of independent studying, encourage self-development, creative attitude of implementing the acquired knowledge, and ways of adapting to professional activity in modern world. At the same time, independent studying process, its planning, organizational forms and methods, system of result tracking is one of the weakest places in the practical side of higher education organizing and at the same time one of the least studied problems in pedagogical theory.

2 Research methods

Theoretical and practical points of student independent studies organization are highlighted in the works of V.Yu. Bykov, S.G. Lytvynova, O.M. Spirin, and M.P. Shishkina. In the studies that are devoted to planning and organization of student independent studying process (S.I. Arkhangelskii, V.K. Buryak, M.G. Garunov, B.G. Johansen, S.I. Zinoviev, V.A. Kozakov, O.G. Molibog, R.A. Nizamov, M.D. Nikandrov, N.A. Polovnikov, P.I. Podkassisty) general didactic, psychological, organizationally active, methodological and logical aspects are studied.

This article gives a view at such research methods as surveys, questionnaires, interviews with students, as well as the methods of comparative analysis and statistical processing of data.

However, the issue of motivational, procedural, technological implementation of independent extra-auditorium activities of students requires special attention - a holistic pedagogical system that takes into account individual interests, abilities and inclinations is needed.

3 Research results

Successful training of the future holders of bachelor's degree in computer science depends on many factors, one of which is student independent studying. Contemporary researchers see student independent studying as the highest form of educational activity, aimed at effective assimilation of general human experience, at development and self-improvement of a future professional cognitive sphere [2, p. 86].

Nowadays, there is a large number of definitions of the term "independent study" in educational-pedagogical literature. For example, Ya.Ya. Bolyubash in the manual on the organization of the educational process in higher educational institutions, characterizes this type of studying as main means of students' learning of the material at the time, free from compulsory educational activities [3, p.17]. The "Encyclopedia of Education" provides: "Students' independent study is a planned individual or collective work of students, which is carried out according to the tasks and methodological instructions of the teacher, but without his or her direct participation" [4, p.804].

In its meaning independent studying is an active mental activity of a student connected with performing an educational task. The presence of a task and an appointed target to achieve are considered as characteristic signs of independent studies [8, p.78].

Analyzing definitions of various authors, O. I. Kucheruk in his research, concludes that student independent studying is seen, on one hand, as a type of activity that stimulates autonomy, cognitive interest and is the basis for self-education and an a stimule for further professional development; and on the other hand - as a system of conditions and pedagogical steps that provide guidance to student independent studying [2, p.87].

Article 50 of the Law of Ukraine "On Higher Education" states that teaching process in higher education institutions is carried out in the following forms: auditorium lessons; independent studies; practical training; and the measures of control [5, p.31].

Main components of training in higher education institutions are: lecture; laboratory lesson, practical lesson (worshop), seminar, individual lesson; advisory meeting.

The contents and types of independent work of the student-programmer are determined by the working curriculum of disciplines on programming (the basics of programming, object-oriented programming and other disciplines related to programming) tasks and recommendations given by the scientific tutor and pedagogical worker (teacher).

Educational process involves two types of student independent studying, which are distinguished as in-auditiorium studies and non-auditorium studies. In-auditorium independent work is carried out following the teacher's on-the-spot guidance after receiving the teacher's task. Non-auditorium independent studying is performed by the student basing on the instructions of the teacher, but without his or her direct participation.

In this article we will consider non-auditing independent studies, which are divided into the following types of independent work:

– preparation for in-auditorium classes;

- consolidation of knowledge gained at lectures;
- implementation of laboratory works and calculations and graphic works (CGW);
- separate topics of programming which were given for independent studying by students;
- implementation of programming tasks during the term;
- work with electronic resources and systematization of the received data;
- preparation for and performing course project;
- use of modern information and communication technologies in education;
- preparation for all types of tests (modular and complex tests, rector's testing)
- work in student's scientific groups, seminars, etc.;
- participation in scientific and scientific-practical conferences, seminars, contests, competitions, etc.;
- completion of final qualification test (diploma work or state examination).

According to the Bologna process requirements, the credit-module system in higher education institutions in Ukraine contains a significant part of training data provided for independent study by students. For example, in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", academic time regulated by the working curriculum for student independent study in the course of stationary full-time education makes on average about 50% of the total amount of studying time allocated for a particular subject. Taking into account that weekly amount of studying hours for a student makes 45 hours, that weekly amount of self-studying hours should be at least 23 hours [6, p.1]. In comparison, academic working load for a student in the USA makes 15 hours of auditorium work per week, while self-studying - up to 45 hours per week. The ratio of auditorium study and independent study is 1: 3 [7, p.31].

To provide successful performance of independent studying process faculty lecturers introduce their students, especially first year students, with forms and methods of organization of the whole educational process at the university, the basics of scientific work organization as well as with the method of independent studies organization. Besides this, the criteria for evaluating the quality of independent studying, its purpose, means, deadlines and forms of control are outlined by the teaching staff. They also form skills in working with textbooks, primary information sources, modern scientific literature, programs; teach to work out optimal variants of answers, do calculations, make decisions; organize research work. They conduct group and individual consultations so that the most difficult questions can be discussed, as well as systematically monitor the students when performing the tasks that are recommended for independent study; lecturers analyze and make assessments of the students' work.

It is important to develop students' positive attitude to extra-curricular work, especially in the first year of studying. To do this, when introducing a new subject, students need to be explained in detail about main tasks that are designated for independent studying. Further on, at each intermediate stage, teachers have to explain the purpose of every task and see how the students understood it. It is most necessary to control knowledge level and warn students about the deadlines. So gradually, students develop their ability to independently set tasks as well as perform them. In the process

of independent studying, computer science students gradually learn to plan their work, find, analyze, process, display information, formulate the results obtained.

In order to ensure the high level of success of full-time education and external form of education, obtaining and systemizing educational information, continuous improvement of the professional level of the future programmer, the teacher needs to properly organize the of future bachelors of computer sciences independent studying process. This is, first of all, the detailed drawing up of the independent working plan of for the student on the chosen subject. Secondly, it is a development of methodological guidelines for carrying out laboratory works and calculation - graphic projects, course and diploma design, with this student has to know which topics are planned for self-studying, what types and forms of independent studies will be applied, the form of control and deadline.

To properly organize non-auditorium education of computer science students, the following conditions are required: student's motivation for independent work; availability and accessibility of educational and methodological support and reference materials; availability of computer classes; a system of regular quality control of independent studying; counseling teacher assistance.

Modern teaching technologies are used to provide the best teaching and methodological support for students. For example, object-oriented learning environments for Moodle or Campus, based on the use of modern information and computer technology. Students can also use these programs for feedback. They have the opportunity to place their laboratory practice sheets, tests and other documents for checking by the teacher.

Digital resources of information are widely used for preparation to the auditorium, laboratory work and workshops on different subjects. It can provide an optimum rate for each student, create gradual perception of the educational material, train ability of independent organization and alternation of the studied material, give the possibility of qualitative self-control development along with the ability to control the quality of acquired knowledge, as well as ability to have access to remote resources, "virtual travel" and other types of information, concentrated in virtual libraries and websites [9].

The use of digital information resources in independent studying aims at revealing its main functions. They are seen as follows: information and reference (presentation of various kinds of information on the screen); visual (computer visualization of the investigated object and its constituent parts); individualization and differentiation of learning material; optimization of the process of independent studying according to the needs of each particular student (possibility of step-by-step work or work at a certain pace); controlling (objective feedback control, knowledge assessment, self-control); correctional (consultations and other kinds of help); diagnosing (determining the level of academic achievement of every student) [10, p.8].

The number of hours per day the student spends dealing with programming tasks and code writing plays significant role in independent studying of future bachelors of computer science, as well as systematic nature of this kind of work (every day, not every day, one, two or three times per week).

A survey among 2-year students of the Department of Computer-Aided Management and Data Processing Systems of Faculty of Informatics and Computer Science of National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" was conducted which involved 120 respondents.

The survey found that for 37% of computer science students programming takes only 1 day per week, 9% - 2 days a week, 5% - 3 days a week, 25% - it takes every day, 24% - not every day (Fig.1).

This fact indicates that students-programmers should increase the amount of time devoted to independent practical work on programming.

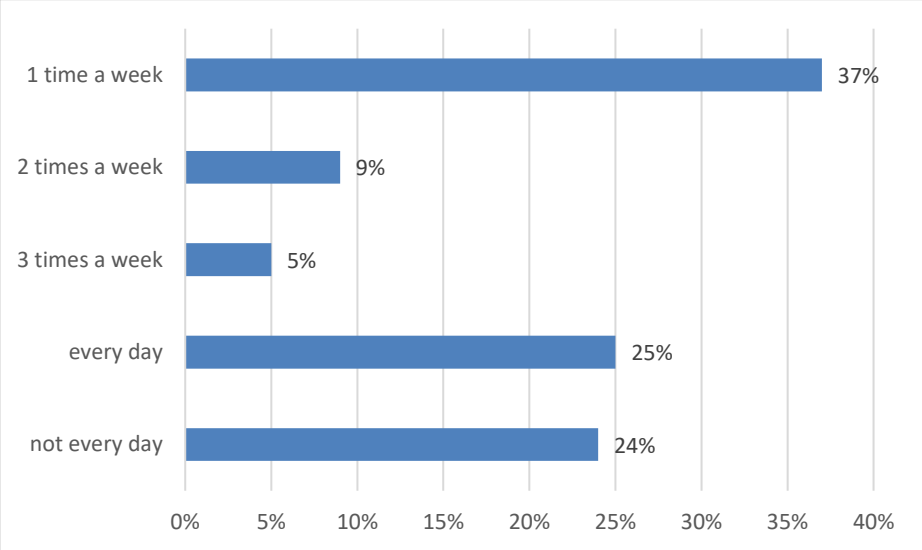

Fig. 1. The frequency of students' independent work on programming

Fig. 2 represents the following survey results on the number of hours per day that a student-programmer spends on performing programming tasks. We see that 34% of future bachelors of computer science devote more than 3 hours per day to doing practical programming tasks, 24% - 3 hours, 25% - 2 hours, 4% - 1 hour, 13% - 0.5 hours.

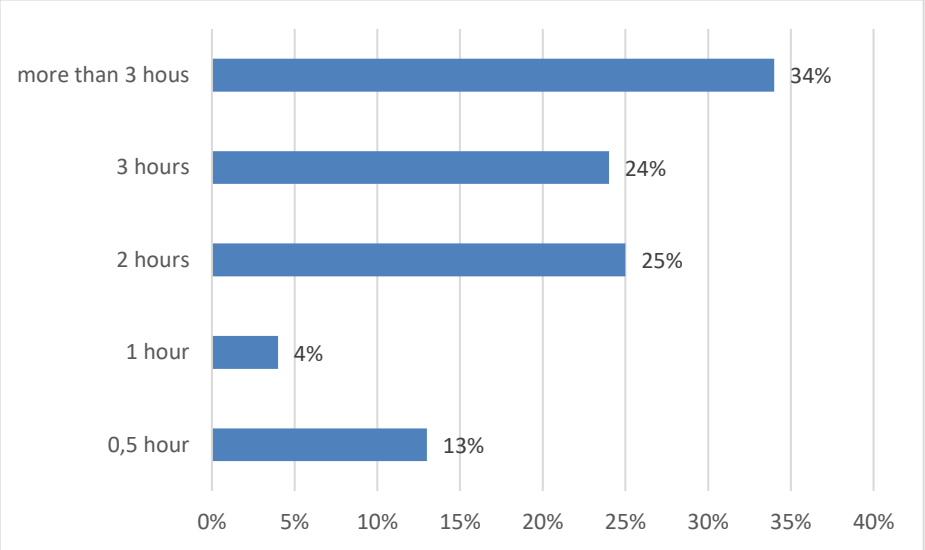

Fig. 2. The number of hours of programming per day.

The authors' point is that such insufficient amount of time per week that students-programmers devote to independent implementation of practical programming tasks is associated with processing of large volumes of educational material in other subjects. But in order to achieve a high level of programming skills for future bachelors of computer science it is necessary to increase the number of days per week on independent practical classes in programming. To do this, you need to review the schedule of the students' workday, to exclude less priority tasks out of it.

While doing the survey special attention was paid to the use of Web-oriented studying technologies by students, such as automated programming verification systems and intelligence maps. Namely: e-olymp Algotester, NetOI Olympiad.

The survey of second year students' opinion shows that the respondents prefer to use Internet portal e-olymp -75%, Algotester - 5%, NetOI Olympiad -3%, Others - 20%.

The above-mentioned data are shown in Fig. 3.

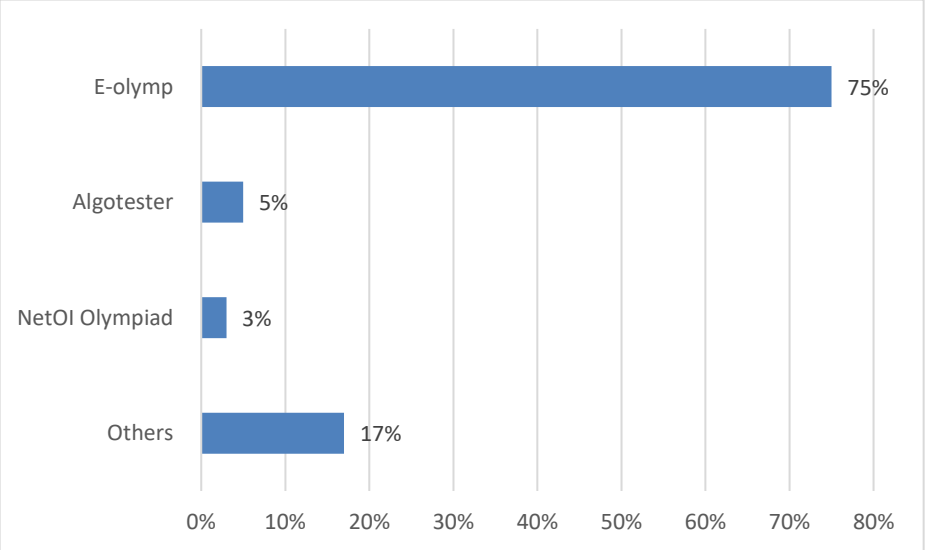

Fig. 3. Application of automated testing system for programming tasks.

This automated system contains more than 7000 tasks, general rating of registered participants, possibility to check program codes for programming languages Pascal, C #, C ++, Java, Php, Phyton, Ruby, Hascell, ability to see interpolations, availability of information about all solution attempts with all tasks performed, methodological section.

E-olymp system is used to conduct knowledge control, along with ongoing monitoring and tracking of results by pedagogical staff. This very result of monitoring and control allows the teacher to make corrections to the level of knowledge. Evaluation criteria are developed to obtain objective assessment of programming students independent studying. Students have opportunity to independently solve tasks, prepare for classes, and check their solutions without teacher's help, as well as to compare their level with other users of the site, which in turn stimulates increase of knowledge level in this field and encourages self-development and self-esteem [11, p.2].

A very effective way of remembering large volumes of information has to be mentioned while speaking about studying and especially independent studying – which is the use of special memory cards called intelligence maps (idea created by Tony Busen). Intelligence maps help students to visualize, structure and memorize large volumes of educational information, quickly search for the information they need, prepare for exams and seminars, create presentations, make their own intelligence maps [12 p.131]. This technique is applied by only up to 10% of the respondents, as shown by the results of the second year programming students survey in the below following Fig. 4.

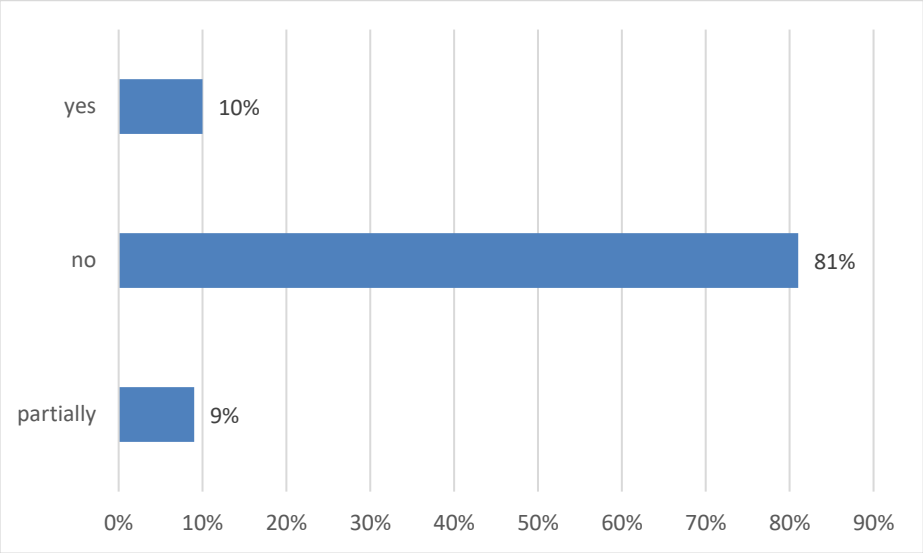

Fig. 4. Rating in the use of intelligence maps by second year programming students.

Programming students independent studying includes preparation and participation in the university Olympiads, all-Ukrainian and international Olympiads in programming. Olympiads are knowledge contests among leading students or gifted young people. Generally, the share of gifted youth is from 10% to 15% of all students.

Olympiads in programming are one of the most important areas for working with gifted youth. While carrying out tasks, programming students apply all the knowledge and practical programming skills which they obtain, have the opportunity to participate in collaborative work and apply various tools for developing programs.

In the process of participating in Olympiads, students not only increase their special skills and abilities but also develop important social skills: communication skills, ability to co-operate and design their activities. Olympiad results appear as valuable educational material that can be used immediately in learning process [2, p.5].

4 Conclusions and further research perspective

Independent studying is an integral and important part of educational process of higher education institutions. Tasks are planned, performed by students under methodological guidance of teachers but without teachers' direct involvement. Independent studying appears to be main means of introducing students to extra-curriculum educational material in times that are free of compulsory training.

Thorough selection of the content and volume of educational material for independent study by teaching staff is strongly required.

Organization of independent studying process contributes a lot to the development of students' autonomy, responsibility and self-organization, as well as the creative approach to solving educational and professional tasks.

Summing up the analysis done in this research, we can conclude:

Independent studying is one of the student's activities organized by the teacher, aimed at fulfilling given didactic goals, but is carried out without teaching staff direct participation;

Students' independent studying process requires teaching staff to carefully plan it;

Creation of conditions for the effective organization of educational work of computer science students supposes, first of all, thorough scientific and methodological supplement.

In its meaning, independent studying is an active mental activity related to the implementation of educational tasks.

Organization of control over the results of independent studying - is an integral part of the educational process, which aims to provide "student-teacher" feedback and to identify the basis of its correct organization.

References

1. Kovalyuk, T., Mazur, V., Martiniuk, S.: Professional Standard "Information Systems Specialist" (project), https://mon.gov.ua/ua/osvita/visha-osvita/suchasna-it-osvita-v-ukrayini/profesijni-standarti, last accessed 2014
2. Kucheruk, O.: The role of students' individual work in the process of formation mathematical competence of future software engineer. Virtus: Scientific Journal. CPM "ASF" Canada. 9, 86–89 (2016).
3. Bolyubash, Ya.: Organization of educational process in higher education institutions. COMPASS (1997).
4. Zinkovsky, Yu.: Independent work of students. Encyclopedia of education Academy of pedagogical sciences of Ukraine, (2008).
5. Law of Ukraine"On Higher Education", https://zakon.rada.gov.ua/laws/show, last accessed 2018/01/01
6. Independent work of a student,: Temporary provision on the organization of the educational process in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", http://kpi.ua/regulations 2014
7. Grishko, L.: Methodical system of studying the basics of programming of future engineers-programmers, dissertation, National Pedagogical University (2009)
8. Byrta, G., Bourgu, K.: Methodology and organization of scientific research. Center for Educational Literature (2014).
9. Litvinova, S.: Organizational and educational problems of implementation of information and communication technologies in general educational institutions. Information technologies and teaching aids 6(14), (2009).
10. Atyaskina, T.: Organization of independent work of students in the discipline "Elements of mathematical logic", http://self-educ.ru/?page_id=33
11. Spirin, O., Vakalyuk, T.: Criteria of open web-operated technologies of teaching the fundamentals of programs of future teachers of informatics. Information Technologies and Learning Tools 4(10), 275-287 (2017).

12. Proskura, S.: Application intellect-cards for improving quality and efficiency of teaching students programming courses of higher education institutions. Topical issues of natural and mathematical education 1(9), 129-137 (2017).