Development of Professional Competencies of Information Technology University Teachers: Motivation and Content

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Abstract. The article sets out to analyze the professional competencies on the standard European e-Competence Framework. The survey of information technology teachers of Ukrainian universities concerning the necessity of forming and development of European e-Competence Framework competencies allowed defining the priority areas for training and forming the content component of a model of professional competencies development of information technology university teachers. The proposed model distinguishes stages, factors, and resources for training teachers. Teachers' attitude to motivation, time and money allocation for professional development was researched. The content component of the development of professional competences of teachers of information technologies is offered. Recommendations for training and advanced training of teachers of information technologies, assessment of the level of development of professional competence, was proposed.

Keywords: European e-Competence Framework, Professional Competencies of Information Technology University Teachers, Development of Professional Competencies.

1 Introduction

The issue of transformation of education according to key challenges is being actively studied and discussed. Microsoft Corporation suggested a framework of higher education transformation comprising the following range of transformation processes: managing the life cycle of a student from admission to employment and maintaining contact after finishing the IT-oriented study; teaching, learning, and research based on the systems of educational content management, new teaching technologies, hybrid cloud-oriented educational environment and services for scientific research and communication; combined campus that unites automatized management of administrative activity, the access policies on resources and services, educational laboratories, network communications and their management, automation of engineering systems etc [1,2].

The world is becoming increasingly technological. All the spheres of human activity are automatized, modern technologies are widely used even in professional activities pertaining to liberal arts. Ubiquitous technologization sets new challenges for higher education, being connected with such global issues as financing and state policy in the field of education, as well as with technological issues, namely use of ByoD/ByoIT/Cloud&Hibrid IT [3]. The approach to work in classroom using personal devices and IT requires a properly organized structure at the university, both network and server ones, while use of cloud and hybrid IT technologies – organization of access and administration of these technologies according to the concept of smart university [4].

The current state of the world IT industry, development of smart education technologies, and constant change of employers' requirements to training of IT specialists at universities force all the participant of educational process to search new models of development of professional competencies of university teachers who provide training of future IT specialists. In higher education, new technologies, based on principles of open education, are also used for organization of academic activities, in particular, for organization of educational process. Teachers should not only master the technologies of e-Educational content, but also the methodology of their use in teaching disciplines according to the technology of blended, adaptive, and project-based learning [5,6]. The constant change of the curriculum of computer science in secondary school, which is becoming more oriented at STEM Education, results in brand new competence in IT of the students entering the higher educational establishments. Data show that the set of core cognitive knowledge, skills, and abilities that are associated with a STEM education are in demand in nearly all job sectors [7,8]. It should also be considered in teaching professionally-oriented disciplines of IT majors. Undergraduate students should obtain basic knowledge in IT, which will be necessary during studying specialized professionally-oriented disciplines in the last years of education to the extent meeting the current requirements of employers. Thus, cooperation with IT business is a real objective for an IT teacher, and its achievement will solve a range of issues connected with the quality of practical training of students. An IT teacher should clearly understand what professional competencies are to be formed by a future IT specialist, as well as realize the importance of forming soft skills, self-education, research, and other competencies crucial for successful career in IT field.

Problem statement: to study the components of professional competence of IT teachers and develop a model of professional competencies development (lifelong learning) of IT teachers at higher educational establishments.

2 Analysis of Publications

Research by Ukrainian and foreign scientists indicate the significant attention to the issues of development of methods, forms, and means for forming and developing professional competencies of university teachers.

Computer science is an educational field that will continue to need qualified teachers and professors to accommodate increased student populations and interest across the

nation. Government initiatives, changing school policies, financial incentives to major in computer science, and an increased need to hire more computer science professionals (including educators) adds to the appeal of pursuing a teaching career in computer science [9].

Namely, Ji Hyun Yu, Yi Luo, Yan Sun, Johannes Strobel [10] studied a model of competencies for teachers of engineering disciplines, in which they distinguished 7 components: Engineering Concept Knowledge, Engineering Skills, Knowledge about Engineering Disciplines, Engineering Pedagogical Content Knowledge, Attitudes toward Engineering, Attitudes toward Teaching Engineering, Integration of Engineering with Other Subjects.

Such a model partially considers modern approaches to competencies of a university teacher in terms of their digital competence. The six areas of European Framework for the Digital Competence of Educators focus on different aspects of educators' professional activities [11]: Area 1: Professional engagement using digital technologies for communication, collaboration and professional development. Area 2: Digital resources sourcing, creating and sharing digital resources. Area 3: Teaching and learning managing and orchestrating the use of digital technologies in teaching and learning. Area 4: Assessment using digital technologies and strategies to enhance assessment. Area 5: Empowering learners using digital technologies to enhance inclusion, personalization and learners' active engagement. Area 6: Facilitating learners' digital competence enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving. The analysis of the level of digital competences of students and teachers of Ukraine according to DigComp 2.1 methodology is given in [12]. It is determined that the level is sufficient, but there is a difference between teachers and students, which is the basis for organizing cooperation within the educational process.

In our opinion, ISTE Standards for Computer Science Educators [13], comprising 4 components: Knowledge of content, Effective teaching and learning strategies, Effective professional knowledge and skills, Effective learning environments, describes the elements of the Computer Science Educators competency in the most accurate manner, in the light of the issue considered. The model of competencies of a teacher includes pedagogical competencies that consist in mastering modern technologies of teaching, methods, and tools for development of educational content, analysis and assessment of e-Educational resources, conducting scientific research and processing their results using modern tools and services, including cloud ones. Both professional and pedagogical competencies of a teacher include the set of digital competencies and specific subject competencies.

Professional competences in information technology deal with the design, creation, management and maintenance of the varied components of the system, including software, hardware, networks, systems integration and multimedia. Broadly, information technology can be divided into four central pathways: network systems, information support and services, programming and software development, and Web and digital communication [14, 15].

Two chapters of ISTE Standards For Computer Science Educators, namely Knowledge of content and Effective professional knowledge and skills, correlate with European e-Competence Framework [16].

3 Discussion

Analyzing the competencies described in European e-Competence Framework, we should pay attention to purely professional competencies presented in 5 sets: planning, development, performance and support, implementation, management. The survey among IT teachers of departments of Information Technology (National University of Life and Environmental Sciences of Ukraine, Borys Grinchenko Kyiv University, National Pedagogical Dragomanov University, Sumy State University, 126 respondents) allows building a general vision concerning the content of the necessary competencies of IT teachers in professional engagement. Namely, while assessing the necessary competencies of the chapter "Planning", teachers noted a significant need for development of the following skills: A.5. Architecture Design, A.6. Application Design, A.7. Technology Trend Monitoring, A.9. Innovating, which gained more than 60% of scores 3-5 on the scale from 1 to 5. In contrary, skills of A.1. IS and Business Strategy Alignment, A.2. Service Level Management, A.3. Business Plan Development, A.4. Product/Service Planning, A.8. Sustainable Development got from 40% to 50% of high scores (Figure1).

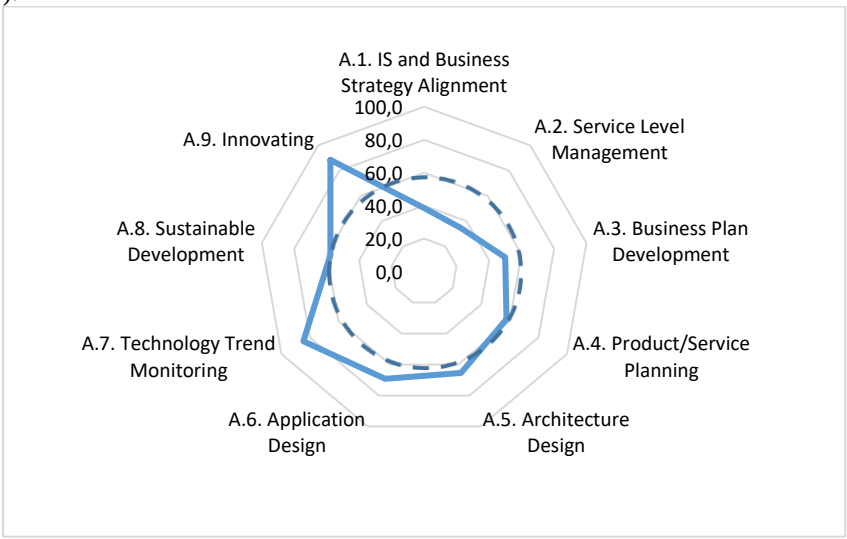

Fig. 1. The quantity of high scores concerning the necessity of forming competencies of IT university teachers indicated in Chapter "Planning" of European e-Competence Framework (own resource).

On average, all groups of competencies of the set B. Build have more that 70% of high scores (Figure 2).

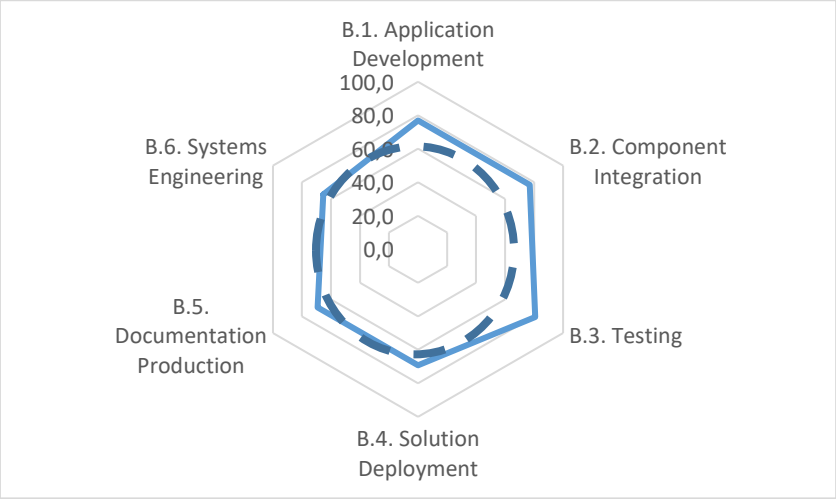

Fig. 2. The quantity of high scores concerning the necessity of forming competencies of IT university teachers indicated in the chapter "Build" of European e-Competence Framework (own resource).

Figures 3-5 show the scores of the rest of groups of competencies. Analyzing the results of the survey, it should be mentioned that IT teachers recognize the need for development of professional technical competencies and to less extent – for development of digital market competencies, as well as competencies in sales technologies and business management.

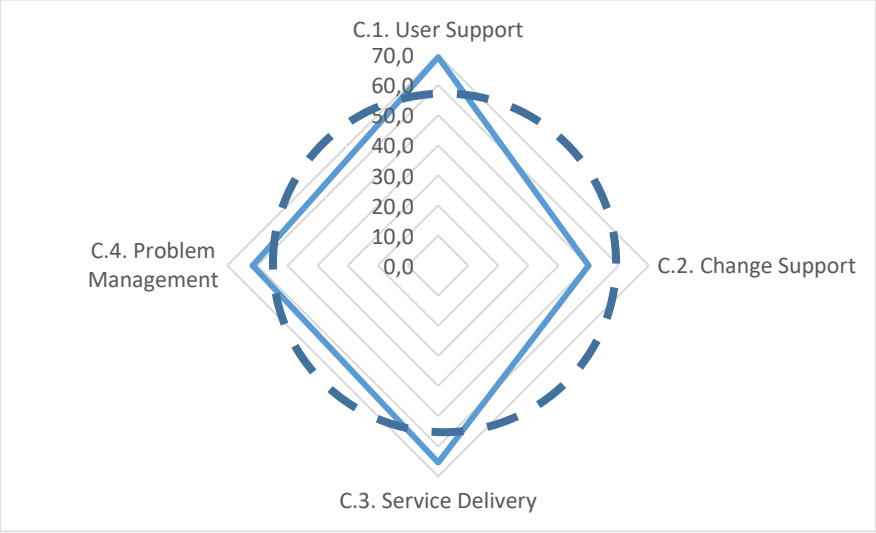

Fig. 3. The quantity of high scores concerning the necessity of forming competencies of IT university teachers indicated in Chapter "Run" of European e-Competence Framework (own resource).

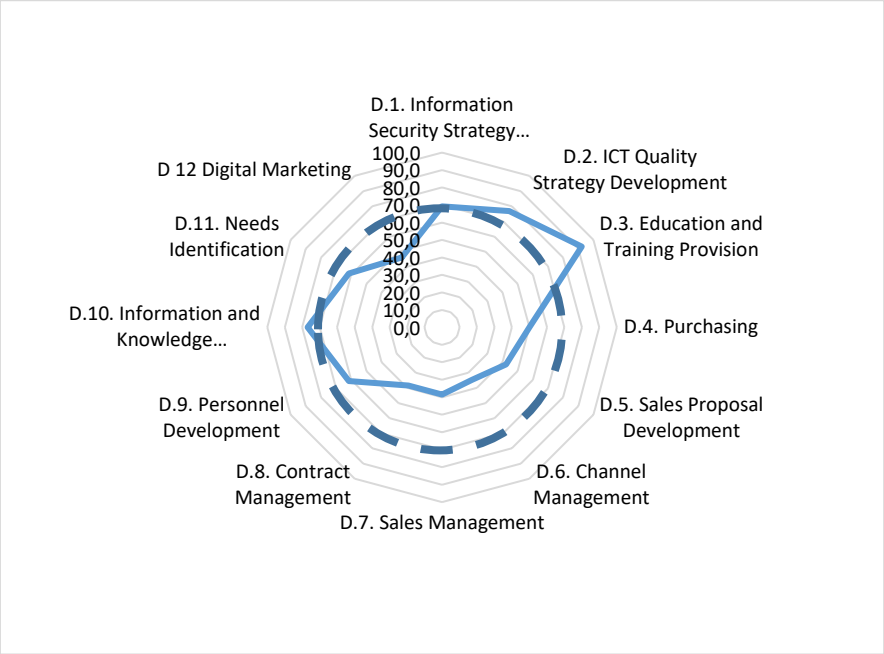

Fig. 4. The quantity of high scores concerning the necessity of forming competencies of IT university teachers indicated in Chapter "Enable" of European e-Competence Framework (own resource).

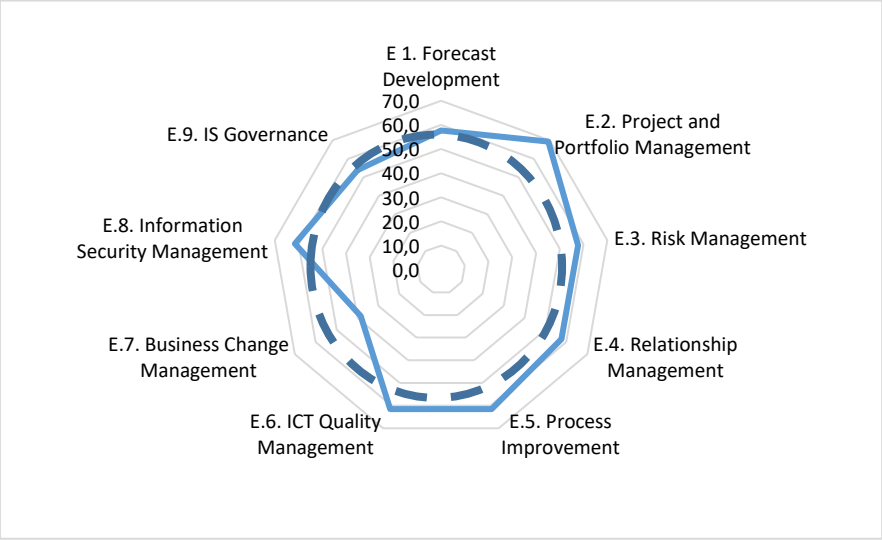

Fig. 5. The quantity of high scores concerning the necessity of forming competencies of IT university teachers indicated in Chapter "Manage" of European e-Competence Framework (own resource).

4 Results of the Research

While conducting a survey among respondents – members of teaching staff of IT departments, we have identified a need for constant improvement of own level of professional competence to ensure a successful career. All the respondents noted that lifelong learning to a large extent provides training for the role of teacher they are currently performing (Figure 6).

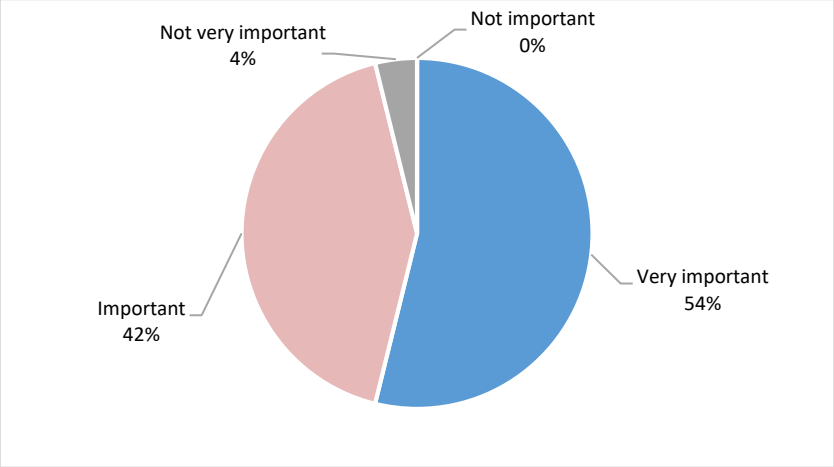

Fig. 6. Need for lifelong learning (advanced training) for further successful teaching activity

Assessing the necessity of training, IT teachers recognize very significant and substantially significant difference between professional activity they are conducting now and that necessary to be conducted in 10 years (Figure 7).

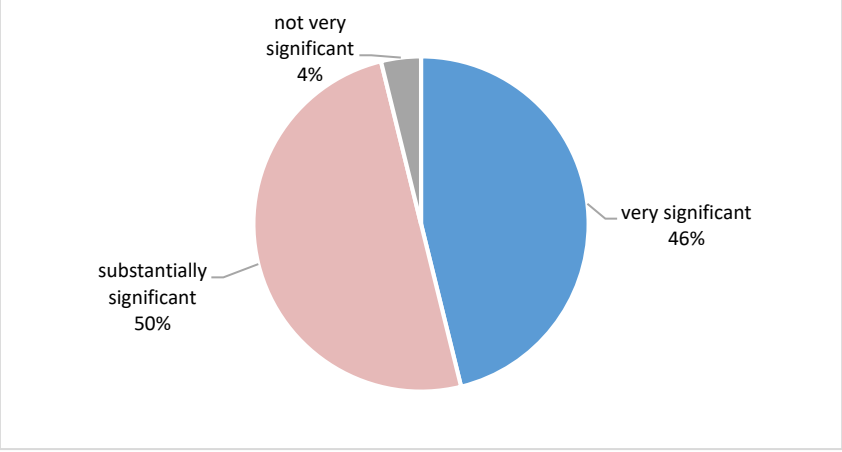

Fig. 7. Assessment of difference in the professional work of the IT teacher now and in 10 years

Considering this issue, a model of professional competencies development is proposed, whose aim is to improve the level of professional competencies of IT university teachers. The model is presented in Figure 8.

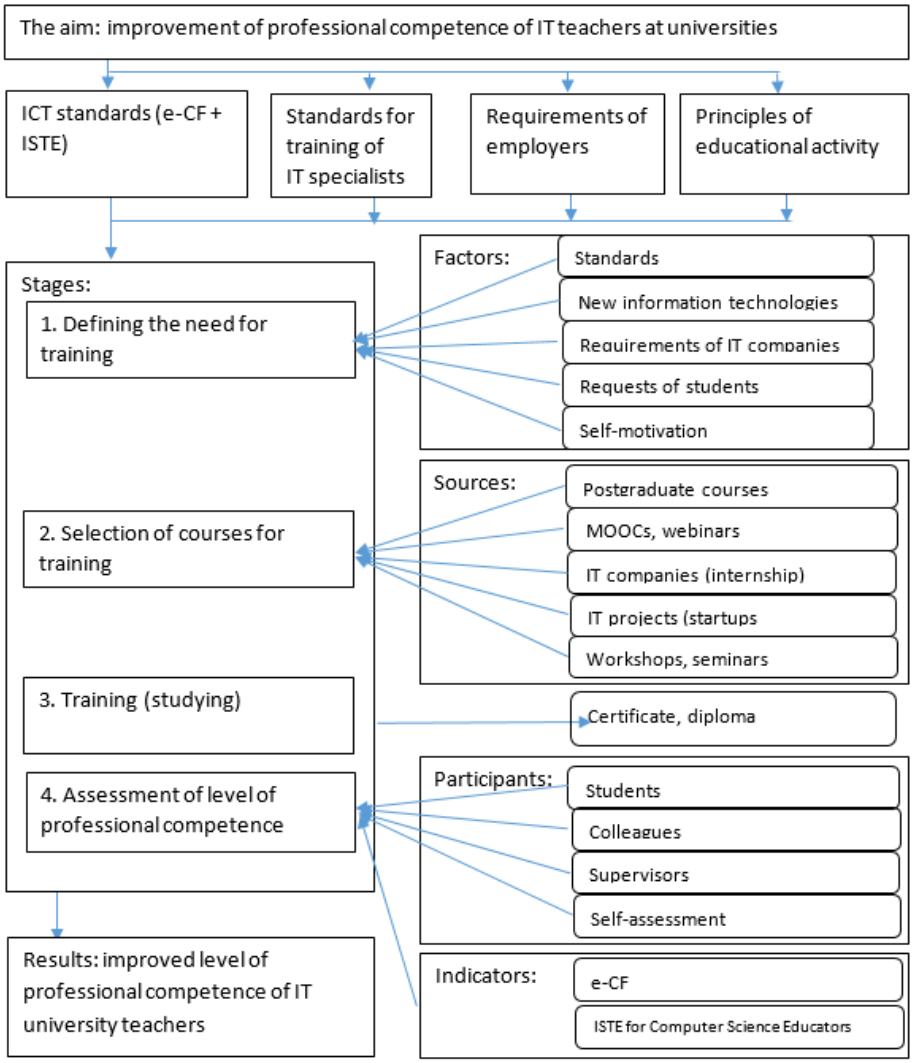

Fig. 8. A model of professional competencies development of IT university teachers

The conceptual unit of the model includes the Computer Science Educators standards, the standards for training of IT specialists (field standards, curricula), requirements of employers, and the principles of educational activity. The content of professional competencies of IT university teachers is devised on the basis of the conceptual unit data. Considering the analysis of the standards and models of competencies Computer Science Educators, the results of the survey presented in figures 1-5, we propose to take 2

following standards as a basis: e-cF (Professional knowledge and skills: Plan, Build, Run, Enable, Manage) + ISTE (Effective teaching and learning strategies, Effective learning environments).

The model distinguishes 4 stages: 1) Defining the need for training; 2) Selection of courses for training; 3) Training (studying); 4) Assessment of the level of professional competence.

4.1 The Need for Training: Factors and the Results of Self-Assessment of the Level of Professional Competencies

The first stage of the model is defining the need for training. The main factors influencing the awareness of the need for development in professional activity include self-motivation, requests of students, requirements of employers, emergence of new informational technologies, new teaching technologies, and standards of competencies for Computer Science Educators. Our research proves that the most significant factors motivating IT teachers to training are emergence of new technologies – 42 % and requirements of IT companies to training of IT specialists – 25 %.

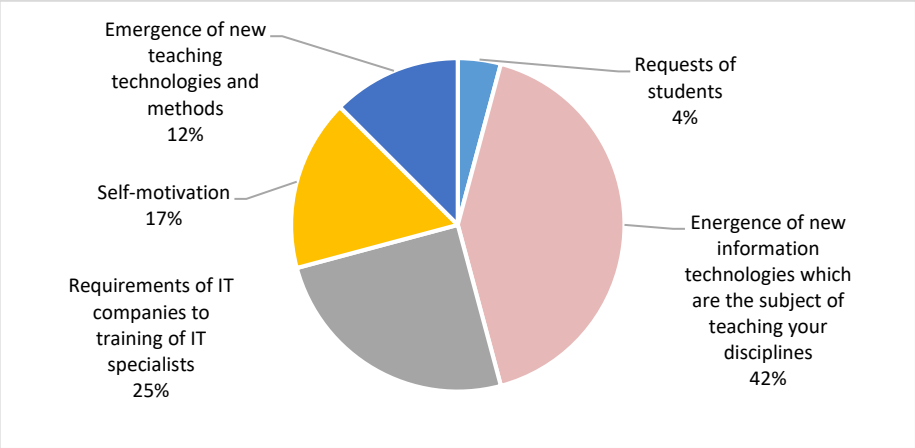

Fig. 9. Factors of motivation to professional competencies development

One of the efficient tools in defining the need for training is self-motivation (17%, according to the results of our research), which is based on the desire of a teacher to comply with the level of professional competence that would satisfy the students, first of all. Addressing the standards and self-assessment of compliance with the competencies specified therein are one of the methods of defining the need for self-development. The proposed questionnaire comprising the levels of mastering particular competencies due to the European e-Competence Framework can serve as the example of such self-assessment. Every IT teacher will be able to assess their level (do not possess, aware, sufficient, advanced, professional) according to a set of professional competencies, proposed by the European competence framework e-CF. In particular, Figure 10 shows the results of such a survey according to the set “B. Build”.

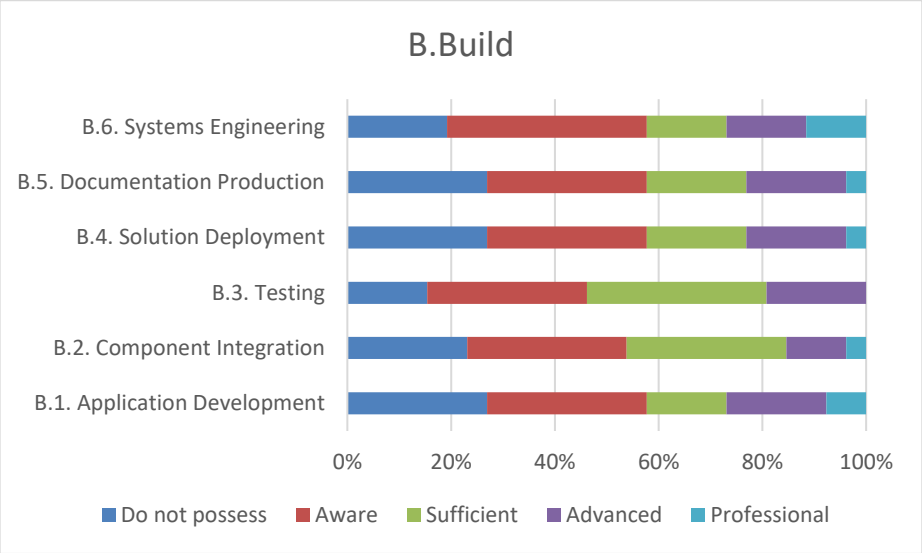

Fig. 10. The results of self-assessment of IT teachers according to indicators of the set "B. Build" of e-CF

4.2 Selection of Courses for Training: Resources and Willingness of Teachers to Allocate Time and Costs for Studying

Computer science teachers are always keep their eyes on the latest advances, the newest tools and breakthroughs [17].

After defining the need for training, the second stage of the model of professional competencies development consists in selection of courses for training.

Institutes of postgraduate education, educational and training centers offer a significant number of training courses. For the purpose of training in modern IT, there exist a great variety of MOOCs and webinars that allow attending a training course in any topic or aspect of academic discipline, passing tests, completing tasks. Such MOOCs and webinars should be selected according to the following criteria:

- Authorship of a course (a technology company, famous specialists);
- Compliance of representation of materials of the course with a teaching style to provide more efficient perception of the materials;
- Possibility to cooperate while completing the tasks of a course;
- Possibility to ask questions and get the answers;
- Control of academic achievements at the end of the year;
- Obtaining a course completion certificate.

Namely, the MOOCs Coursera, EdX and others in the IT field contain a large number of resources for professional self-education and training. One example of a certification course for a computer science teacher is a course "Foundations of Computer Science for Teachers" hosted on a platform EdX [18] is shown on fig.11.

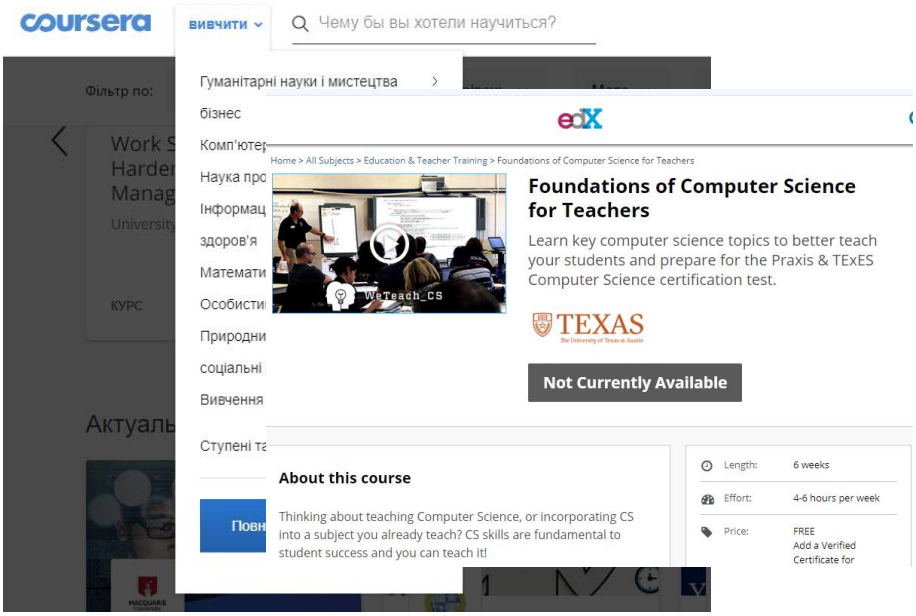

Fig. 11. The subjects of the MOOCs Coursera and EdX

Another example is the training courses, which teach how to teach computer science. Typically, these courses consist of two parts - computer science and didactics. For example, the course “Teaching Subject Computer Science” [19] contains the following content: Computer Science (ways of thinking and working specific to computer science, learn to judge the effects of technology and reflect on social aspects of computer science, learn about fundamental aspects of computer science e.g. mathematics, logic, theoretical computer science, hardware and computer networks; acquire sound knowledge of the software development process e.g. how to select a suitable programming environment, algorithms and data structures) and Didactics (how to plan, teach, reflect on and evaluate computer science lessons; how to prepare computer science topics in an age-appropriate and motivating manner; how to understand, analyse and support subject-specific learning processes, how to connect computer science with pupils’ everyday experiences; work with new technologies, as well as media-related and pedagogical concepts which you apply in lessons).

Needless to say, not all the courses and trainings are free. The results of the survey show that not all the teachers are willing to allocate time for their development or pay from salary for their development. 20% of teachers do not consider it necessary to invest their own money into their development. About a half of respondents are willing to allocate only 1-2 hours per week for their training (Figure 12).

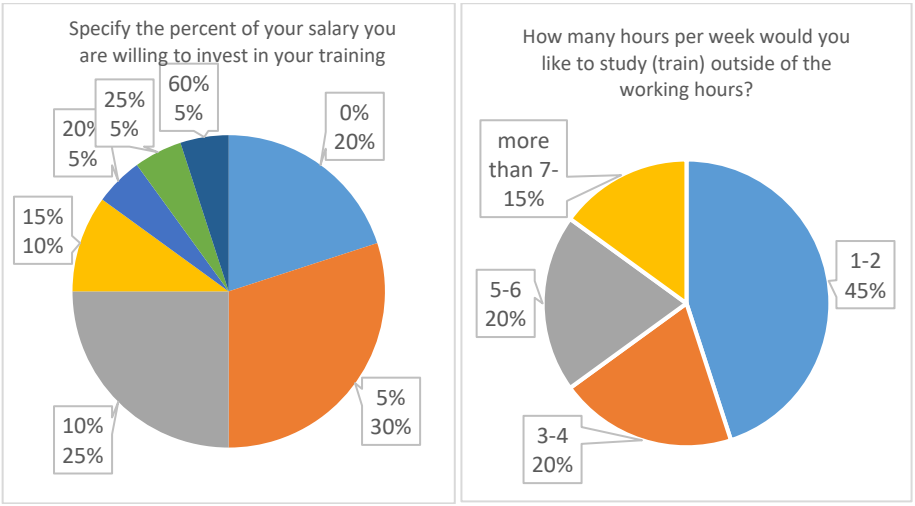

Fig. 12. Willingness of teachers to allocate time and costs for professional competencies development

For development of practical skills of teachers, it is necessary to constantly cooperate with IT companies and participate in development of IT solutions of various level of difficulty. Internships and involvement in project solutions at IT companies are one of the most efficient mechanisms of consistent improvement of professional competence in practical dimension. Cooperation with IT companies can be provided by means of:

- Involvement of students and teachers in implementation of the projects ordered by IT companies. Hence, a teacher is managing a project and improving the level of practical skills of IT specialist;
- Involvement of companies in teaching academic disciplines and practices. A teacher receives recommendations, practical cases, and assistance in their resolving;
- Part of academic classes is transferred to a company and conducted under supervision of a company's tutor. Together with students, a teacher acts as an executive, improving the level of practical skills.

Attending conferences, workshops, and seminars where teachers are able to obtain new knowledge and skills, is another efficient mechanism for their self-development.

Every member of teaching staff of university should not only conduct educational activities, but also carry out research, scientific projects, and publish the results of research. Scientific achievements form a basis for their educational activities, since they are of significant theoretic value and, thus, should be accessible for students.

4.3 Studying and Assessing the Level of Professional Competencies Development

The third stage is a direct training of teachers, which results in obtaining certificates, diplomas, etc.

The fourth stage consists in assessment of the level of professional competencies and, if necessary, returning to the first stage. Assessment of the level can be conducted by a teacher themselves, their students and colleagues, as well the supervisors. This model of assessment is widely used in business, known as "360-degree feedback". It is necessary to properly develop behavioral indicators that will characterize the level of professional competence, or use the ones offered in e-CF.

5 Conclusions

The proposed model, based on the analysis of modern standards of professional competencies of IT teachers, consists in a range of consecutive stages: defining the need for training, selection of courses for training, completing the courses, assessment of level of professional competence. The need for training is formed due to the following factors: emergence of new information technologies, new teaching technologies, requirements of IT companies to qualification of graduates majoring in IT, requests of students, and self-motivation. To define the need for professional competencies development, the existing standards (e-CF, ISTE) should be used, in accordance with the devised indicators for each set of competencies. The same indicators are to be used for assessment of professional competencies of teachers. Postgraduate courses can be used to substitute the advanced training courses. Additionally, it's possible to use training programs for teaching staffs of departments, which are based on MOOCs and form the necessary competencies.

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