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PROBLEMS OF TEACHING SOFTWARE ENGINEERING IN AZERBAIJAN

The article explores the current state of teaching software engineering in Azerbaijan and emphasizes the importance of the training experts in compliance with modern standards in order to develop competitive software systems. The problems existing in teaching software engineering are analyzed, and recommendations for addressing these problems are proposed.

Keywords: *software engineering, software systems, teaching, summer schools, standards.*

Introduction

The application of advanced technologies is one of the primary factors boosting the economic prosperity of any nation. The development of information society in recent period has also increased the demand for information communication technologies (ICT), and software-managed systems have begun to be applied in all sectors.

Technologies of establishment of software complexes is based on modern automatized methods and technical tools applied during the lifecycle of software products. The expensiveness of such tools is a culprit for the increase of software products.

The development of information communication technologies and the systems operating on their basis has led to the emergence of some difficulties during the process of development, maintenance and upgrading of software tools. Large volume of codes and the growing complexity in terms of architecture and technological solutions have necessitated the attraction of large expert staff for the development of such software tools. Individual programming of small software tools was abandoned, and it was shifted to the technology of collective development of large software complexes by employing modern methods of design. Acquired knowledge, experience on the development of excessively complex software tools, etc. have led to the systematization and generalization of new technologies and methods of software tools. Hence, the sphere of Software engineering (SE), providing the life cycle of software tools (ST), has emerged on the basis modern methods. Software engineering is a scientific field providing the development, practical application, maintenance and upgrading of software tools and complexes by using systemized group of standards [1].

Software engineering is not only engaged in technical issues of ST, but also the management and financing of software projects, as well as in staff management and other issues. Alongside, one of the main purposes of SE is to support the manufacturing process of ST, and to develop tools, methods and theories in order to achieve maximum level of effectiveness and quality.

Special place is devoted to the development of information communication technologies as a sector being alternative to oil sector in the economy of the Republic of Azerbaijan. It is certain that it is unattainable to compete with leaders of hardware manufacturing. Hence, the development of modern software tools and the training of software engineers of the world level should be considered as one of topical issues.

Current state of the teaching of software engineering in Azerbaijan

The development of science and technologies, economic globalization, integration processes in civil society necessitates the establishment of more advanced systems of defense, training, production, transportation, energy and other systems. Acceleration of technological advancements leads greater complexity of such systems, and in some cases, the lifecycle of software systems, put into operation, are prolonged for several times. Not only systems, but also establishment tools of those become more complex. In order to preserve the high quality and the competitiveness of software systems, professional experts are on demand capable to enhance their knowledge

continuously, and find effective solutions by benefiting from the contributions of international colleagues and possesses the ability to pursue purposeful activity. These features must be instilled and improved during the years of studentship. The experts capable to develop competitive software systems in world markets must be educated in higher education institutions.

Software engineering is a dynamically changing subject field. An incessant development of the hardware platforms, and at the same time, enhanced application of those in various fields of industry and production has increased the demand for ST. Alongside, programming technologies also develop dynamically. Thousands of programming languages have fostered the establishment of various libraries, modules and development environment.. In order to develop software tools, models entailing all stages of software lifecycle have been generated. At present, the training of IT experts is considered to be one of the priority spheres in the world. SE experts must be capable to work with the most advanced technologies of programming for being able to develop and maintain modern ST's. Students study 4-6 years at universities. After completion of their studies, the acquired knowledge is either outdated or not topical anymore, which discourages the students to pursue the education and the programming specialty [2].

In the majority of higher education institutions in Azerbaijan, students are not taught software engineering, but rather the algorithms of solution of some problems and the coding of medium-size programs are covered. Demand management, software project management, software testing, etc. which are integral parts of SE are either not taught, or taught at masters' level in some universities. While the teaching of these topics is not at desired quality and level, students receive these classes as auxiliary and redundant information. Hence, students form the opinion that, it is sufficient to learn programming in order to become a programmer. However, the largest part of expenses devoted to the development software tool is not spent on program coding as such, but rather on the actions mentioned above. ST integration into existing infrastructure also leads to additional expense. As a result, national software system does not achieve competitiveness in the world market, and the elimination of system and technical errors necessitate their upgrading. Higher education institutions do not train system analysts, project managers, experts on software testing and quality maintenance. Students are unaware of modern methods, technologies supporting lifecycle of software systems, automatized instrumental tools and international standards.

The teaching of software engineering must be organized in such a way that to be able to train experts possessing organizational and management skills and capable of developing competitive software systems of any class. Countries with advanced software industry have developed knowledge digest on modern software engineering ("IEEE-SWEBOK Guide V3" [3]) and teaching standards ("Software Engineering 2014: Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering" [4], "Computer Science Curricula 2013" [5]) by applying the complex of international standards covering the life cycle of software systems [6,7]. National standards must also be developed in Azerbaijan in accordance with international standards.

The following knowledge and skills are required from professional programmer in SE standards:

- communication skills with customer;
- adequate specification of requirements;
- selection of employed technologies;
- software settings;
- software testing;
- integration of developed modules into existing software;
- preparation of various documents;
- project management.

One of the challenges in educating software engineers is the language problem. The majority

of students at higher education institutions are not capable to work with original scientific-technical and compulsory materials in English. This necessitates the preparation of new textbooks in Azerbaijani language. Moreover, western universities cooperate with leading companies of the world. Alongside with methodical expertise in teaching at universities, educators also possess large work experience in leading software system companies of the world (for example, leading experts and some high-ranking employees of ISO/IEC/SEI are also university teachers). It is necessary to benefit from the world practice in this field.

Traditionally, practical tutorials, laboratories and course works are held in order to teach programming to students at universities, which is very different from the realities of advanced programming industry. Hence, in order to deliver up-to-date knowledge to students, it is necessary to have close relations with organizations developing real software projects, to attract experts with rich work experience, improve curriculum and add new modules topical for the modern life. However, all the above mentioned require additional financing, and universities prefer the traditional teaching of programming [8].

It is also very important to organize student projects and summers schools in order to fill the gap between university education and real industrial programming. For example, universities can cooperative with industrial companies and attract students interested in this field to work on the solution of a particular topical problem with professional programmers. As this activity will not require additional costs by universities, and companies are interested in training new experts, those would allow the students to work with company experts. It is already practiced in countries such as Russian Federation and Ukraine. Microsoft Summer School in Software Engineering and Verification [9], Microsoft Computer Vision School [10], Microsoft Data Structures and Algorithms School [11] summer schools can be shown as examples in this regard. Several events are held in European universities for professional programmers and candidates.

Summer schools last from several days to two weeks. These events are research-oriented and resemble the format of conferences; organizers, acknowledged scholars and members of organizations are invited, reports are presented, discussions and seminars on various topics are held. There is also an opportunity to carry out middle-size assignments for familiarizing with new technologies and software tools.

Google Summer of Code [12] software event of Google corporation should be mentioned in particular. Several large-scale projects are annually chosen to develop open software tools within the scope of the project, and students participating in this competition propose their ideas on the development of such products. Head of each project adopts the idea most favored and carries out with the participation of students. Participants successfully completing the tasks posed by the Google Corporation and receiving positive feedback from project head are financially remunerated.

The experience shows that both parties participating in student projects benefit from them. It facilitates the companies to give more advertisements at universities, spark the interest of young programmers and invite best of them. It gives students the opportunity to acquire to programming languages and technologies, adopt knowledge and skills from experienced programmers, and receive positive feedback in order to be employed in future. Universities, in turn, improve the quality of the teaching and attracts the students to education.

One of the main features distinguishing an expert of software engineering from regular programmer is his/her ability to work in team. It is only learnable in practice. Students acquire the skills to ask questions, clarify unclear issues in posing the problem and explain carried out work to experts and high-ranking employees. They learn the responsibility for: the work done, carrying duties, not to leave colleagues in bad situation and serve to common interests.

The absence of large-scale software projects, low remuneration of programmer work, low level of education impedes the formation of software engineering as an industrial field in Azerbaijan. Continuation of such situation and negligence of problems does not allow improving

the competitiveness of the science of Azerbaijan and occupying the desired position in technologies among world countries.

However, alongside with above mentioned limitations, some measures are being carried out in our republic in recent years to provoke the interest of students for programming. For example, AzRoboHack – I Republican Robot Programming competition was organized by ICT Scientific Research Center of Qafqaz University in 2014, for the first time, devoted to 91st anniversary of national leader Heydar Aliyev.

The aim of the projects is to reveal the potential of university students, to develop students' skills in carrying out large-scale work in short period of time, as well as to raise the interest of students for robototechnics and programming. The University calls other universities to compete by demonstrating the acquired potential.

Fortunately, the interest for programming is increasing in our republic. Azerbaijani programmers work in leading companies of the world; students of Baku high schools participate in international Olympiads, and some of them occupy the first place. The signs of software engineering can be seen in the activity of some programming companies. All of these, once again, emphasize the scientific potential of our republic.

Conclusion

The science of cybernetics and programming in Azerbaijan has started to be established starting from the 60's. Although a programmer position existed as a specialization during the Soviet period, the mentality of software engineering was not formed. Despite that, the programming sphere has emerged in the middle of the 20th century, national programmers lack the expertise to create large systems and the capability (and interest in some cases) to benefit from the achievements of the world science. Azerbaijan lags 15-20 years behind the advanced Western countries in the development of methods and tools of complex systems.

It is to be noted that existing experts in our country (scientific workers, engineers, managers, teachers) are not professionally and psychologically trained to utilize the achievements of software engineering in a planned and efficient way. It is a great loss in economic and strategic terms for our country and society. Teachers, experts and students must consolidate their efforts in order to form the modern teaching processes and professional environment oriented towards the education and further training of experts developing the complex software tools in our country. Complex software tools must be developed in order to achieve complete information sovereignty. It is possible to crowd out foreign software tools and establish the national industry of software year by year and step by step. This is not an easy task and the experience of foreign countries show that there is a need for thousands of experienced programmers for this purpose.

Hence, it is important to deliver the following topics to students at universities preparing experts for IT sector in order to develop competitive software tools in the world:

- Contemporary programming languages;
- alongside with coding, the teaching of specification of requirements, documentation and project development;
- the shift from “small-scale” programming to “large-scale” programming based on ready architecture and components;
- methods of application, verification and validation of standard at all stages of life cycle of ST;
- project management (management and evaluation);
- shift from individual activities to collective activities;
- code of conduct of software engineers;
- CASE-tools;
- teaching of cloud technologies (cloud computing);
- Big data technologies;
- Data mining;

- Internet of Things.

In order to deliver this knowledge to students, textbooks must be prepared on these topics, and state standards and curriculums must be developed according to international standards. If the mentioned problems are not addressed in the near future, it is impossible to achieve the competitiveness of goods and services of national programming.

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