***Peculiarities of Bachelors of Computer Science Professional Training:
Japanese and Ukrainian Experience***

Inna Pododimenko, Khmelnytskyi National University, Ukraine

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Abstract
The article presents the most urgent problem of the professional training of human resources for the information technology industry in higher educational establishments of Japan and Ukraine. The comparative analysis of the models of bachelors of computer science training at the universities of Japan and Ukraine suggest the presence of similar (the orientation on the requirements of the labour market and society; the use of methodological approaches, pedagogical, psychological, didactical and methodical principles; the organization of specialists' training on multilevel basis; the division of cycles of disciplines on the obligatory and elective blocks; the orientation of the content on integration of fundamental and special knowledge; the creation of optimal conditions for the formation of professional competence) and different approaches (in Japan: the standardization of professional training; the variability and flexible character of educational programs; the possibility of choice of the future specializations; the high level of organization of independent students' work; the wide implementation and use of modern teaching techniques and innovative technologies; the creation of possibilities for professional development and self-realization by participating in the international exchange and internship programs; in Ukraine: the inconsistency between qualification level of bachelor and the world requirements; the training orientation on the formation of the comprehensively developed IT specialist; the shortage of proper scientifically-methodological, material-technical providing and high-tech learning environment of the universities). The especial value and primary importance of achievements of Japan for pedagogical public of higher educational establishments of Ukraine are emphasized.

Keywords: tertiary education, bachelor of computer science, curricula, quality assurance

Introduction

The calls of globalization, reference-points of information world space, rapid development of information communication technologies, intensification of computerization process in all industries have intensified the strengthening of attention to specialists in computer science professional training who not only own thorough theoretical knowledge and practical skills but foremost able to form effective interpersonal relations, creatively and non-standard come to problems solving, achieve set aims and results in constantly changeable production and social situations.

The tendencies of professional training of specialists in the information technology industry in Ukraine testify the attempt to co-ordinate study and practical activity with European and international standards, in particular by the improvement of conceptual, legislative, socio-economic, institutional, organizationally-pedagogical and informative constituents. The normative maintenance of specialists in computer science professional training is worked out at the level of the Industry-standard of Higher Education of Ukraine on Undergraduate Program 6.050101 "Computer Science" (Industry-standard, 2011), that was worked out on the basis of international recommendations Computing Curricula 2001-2005 with taking into account of new realities of Ukrainian economy, labour market, requests and needs of graduate students, employers on the basis of such principles: contemporaneity; system and strictness; continuity and integrity; educational program integration and differentiation; block-module approach to educational program formation; practical orientation.

Notwithstanding certain theoretical groundwork and considerable practical achievements of native pedagogical experience, information technological and software providing, the insufficient amount of study hours of professionally-oriented and elective courses of speciality, insufficient scientific level of faculty members, low level of international cooperation, teachers and students academic mobility, insufficient amount of professional IT associations and unions, absence of the effective IT human resources certification and accreditation system negatively influence on the quality of information technology specialists professional training, slow down their further professional development.

Taking into consideration all aforesaid one of ways to increase the efficiency of these specialists professional training is the search of new approaches with an orientation on the experience of highly developed countries. In the analyzed context the scientific interest is in the achievements of Japan, the most educated country of the world, that has considerable achievements in modernization and permanent improvement of higher education, powerful scientific base, high-tech conditions, international authority in IT human resources training. The multifold research and objective study of the best pedagogical achievements of Japanese experience will assist the enrichment of scientific views of native scientists with new ideas concerning the set of conceptual principles, content transformation, improvement of forms, methods and techniques, scientifically-methodical providing of bachelors of computer science professional training.

The obvious urgency, insufficient amount of research on the problem and practical requirement in its solving have defined the aim of the research is to characterize the peculiarities of bachelors of computer science professional training in Japan and Ukraine and define possibilities of the positive ideas of foreign experience implementation into the native system of higher IT education.

Literature Review

Many researchers contributed to the problem of the training of engineers in the information communication technologies industry in Ukraine and abroad. The problem of the training of future professionals in the field of computing is investigated in the dissertations of A. Gudzhiy (the teaching of programming at higher education), H. Kozlakova (the continuous training of specialists in computer systems), T. Morozova (the theoretical-methodological fundamentals of higher information technology education), Z. Seidametova (the methodical system of continuous training of specialists in information technologies), S. Semerikov (the basics of fundamentalization of computing courses teaching), et al.

The research works of V. Bykov, B. Vulfson, O. Karelina, I. Kozubovska, V. Kukharenko, N. Nychkalo, P. Stefanenko, N. Syrotenko, et al are dedicated to the aspects of lifelong education and distance education.

The problems of the professional training of specialists abroad are investigated in the research of Ukrainian scientists in comparative professional pedagogics such as N. Bidiuk, T. Desiatov, V. Kovalenko, T. Koshmanova, K. Korsak, N. Patsevko, L. Pukhovska, A. Sbruieva, N. Sobchak, B. Shunevych, et al.

The scientific pedagogical research on the problem of development of Japanese pedagogical theory and practice with the aim of creative implementation of progressive ideas at the native educational practice were conducted by Yu. Boiarchuk, A. Dzhurynskyi, V. Elmanov, V. Kudin, I. Ladanov (the modern state of the education system), O. Myhailychenko, Ya. Neimatov, O. Ozerska (the professional training of English language teachers at higher educational establishments), N. Paziura (the theory and practice of intercompany training of specialists), V. Pronnikov, N. Repetiuk (the formation of education in modern Japan), T. Sverdlova (the theoretical fundamentals of the process of education humanization), L. Tsarova (the aesthetic culture of personality in modern school education), et al.

Training of IT Human Resources in The New Paradigm Of Professional Education

Researchers V. Yelmanova (1989), K. Korsak (1997), N. Abashkina (2002) justly assert that the previous paradigm of professional education was oriented in its development on the existent (planned) supply, while the new one must be orientated on the real demand of the labour market. Such situation is determined by many factors: one-time acquisition of qualification changes by realization of the necessity to obtain education during the whole life; need to obtain qualification of wide profile for possibility increase, change of profession, search of new job (unlike past approaches where qualification had a narrow profile, provided activity on a certain workplace); integration of processes of practical and theoretical training; flexible approach to set

study duration; orientation both on needs of formal and informal sectors of economy; orientation both on hire work and enterprise; decentralization of professional education management system that needs the presence of central, local structures, private sector.

The new paradigm of professional education is called to form the ability of specialist to find job and easily get along with professional duties. It is recognized that in modern market conditions an IT specialist must possess such qualities:
- skills of diagnostication, analysis of phenomena and processes, innovative activity, self-education;
- skills of team work, communication, decision making;
- professional knowledge and skills of fundamental character that can become the basis for providing of professional mobility;
- enterprise skills (creative approach to work, initiative, foresight of risks in the acceptance of new decisions, etc.) (Information-Technology Agency, 2010; MEXT, 2010).

Taking into consideration the abovementioned, the primary purposes of professional education recognized by both on Japanese and Ukrainian state level on the modern stage are the following:
-   providing for the youth general and professional knowledge that will become the sufficient basis for continuous life-long education;
-   providing the already working specialists with new knowledge and skills necessary for satisfaction of current production needs.

Comparative Analysis of Bachelor of Computer Science Training in Japan and Ukraine

The analysis of model of bachelors of computer science professional training has shown that leading universities of Japan (the University of Tokyo, Kyoto University, Osaka University, Kyushu University, Tohoku University, Tokyo Institute of Technology, Keio University, Waseda University, the University of Aizu and others) are oriented on IT human resources training with high level of creative potential, competitive on the labour market, responsible professionals who combine thorough professional knowledge, innovative culture, knowledge and skills of production manager and organizer, skills of interprofessional communication. In this direction Japanese scientists M. Ikeda (2010), N. Hativa (2000), K. Soetanto (2003), et al., conduct solid scientific pedagogical research: methodological approaches, pedagogical technologies, teaching techniques of studies are worked out and constantly improved and, as a result, graduates of higher educational establishments of Japan, achieve high results in professional activity.

The research results of the system of higher education of Japan convince that the characteristic feature of bachelors of computer science training is transference of accents from educational information transfer on development of personality through students' involvement into active creative activity in the field of disciplinary practice-oriented groups, mass participating in research and creative activity.

The study of Japanese experience of bachelors of computer science training has made possible to define main differences that positively distinguish Japanese model from native one, in particular:

- absolute advantage of Japanese higher education in amounts of financing, material-technical providing (Maruyama, 2004);
- orientation of Japanese higher education system on formation of independently intellectual, initiative, creative personality of IT engineer on the basis of individual-oriented curriculum, unlike in higher school of Ukraine where an accent is made on the systematic, successive mastering of courses content in the curriculum (Kumagai, 2001);
- flexible variants of courses study, mobile trajectories of education, possibility to chose teacher (unlike in Ukraine where actually there is not practice of free independent choice of educational course by student);
- close collaboration of Japanese universities with industrial enterprises and companies, professional IT associations;
- academic mobility and possibility to obtain double and joint degrees by continuous cooperation with foreign universities in Japan are system and organized at state level and presented by great number of programs, in Ukraine it remains spontaneous and individual the phenomenon (MEXT, 2011);
- material and technical providing of Japanese universities allows actively implement interactive technologies in the training process of specialists of different specialities, including bachelors of computer science. Universities possess high-tech equipment of lecture halls, computer classes and specialized educational-scientific experience computer laboratories that can sometimes occupy whole floors, and even separate building, and mainly is accessible for students around the clock;
- prevailing in the structure of study work of Japanese student the real independent obtaining of profession;
- mutual responsibility for quality professional training of Japanese students and teachers.

Also of important value for providing of quality training of competitive specialists is accreditation of educational program by professional organization JABEE. Unfortunately, for Ukraine such accreditation of educational program by professional organization in information technology industry is an off-type phenomenon.

It should be noted that at Japanese universities the Career Support Centers actively function that create favourable conditions for search and employment of students and graduates of university. This Japanese practice needs further comprehension and mastering by higher education pedagogical community of Ukraine.

At the same time the contradictory aspects of bachelors of computer science training at Japanese universities were noted. In particular, the positive feature of Ukrainian educational program of bachelors of computer science training we consider the presence of the complex program of through practical training that includes the different types of practical training (educational, project technological, diploma internship) and is realized during the whole term of study. Japanese curricula also include on-site, field internship on the senior years of study, however their amount is not considerable as Ukrainian ones. It can be explained by the fact that in Japan the practice of on-the-job/in-house training of university graduates exists for a long time.

Although the tendency of refusal of such practice currently is observed because of high cost for enterprises.

Differences in Undergraduate Curricula

The similar factor for both educational programs of bachelors of computer science training in Japan and Ukraine is the orientation on training of a specialist of wide profile oriented on problem solving connected with analysis and synthesis of the difficult systems on the basis of the newest information communication technologies with the application of modern achievements of fundamental and engineering sciences.

The comparative analysis of Japanese and Ukrainian curricula has showed that there is a substantial difference in the content of training of Japanese and Ukrainian computer science specialists. It has been distinguished the content component of the curricula for bachelors of computer science training at Japanese universities adapts all the variety of background educational environment. It is worth to be noted that although students are concentrated in one major specialization, however at the same time they can freely elect academic disciplines from the education program of other major specializations. Thus, it has been shown that the educational programs of bachelors of computer science training at Japanese universities are based on the interdisciplinary approach. Just such approach is aimed at the formation of wide-view understanding of the field in students, creativity of thinking, ability to solve general problems that arise up on verge of different fields, see the interconnection of fundamental research, technologies and necessities of industry, the ability to estimate the efficiency of certain innovation, fulfill its practical realization. Besides, such approach assists the formation of the ability not only to decide but also formulate problems, estimate them from different views and envisage possible consequences for the society development that is extremely important at the training of human resources for the information technology industry.

The educational program of bachelor of computer science training at Ukrainian universities contains of mathematical, programming, system technical and technical courses (Industry-standard, 2011). It should be noted that the courses titles and their amount at Japanese and Ukrainian curricula differ considerably, that is explained by differences in conceptual vision of the profession, the needs of Japanese and Ukrainian societies in such specialists and in the marketabilities of IT profession in the current terms of the labour market.

The comparative analysis of the curricula structure of bachelors of computer science training has showed that both in Japan and Ukraine the curricula consist of the block of obligatory (normative) courses and the block of elective (optional) courses. But the content of these blocks differs considerably. Thus, for example, in Ukraine the block of normative courses consists of the cycle of humanitarian and socio-economic courses, the cycle of mathematical and natural-scientific courses and the cycle of professionally-oriented courses. Concerning the block of optional courses, it is worth mentioning that in Ukrainian curricula it is presented by the cycle of courses of independent choice of the higher educational establishment and the cycle of courses of free choice of students. The curricula structure of Japanese universities depends

directly on the university however the general education courses and the specialized courses are included to the block of obligatory courses.

IT Human Resource Development Using PBL

The conducted analysis of the system of training of future bachelors of computer science at Japanese universities testifies the prevailing in educational process organization the problem- and project-based learning (PBL). Japanese teachers (Fukuda, et. al., 2011; Nakayama, et. al., 2012; Ikeda, 2010) are convinced that it is necessary not only to form thorough theoretical knowledge in students but also teach them to apply independently these knowledge for the solving of real practical problems. PBL provides the successful formation of social and communicative abilities of students for work in professional teams, acquisition of skills to fulfill different social roles (leader, opponent, idea generator, performer, etc.).

It should be noted the requirements concerning PBL implementation are the following:
- presence of research problem in primary data for project development;
- theoretical, practical and cognitive meaningfulness of predictable results;
- use of scientific search methods (problem setting and planning tasks);
- hypothesis formulation;
- analysis of scientific sources;
- development of research methodology;
- experimentation;
- generalization of scientific search results;
- foundation of conclusions and practical recommendations;
- fulfillment of project by small groups of students and general defense (presentation) by the project developers of variants of practical problem solving.

It is important that Japanese researchers (Fukuda, et. al., 2011; Nakayama, et. al., 2012; Ikeda, 2010) suggest to evaluate the conducted projects by such evaluation criteria:
- argumentation of topic choice (in one cases the project topic can be suggested by teacher, in others students choose project topic independently);
- practical meaningfulness of executed job results;
- independence and completeness of research;
- argumentation of offered problem solutions;
- level of creativity, originality of problem solving and offered solutions.

The marked technology, to our opinion, is urgent for native practice of bachelors of computer science training.

Teaching for Effective Learning in Higher Education

The complex of positive acquisitions of Japanese system of information technology specialists training is characterized by the experience of individual independent students' work organization. The current research findings have provided the possibility to distinguish the main conditions of this practice success, in particular:

- teaching students of independent educational-cognitive activity methodology (formation of skills to work effectively with the sources of educational-scientific information, planning of time budget, acquisition of reflexive knowledge necessary for self-analysis and self-control, etc.);
- organization of individual planning of students' educational work and strict control of fulfillment of individual plans from the side of pedagogical communities (academic advisors, dean's office, departments, laboratories);
- previous acquaintance of students with the structural-logical chart of a course, providing all information concerning the course, teachers, time and place of consultations, control form and evaluation criteria, etc.;
- development of educational textbooks of interdisciplinary character;
- providing students with complex textbooks aid for independent study that combine theoretical material, methodical instructions and practical tasks;
- individualization of home tasks and laboratory works, and in the conditions of group work clear distribution between the members of microgroup;
- availability of educational laboratories, computer classes for providing students (or group of students) with possibility during work day to independently conduct research, use equipment for educational needs;
- obtaining by the most capable students of status of Assistant Professor or Assistant and their involvement into research work of the laboratory and conducting of classes;
- creation on the basis of laboratory consultative centers, classes of project planning with laboratory libraries with flexible working hours.

At the same time characteristic for Japan primacy of democracy and freedom of choice determines also the specific of theoretical classes. In this country a teacher owns a right for optimal, according to his own opinion, programs and teaching techniques. It can be illustrated by the democratic character of educational material exposition, implementation into teaching practice the case-study method and search of alternative solutions (Hativa, 2000).

All technology of bachelor of computer science training is inferior to the leading objective: the thorough development of student's personality, exposure of his capabilities and talents, enriching of intellectual and creative potential.

The professional formation of students in higher educational institutions depends upon the level of their cognitive qualities development, in particular, such as: persistence, motivation, emotional firmness (Soetanto, 2003). Enormous influence on the professional formation of students in higher educational institutions is carried out by their professional orientation, meaningfulness of educational task and own activity.

In current educational techniques innovative processes carry discrete, periodic character, closely connected with the life cycle of innovation, and depend upon the rows of factors among which the main are (Ichikawa, 1995):
- readiness of students to the assistance of current educational techniques and positive motivation of educational activity in this situation;
- readiness of teachers and students to creative activity;
- optimal psychological climate of educational process and pedagogical mastery of teachers;
- taking into consideration the aspects of university management system.

For effective training of modern IT human resources both in Japan and Ukraine, next to traditional technologies, in the new educational system a large value has the creation and implementation of leading educational technologies: informative, computer, telecommunication-technological innovations, application of which requires radical changes in the methods and facilities of study, forms of educational process organization, theory and methodology of modern professional education. It makes the process of training of modern specialists in industry of information communication technologies guided, individually-differentiated, with the large part of independent educational and educational productive activity.

Innovative educational technologies assist the development of individual abilities of personality, increase of level of thinking creativity, formation of skills of active search of decisions of both educational and practical tasks and prognostication of results of made decision realization. With passing to new educational technologies radically changes the influence of study on initial possibilities of student and character of him own intellectual efforts.

Conclusion

In the conditions of new strategy of modernization of the content of higher education the problem of competitiveness of specialists in accordance with the modern requirements of the labour market acquires the special significance. The study of the peculiarities of bachelors of computer science professional training in the world context has allowed us to set, that both in Japan and Ukraine students study identical courses: architecture and structure of computer systems, programming language, organization of information systems, etc. However, the basic accent in Ukrainian higher educational establishments is made on theoretical training of IT specialists, while the practically-oriented approach prevails in Japanese ones. The professional training of bachelors of computer science in Japanese educational space is based on the individual trajectory of study, that makes possible the teaching of students in the optimal for them mode and independently regulate time of implementation of laboratory, workshop, computational-graphic and other tasks, independence in the choice of scientifically-methodical literature for classes preparation; providing the possibility of individual correction-pedagogical maintenance of independent students' work.

The results of comparativistic research convince that Japan has more considerable and prominent achievements in professional training of bachelors of computer science due to well-regulated higher education legislation and quality assurance system; clear structure of study organization on all levels; operative reacting of the system of higher education on the changes of the labour market; professional orientation of educational programs; flexibility of system connections and close cooperation with employers and professional IT associations and societies. Powerful scientifically-pedagogical potential of native higher education in combination with the progressive ideas of Japanese experience will assist the upgrading of professional training of information technology specialists in Ukraine that requires further research.

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Contact email: pododimenko@hotmail.com