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Competency Based Modular Educational Programs

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ABSTRACT

It has been established that the basic documents on development of higher education of the Republic of Kazakhstan declared the principles of competence approach and modular learning, but in practice their implementation is faced with certain difficulties and that it is particularly difficult to implement the competency based approach in the absence of professional standards. In this regard, the goal was set to develop a methodology for the formation of integrated standards and implement it for a modular educational program of any specialty. The essence of this methodology consists in that development of integrated standard is not a single process. It is divided, because at the initial stage the representatives of education sphere determine only the expanded list of competences, then the employers enter the process independently on them, and the faculty formulates the learning outcomes only after specification of the competences' list.

To achieve this goal, an algorithm for the development of modular educational programs has been created, methods of document analysis, retrospective analysis and questionnaires were applied, experimental work on the formation of the list of competencies was carried out. The experts who participated in assessing of the competencies importance showed the high qualifications, good knowledge in the labor market and the skill to formulate the required data. On the basis of this list, the list of necessary competencies for "Computer science and software" specialty has been compiled.

Contribution/ Originality

For the first time in the pedagogical science of Kazakhstan methodology for the formation of integrated standards has been developed, and algorithm for the development of modular educational programs has been created. Practical significance of the study is determined by the fact that this algorithm is implemented on the example of a certain specialty. In this regard the study contributes to the theory and practice of pedagogy.

1. Introduction

Credit training technology has been introduced in the higher education system of Kazakhstan. This technology is one of the fundamental principles of the Bologna process. Alongside with the credit technology principle such principles as competency based approach and modular training are of great importance.

However, although these principles are declared in the basic documents on education development in our country, in practice, implementation thereof encounters certain difficulties. Peculiarity of the objectives to implement at each of these principles is that they should be solved integrally, because a Modular Educational Program (MEP) is a set of modules aimed at mastering certain competencies. The need to solve of the problems proceeds from the global trends:

1) in educational process the emphasis is transferred from the subject (disciplinary) result to the expected results of the knowledge and skills mastering by a student;

2) competences are formed based on the requirements of employers or their associations, and then the required learning outcomes are determined by the competences.

Currently there exists perception of the necessity to reorient assessment of the student's learning outcome from the "knowledge, skills, abilities" concepts of to "competence / competency" concepts. It means the necessity to make the transition from qualification approach to the competency based one in vocational education (Figure 1). Thus, the learning outcomes constitute one of the most important structural elements of the higher education systems (Nabi, 2013).

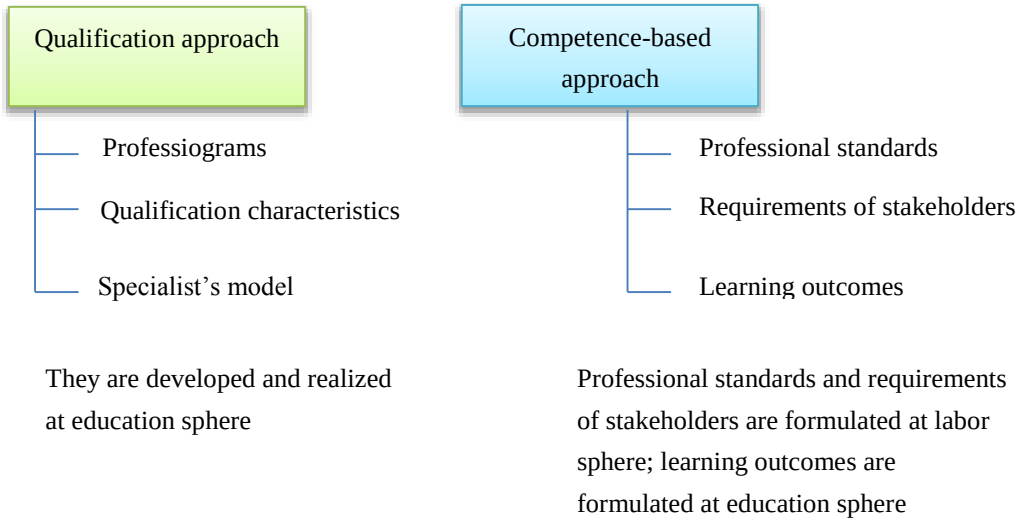

Figure1

Nevertheless, it was believed that it is impossible to describe this result, and much less to standardize it.

Approach to the learning outcome as to a possible basis for recognition of the education content and qualifications

(degrees) has become decisive due to Kazakhstan entering into the Bologna process.

There are three known types of standards required for vocational education and training, namely:

- professional standards to describe the functions which a specialist should perform, and the requirements to the competencies needed to perform these functions;

- assessment standards to describe the assessment process needed to award the qualifications;

- Educational standards to describe the learning outcomes required for the qualification gaining, teaching objectives and methods of, and the training context.

In the Republic of Kazakhstan the situation with professional standards is such that they have not been developed yet for most sectors of the country's economy, and there are only 70 professional standards for the training of specialists with higher and postgraduate education (The State Program, 2016).

In connection with this situation the university teachers are bound to seek independently the ways of standards development with due regard to both the requirements of employers, and the experience and knowledge of the education sector representatives. We named such standards as educational-and-professional (or integrated) standards and determined a goal: "to develop a methodology of the integrated standards formation and to implement it for Modular Educational Programs (MEP) on some specialty".

The methodology will consist of two tasks:

1) to develop a structure of the integrated standard;

2) to develop the document layouts for initial data collection.

2. Methodologies

2.1. Document analysis method

Cognitive activity is always based on practice, experiments, and observations, as a result of which the factors are established. The comprehending of factors begins with analysis. Analysis (from the Greek "breaking down the whole into elements") is a study method consisting in the mental division of the whole into its component parts in order to identify certain properties and links.

The document analysis method is a method of data collection during the research based on the use of information recorded in written or printed form, on a magnetic film, in electronic and iconographic format, etc. (Shevchuk D., no date). A document is information recorded on a physical medium with certain requisites. Formalized analysis of documents (content analysis) is a method of data collection by means of the information available in documents. Various sources of information are analyzed. The content analysis is divided into several stages, the first of which is the definition of system of analysis categories, i.e., semantic units. In our case, in order to achieve the semantic units' conformity to the solution of the research problem we limited the circle thereof by two concepts ("professional standard" and "learning outcomes"), and have studied the relevant documents, in particular, the official documents (decrees, orders, etc.), scientific articles, questionnaires, etc.

2.2 Retrospective analysis

Retrospective analysis consists in the study of trends turned out during a certain period in the past. Its meaning consists in exhaustive characteristics it gives concerning the process in the statics (the level in the selected period of time) and in the dynamics during the past period (Pimchev, 1992). For the purposes of this article the retrospective analysis of the transition from educational standards to professional ones was conducted.

At the first stage (1994-2004), the State education standards have been developed. Their authors were universities teachers only. They have formulated the requirements to knowledge, skills, acquired habits of the trainees, and determined

the education content, methods to check the degree of knowledge and skills mastering.

Due to the university system transition to the credit technology in education in 2004, the form, but not the content, of standards was revised, so they were also developed by the university professors. In the subsequent standards the terms "to master..." and "be competent ..." appeared in the requirements for graduates. The terms "professional-and-personal competence" and "learning outcomes» did not come into use in the state documents on educational policy until 2010, but in the State Program (2016) it is explicitly pointed out that the share of educational programs developed on the basis of branch frameworks and professional standards should reach 45% by 2019.

2.3 Questionnaire method

Questionnaire is a main tool of sociological research and constitutes a document containing a structurally arranged set of questions each of which is related to the research objectives. This relation is expressed in the need to obtain information reflecting the characteristics of object under study. It is expedient in two cases:

a) when it is necessary to question relatively great number of respondents in relatively short time, and

b) respondents should give their answers a good deal of thought, having a printed questionnaire before their eyes.

A necessary component of the questionnaire is the preamble, in which the questionnaire purpose is described, the respondent's motivation to questionnaire filling is grounded, and the necessary comments and instructions on the respondent's work with the questionnaire are given.

In our case, "closed" questions are preferable than "open" ones, because they are formalized and processed easier. Supplementing the qualitative ideas about its subject with formalized generalizations the pedagogical theory acquires the necessary strictness and stability; therefore we will use "polar" questionnaires with point rating. Based on them, we have compiled questionnaires for evaluating and processing the results.

3. Results

3.1 The methodology of Modular Educational Programs development

3.1.1 Analysis of documents for the MEP development methodology substantiating

Competency-based approach involves the design of education focused on the outcome. Conceptual framework of the competency-based approach is to replace the teaching paradigm with the learning paradigm. This paradigm is defined as an educational process motivating not only to perform of actions but also to analyze them (Johnson and all, 1992).

As the world's best practices show, in most countries the learning outcomes are formulated in the labor sphere, i.e. by the employers, and allow forming the qualifications. Educational institutions translate them into the competences language; and it is generally accepted that knowledge, understanding, skills, experience and attitudes (valuable aims) are integrated in the competencies: "Statements of what a student knows, understands and is able to do on completion of a learning process "(ECTS Users' Guide, 2015).

Award of qualification and issue of the relevant certificate; diploma or degree should be awarded based on the assessment of learning outcomes. This circumstance has effect on the function and content of the learning outcome assessment evaluation and compels to apply the special methods and tools of assessment. The learning outcomes determine the student's achievements in the process of mastering the knowledge and practical skills acquired and demonstrated by him/her upon successful completion of the training in whole or on separate module of the educational program. So the concrete individual educational achievements should be evaluated. Therefore, it is necessary to develop the objective criteria for assessment and indicators of the learning outcome achievement, to substantiate the methods and means for learning outcome assessment, and to form unified mechanism for outcome assessment.

When educational standards developing the main load falls on the education sector representatives, because they

should implement following:

- to determine an object, a subject, the professional activity functions, and formulate the competences, etc., although this is a prerogative of the labor sphere representatives;

- to develop the education content, the requirements to the graduate's preparedness level and solve other problems.

It is not difficult to see that in this case the educational component prevails in the standards. Thus, the problem of standard's components equalization arises. To solve the problem let us consider one of the economic specialties, as an example. This is due to the fact that among a small number of professional standards there exists a standard of "economic activity", so there is a reason to analyze this document. The content analysis of the document showed that for the "economist" profession the following job functions are distinguished: analysis of the economic activity of the organization and determining of the basic indicators of labor and production management; improvement of the efficiency of labor organization and production profitability; planning of the economic activity arrangement; registration of the contractual obligations of the organization; work with computer facilities.

As you see, the activity goals (efficiency improvement) and the work performed by the specialist of any industry are named as job functions. Besides, the functions are defined in a general form and therefore are applicable to many professions. However, the main drawback is that the professional standard does not conform to the level defined by the National Qualifications Framework (National Qualifications Framework, 2016). Indeed, in the annex to the National Qualifications Framework its structure at the 6th level (Bachelor's) is defined as follows:

Level	Knowledge	Skills and abilities	Personal and professional competencies
6	Wide diapason of theoretical and practical knowledge in professional field	The independent developing and promoting different options of the professional problems solutions using theoretical and practical knowledge	Independent management and control of the labor and educational activities in frame of a strategy, policy and organization objectives, problems discussion, argumentation of conclusions and literate operating by information

The comparison shows that the requirements to the job functions of this level are not reflected in the professional standard.

Thus, in the considered professional standard there are serious shortcomings which do not allow it's accepting as a basis for description of the learning outcomes. We believe that these shortcomings are resulted from the poor preparedness of employers to development of the professional standards.

In order to assist in these shortcomings eliminating, we propose a methodology consisting of two tasks (see Introduction).

When the first problem solving we took into account the shortcomings identified earlier as well as the lack of reference to the professional activity sphere in the standard. Besides, we made a content analysis of a standard's elements structure. We define the order for formation of structural elements "from the general to the particular", i.e. from the professional activity sphere to the tasks from which the learning outcomes are formulated. Then the integrated standard's structure will take the form shown in Figure 2.

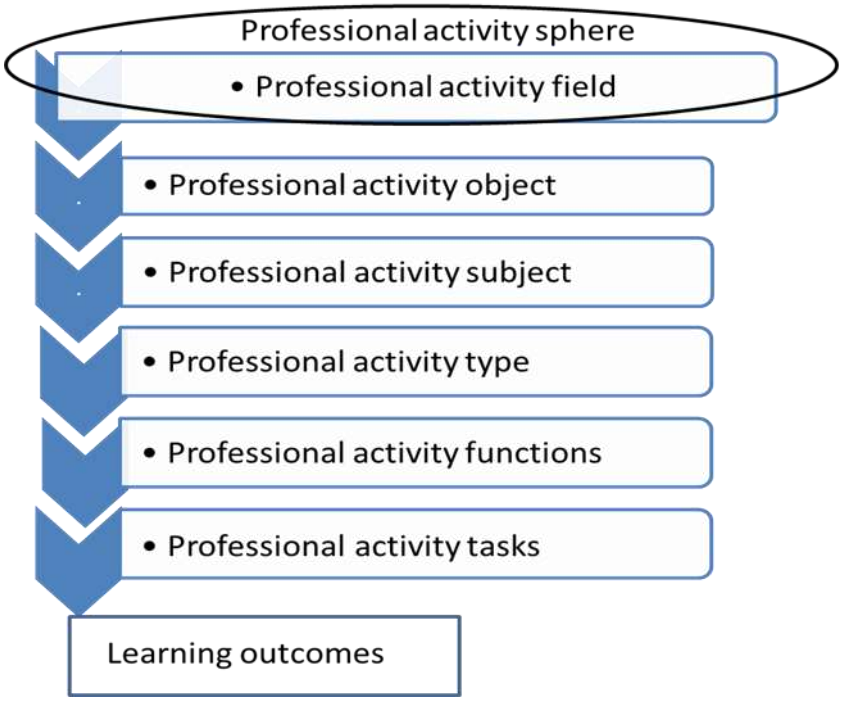

Figure 2

As it is seen on the diagram, only one box relates to educational standards.

Thus, the development of integrated standards can compensate the shortcomings of the professional standard. The methodology of its developing includes the opinion of experts, representatives of business structures, employers and other specialists, and excludes the educational component prevalence.

3.1.2 Stages of Modular Educational Programs development

State Compulsory Educational Standards of the Republic of Kazakhstan are based on the educational paradigm, in which the competences constitute its main components. However, the practical implementation of new paradigm raises certain difficulties. The universities have not abandoned the qualification approach yet.

In our early works we paid attention to the systemic error has taken place for many years in the system of education quality assessment (Nabi, 2013; Nabi and all, 2016).Indeed, requirements to qualification of the higher educational institution graduates were given in the qualification characteristics of the graduate approved by the representative organ in the education field (Ministry) as a guideline document. As the qualification was confirmed by the state examination commission created in the higher educational institution, both the approval and its confirmation were carried out in the education sphere. This results in the situation when a graduate is to learn additionally under real industrial conditions. This model of the professional quality assessment is called "entry" control, and the approach may be called as qualification based one. When the qualification approach is applied a professional educational program is linked with the labor objects (subjects) and conforms to characteristics thereof.

MEP are developed in the context of the competency model of specialists training, this is specially indicated in the Rules (2011, 2016).

As is known, the modular training essence consists in the training content structuring into autonomous organizational and methodological units (modules). The module content and its scope may vary depending on didactic goals; profile and level of the learners' differentiation, there desire to choose the individual movement trajectory according

to the educational course. Modules may be mandatory and elective.

The module is a complete set of skills, knowledge, attitudes and experience (competences) required to be mastered and described in the form of requirements which the learner should meet by the module completion, and representing an integral part of more general function. The module is significant for the labor scope (Abbasion & Omani, 2013]. Each module is evaluated and is certified usually.

The module is formed as a structural unit of specialty curriculum; as an organizational and methodological interdisciplinary structure in a form of a set of sections from different disciplines united by a thematic basis; or as an organizational and methodological structural unit in an academic discipline framework.

We distinguish 3 types of works related to the MEP development: preparatory, basic and final.

During the preparatory work it is necessary to carry out a set of activities related to the employers.

Competences may be selected on the basis of the branch framework of qualifications and professional standards or, if there are no branch framework of qualifications and professional standards, based on the requirements of employers (see Figure 3). The second stage should end with the description of learning outcomes on the specialty (the whole EP), but this description should be carried out anew if it does not meet the requirements based on the results of expertise of the employers and foreign partners (see the 5th stage in Figure 3).

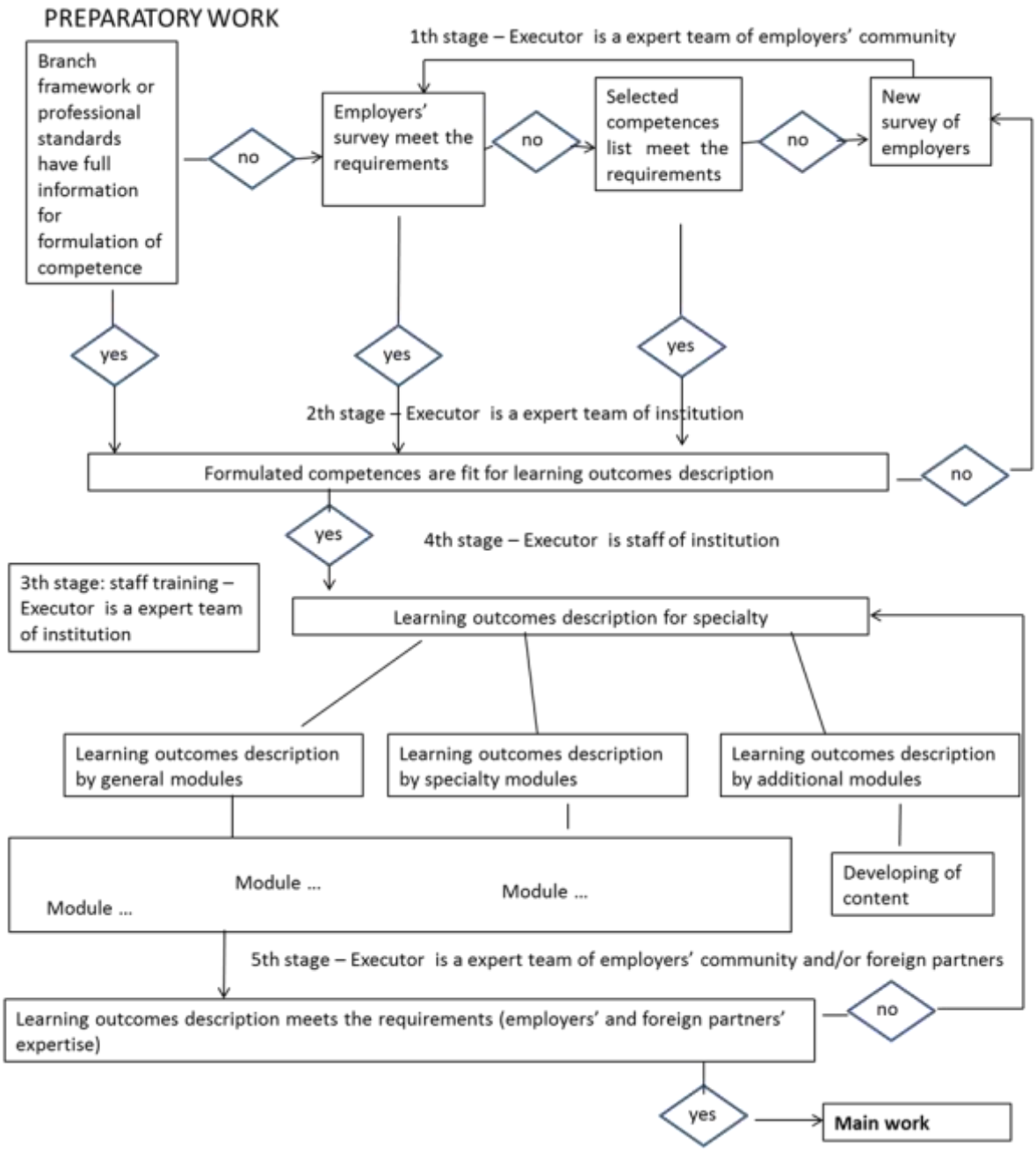

Figure 3

The fourth stage consists in description of the learning outcomes by modules. The modules combination should provide a necessary flexibility degree and freedom in selection and completion of the required specific educational material for the learning (and self-study) of a certain category of students and implementation of the special didactic and professional goals. At this stage, we propose to develop invariant modules, although within the modules there may be the changeable sub modules - course modules. If, according to the results of expertise conducted by the employers and foreign partners, the program meets the requirements, the main work may be commenced.

The main work is the most labor-intensive time-consuming and responsible. It also consists of several stages (Figure 4). For example, at the 3rd stage it is necessary to develop all documents concerning, in particular, the criteria for

assessment of learning outcomes and the system of learning outcome assessment. However, it should be kept in mind that the expected learning outcomes shall be easily verifiable and accompanied by appropriate assessment criteria. Assessment criteria for the learning outcomes are selected by the developers. We recommend using the Dublin descriptors or the Bloom's taxonomy.

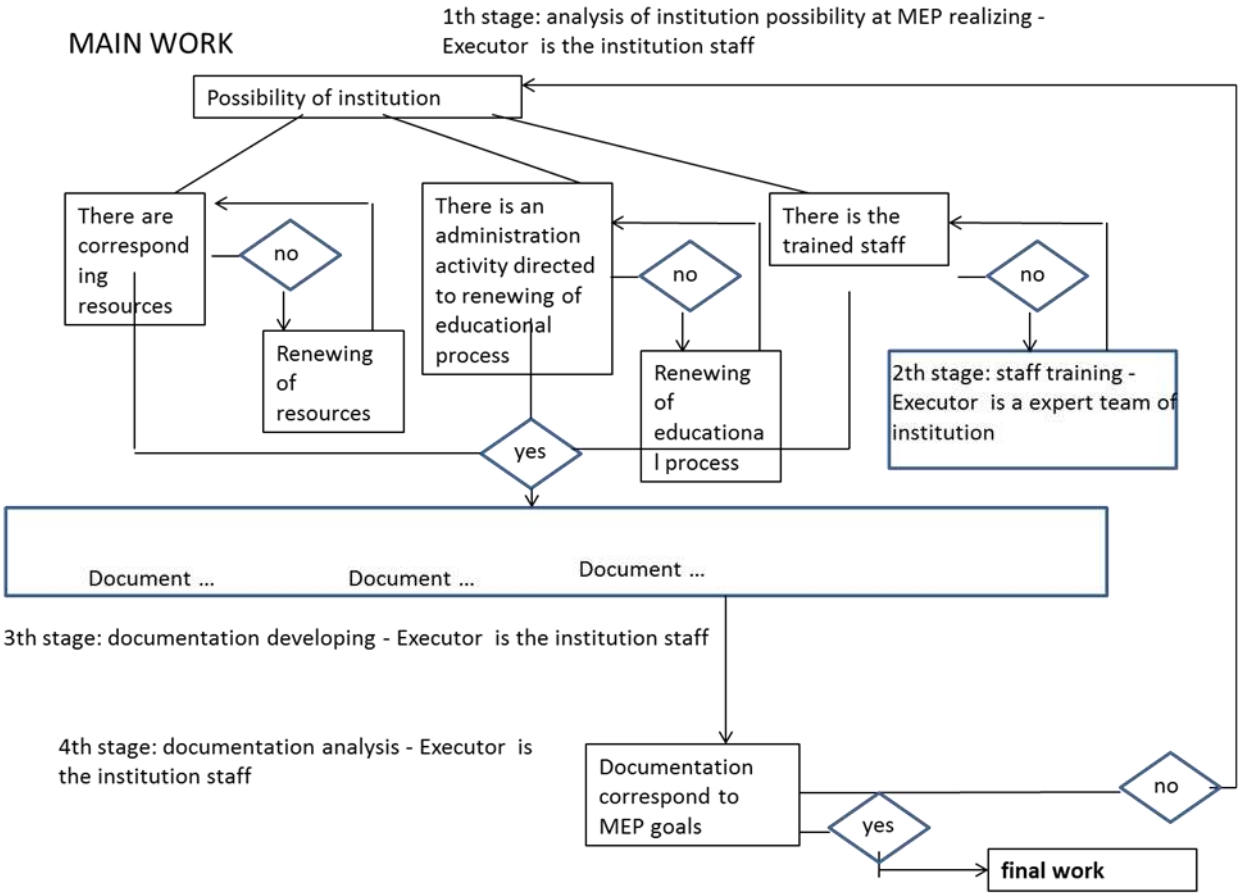

Figure 4

The system for assessment of the student's educational achievements includes forms of assessment, composition of educational assessors, place of assessment, assessment of the levels of learning outcome achievement, and others. The best scenario is when the documents will be drawn up as a Modular Educational Program.

Transition to the final work is possible only upon analysis of the documents.

The work is required for analysis, and in case of the program's positive results the distribution and expansion may be recommended (Figure 5). Analysis of the learning outcomes should be carried out on the basis of independent assessment including that carried out by the students.

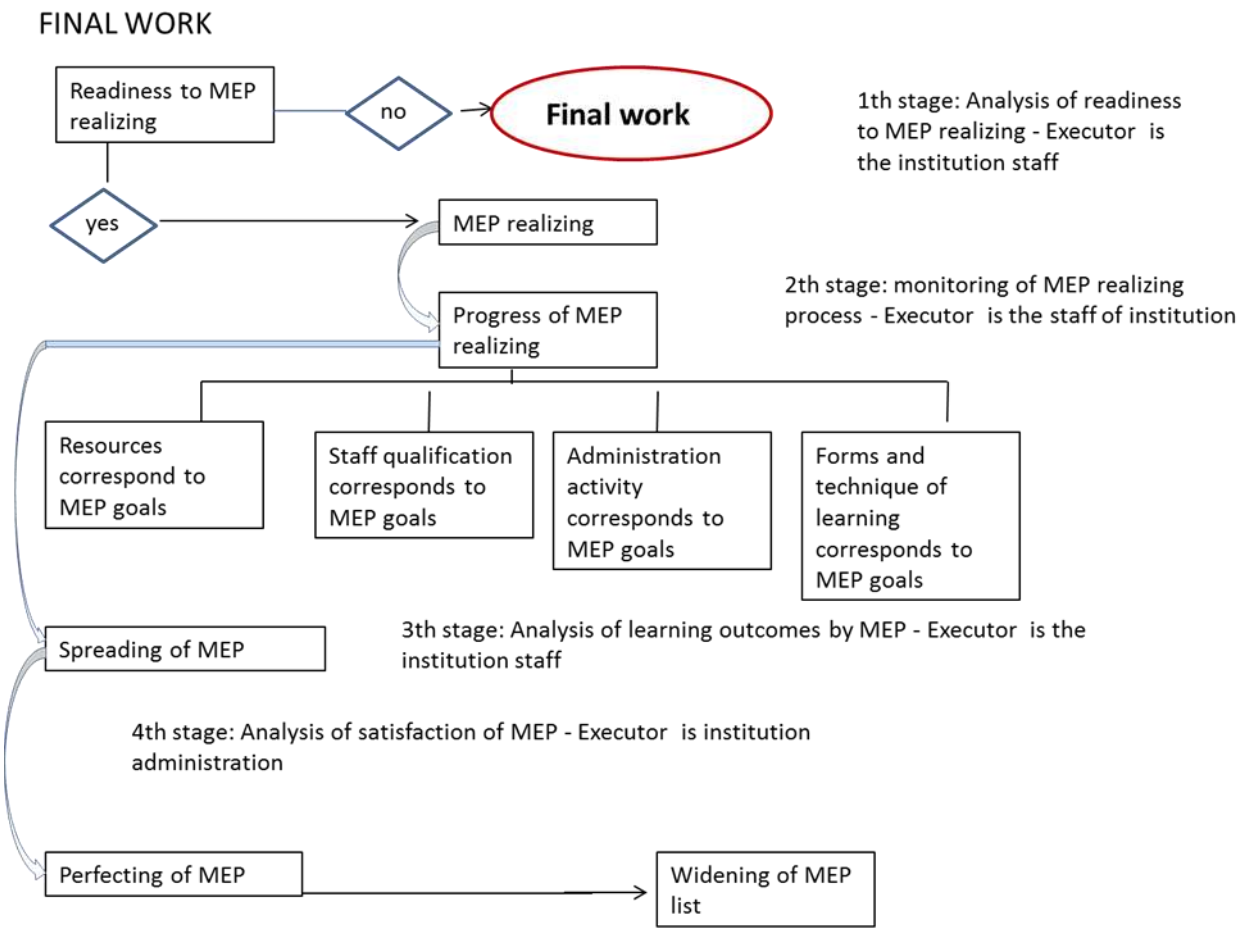

Figure 5

3.2 Implementation of the methodology for development of Modular Educational Programs

3.2.1 Methodology for initial data collection

Two forms of questionnaires for initial data collection are under development. The first questionnaire serves to evaluate the required professional competences by the expert. Its form is presented in Table 1.

Table 1. *Form of the questionnaire for evaluating by expert*

We ask you to evaluate (in points from 1 to 5) the importance of the key and professional competencies of the bachelor in the specialty "computer technology and software" presented below and exclude non-core competencies (if any) or supplement the list		
#	Competence	Evaluation of a professional competencies importance
1		
2		
…		
…		
Position, surname, initials, signature		

Representatives of the large manufacturing enterprises and leading professors of the universities are involved as the experts. Joint work helps to take into account the labor market requirements and present them in an intelligible form. As a result, the comprehensive list of competences is formed.

The second questionnaire form is distributed among the representatives of business structures, employers and other specialists. They evaluate significance of the professional competences, selected on the basis of the first questionnaire results. Preliminary list of the competences will be ranked according to the level of their criticality and selected for adding to the final list for formulation of the learning outcomes as the result of information collecting by means of the second questionnaire.

3.2.2 Modular Educational Program of the "Computer Science and Software" specialty

Analysis of European universities' experience in the development of modules indicates their great diversity. However, there is a certain tendency in their classification. For example, the modules are most often classified as follows:

• main modules are the modules which compose the relevant science core;

• supporting modules are the modules which support the vocational training (for example, in mathematical disciplines, physics, mechanics, etc. for technical specialties);

• organizational-and-communicative modules (for example, time management, team work, rhetoric, foreign languages);

• specialized modules expanding and deepening the competences in the chosen field, and optional ones;

• portable modules (diploma thesis works, master's dissertations, internships, projects establishing the links between theory and practice) (Kovtun &Rodionova, no date)

Module types given in the Rules for educational process management according to the credit technology of training and in the Teacher resource book (Omirbaev & Jarasova, 2014) are as follows:

1) general modules including the disciplines of cycles of general educational disciplines and basic disciplines forming the general educational competences not related directly to the specialty, as well as social, ethical, cultural competences (interpersonal, intercultural, civil), economic (entrepreneurial) and organizational-and-managerial competences;

2) specialty modules including the basic and profiling disciplines forming the specialty base and are aimed at the forming of general professional and special competences within the framework of specific educational program, as well as the general competences (critical thinking, creativity, active life position, innovativeness);

3) additional modules going beyond the qualifications and including cycles of disciplines that are not related to the specialty and aimed at the forming of additional competences (information technologies, foreign languages and others).

Comparison shows that the specialty modules consisting of major disciplines constitute analogues of the core modules; and the modules consisting of basic and general educational disciplines are similar to the supplementary modules.

As mentioned above, we have carried out the experimental work aimed at the questionnaires collecting and processing. At the 1st stage the list of competences was formed. At the second stage the business representatives, heads of the universities' structural subdivisions dealing with the computer technology and programming (other than teachers!) and specialty graduates participated in the experimental work. The specialists of "Center for Information Technologies "Paradigms" LLP , "Center for Sustainable Development of the Capital" LLP, "Open Systems Development" LLP, Branch of "Forte bank" JSC, "Pride Systems" LLP etc. were invited as experts.

The results of questionnaires processing are shown in Figure 6. As it is seen in the figure there are no competences

rated very low (under 2.5) in the competence list compiled by experts. This points to the high qualifications of experts their good knowledge in the labor market and the skill to formulate the required data.

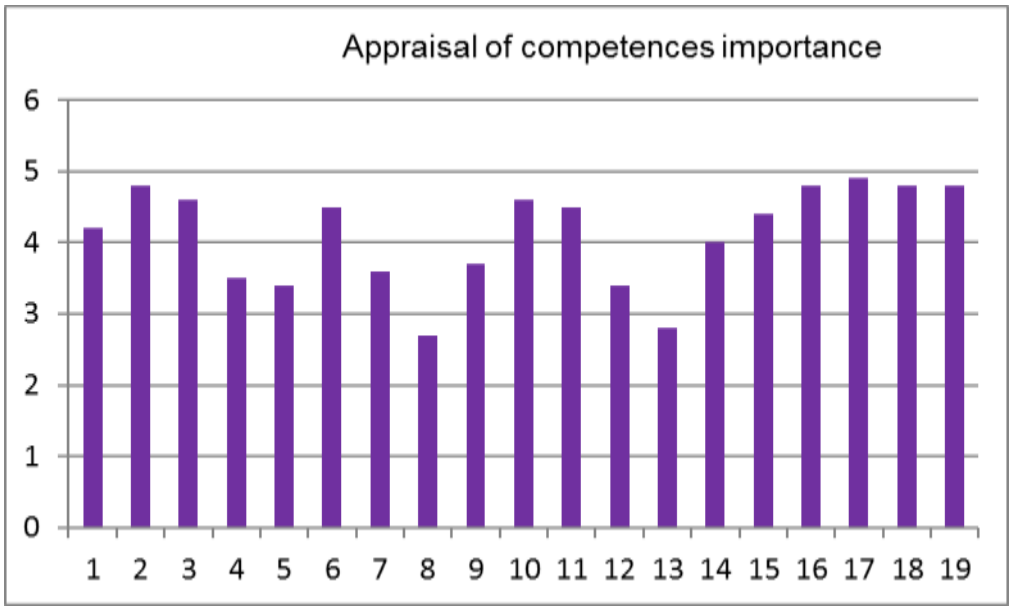

Figure 6

We formulate the names of modules according to the final list of competences, namely:

1) general modules

- business communication and record management;
- principles of research work;
- principles of marketing;
- principles of management;
- economics and accounting;
- principles of entrepreneurship and taxation in the Republic of Kazakhstan;
- engineering psychology;

2) special modules:

- integration of the program modules;
- Methodology for troubleshooting during installation and operation of the equipment;
- Methods and tools for assembly of the modules and software components;
- Customer service methods;
- Methodology for design in the programming;
- Complex SQL queries, query optimization;
- System integration;
- Mobile development;
- BackEnd development;

3) additional modules

- methodology for identification and discussion of the professional problems.

The Modular Educational Program for the "Computer Science and Software" specialty is obtained on the basis of

the received data given in Table 2. When considering this curriculum, the following features should be taken into account. The state compulsory educational standards establish the disciplines cycles and the entire volume of credits (129) is divided between them in the ratio of 25, 50 and 25%. Each cycle contains obligatory disciplines and elective disciplines. The number of credits on compulsory subjects and recommended semester of their study are specified by the standard curriculum of the specialty.

Table 2. *Curriculum for the specialty "Computer Science and Software"*

Semester	Type of component	Name of discipline or module	Credits quantity	
			Kazakhstan's credits	ECTS credits
1	OC	Modern history of Kazakhstan	3	5
	OC	Kazakh (Russian) language	3	5
	OC	Foreign language	3	5
	OC	Mathematics	3	5
	OC	Algorithmization and programming	3	5
	EC	General module	5	8
Total			20	33
2	OC	Kazakh (Russian) language	3	5
	OC	Foreign language	3	5
	OC	Information and communication technologies	3	5
	OC	Physics	3	5
	EC	General module	5	8
Total			17	28
3	OC	Professional Kazakh (Russian) language	2	3
	EC	General module	5	8
	EC	General module	5	8
	EC	Special module	5	8
Total			17	27
4	OC	Philosophy	3	5
	OC	Professionally oriented foreign language	2	3
	OC	Architecture and organization of computer systems	3	5
	OC	System Programming	3	5
	OC	Electronics	2	3

	EC	General module	5	8
Total			18	24
5	OC	Digital Circuitry	2	3
	OC	Software Development Tools	2	3
	EC	General module	5	8
	EC	Special module	5	8
Total			19	27
6	EC	General module	5	8
	EC	Special module	5	8
	EC	Special module	5	8
	EC	Special module	5	8
Total			20	32
7	EC	Special module	5	8
	EC	Special module	5	8
	EC	Special module	5	8
	EC	Discipline "Technique for identifying and discussing of the professional problems"	3	5
Total			18	29
In all			129	200

4. Discussion

To understand the methodology novelty you may refer to international experience. As it is known (see, an example, Oleinikova & Muravjeva, no date) in most European countries the employers' associations (corporations, unions, etc.) develop the professional standards that constitute the basis for development of the educational standards. However, in a number of countries (Ireland, Scandinavian countries and some others) such standards are not developed separately. But this does not mean a departure from the education model of focused on the result. This is a consequence of the fact the employers' representatives actively participate in the preparatory work consisting in the description of learning outcomes (the required competences for execution of the labor activities) and in formulation of the requirements to their evaluation, etc. Thus, in these countries the development of professional and educational standards is a single design process.

According to our approach which is different from the approach above the development of integrated standard is not a single process. It is divided, because at the initial stage the representatives of education sphere determine only the expanded list of competences, then the employers enter the process independently on them, and the faculty formulates the learning outcomes only after specification of the competences' list.

We reported the main provisions of the methodology to the teachers of the Kazakh National Agrarian University and Kazakh Innovation Humanitarian Law University and the executive staff of the International Educational

Corporation. As a result of the discussion, we received comments and suggestions, in particular, concerning the need to develop interdisciplinary modules.

Problem of the proposed methodology innovativeness remained outside the scope of this study. We define innovativeness as a result achieved in the course of certain process with observing totality of conditions as a source to improve the system effectiveness. (Nabi et al., 2017). As you can see, innovativeness is closely related to validity. We have revealed the aspects of validity by the example of technology (Nabi et al., 2018) and model (Nabi et al., 2017). This seems to be easier than investigation of the methodology validity, because the latter will require substantiation of the methodology use to improve the process efficiency in specific conditions. Since the effectiveness definition takes the certain time, we consider it necessary to study the methodology validity in the further researches.

Conclusion

Competency based approach and modular training are important principles of the Bologna process. The world tendencies of education system development dictate the need to introduce these principles into the education system of our country.

When the competency based approach is applied the education goals are connected with both the labor objects performing specific functions and interdisciplinary integrated requirements to the educational process result. Therefore, the vocational education goal consists in the knowledge acquiring and the professional qualifications mastering by the students, and in forming the personal experience which gives them the opportunity to cope with various business and life situations and work in a team. Its implementation creates the conditions for the effective use of capabilities which make it possible to carry out the professional activities fruitfully in accordance with the workplace requirements. In this sense, competences go beyond the professional triad: "knowledge-skills-abilities" and include the informal knowledge. The competences and learning outcomes give an opportunity to rethink the goals and problems of the educational process.

The proposed methodology for development of integrated standards makes it possible to reduce the shortcomings of both educational and professional standards. These shortcomings consist in the prevalence of educational standards over professional standards, and lack of possibility for the professional standards to reflect the job functions performed in the workplace. The methodology under development consists of two interrelated tasks and is based on the principle known as "from general to particular" concerning formation of structural elements.

Each stage of the MEP development (preparatory, main, final) has its purpose, methods of goal achieving and the result. Transition to the next stage is possible only upon obtaining the result. At each stage the goal achieving algorithm represents a flowchart with a clearly defined transition depending on the "yes" or "no".

Implementation of the proposed methodology for development of Modular Educational Programs is shown on the example of the "Computer Science and Software" specialty. Extensive initial material (expert selection of competences at the first stage and evaluation of these competences by stakeholders at the 2nd stage) give the possibility to make a reasoned decision related to due regard to any competence. The final list of competences constitutes the basis for the MEP formation. The program consists of the disciplines of the mandatory component of the standard curriculum and the modules depending on the final list of competences.

In accordance with the structure of integrated standard, after the MEP forming it is necessary to formulate the learning outcomes.

The tasks considered in the study do not cover the full range of problems related to the MEP development. In this regard, we will continue our research in this area.

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