Development of Hierarchical Educational Qualifications Frameworks Based on Feedback from Stakeholders

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ABSTRACT
The paper presents an approach to the development of qualifications frameworks and its actualization for all qualification levels of education. Proposed the concept the hierarchical structure of qualifications frameworks, the filling of which is required to produce top-bottom. Actualization of qualifications frameworks is offered to produce on the basis of the views of stakeholders from the lowest level of the hierarchy to the upper in order to improve educational programs.

Keywords
Qualifications Framework, hierarchical structure, stakeholders, actualization

1. INTRODUCTION
Nowadays great attention is paid to the modernization of higher education, aimed to improve the quality of the educational process. The basic idea of the modernization is to aim to the competence approach in education, which aims to improve the interaction with the working market, improve the competitiveness of professionals, update training content. The main elements of the competency approach are learning outcomes, which components are knowledge, abilities and skills. Using this approach in practice of higher school leads to the introduction of new requirements for the content of education, its methods and technologies. One of the main requirements is the development and use of qualifications frameworks, the importance of which has increased due to the transition to the Bologna system of higher education. Qualifications frameworks allow to change educational program and leading them to the requirements of working sphere. They ensure the comparability of national education systems, which leads to the possibility of academic mobility of students and alumni [1].

Qualifications Framework is a systematical and structural set of learning outcomes, which describes qualificational levels. Qualifications Framework can be represented at any level of table, where rows will represent educational levels and columns - descriptors of learning outcomes.

Qualifications Framework, in principle, can be represented as a hierarchical structure. At the highest stage of this hierarchical structure can be located in National Qualifications Framework (NQF) and the lowest - framework of separate disciplines. The number of stages between those stages [2] will correspond to the structure of the national educational system of the country. Each stage of the hierarchy, except the NQF, contains a certain number of qualifications frameworks. For example, on the next stage may be the NQF Qualifications Framework activity fields, which may be the fields of engineering, medicine, economics, etc. Each field in its turn, for example, engineering will be split into several sectoral qualifications frameworks, such as, computer science, cybernetics, mechanical engineering, etc. Consequently, each subsequent stage will correspond to the set of qualifications frameworks the number of which increases by several times.

Descriptors of each stage concretize learning outcomes, which are obtained at current stage, but in turn are more common for the associated descriptors of the following stage. For example, in the NQF are quite generally described the descriptors of bachelor's, master's and researcher learning outcomes. At the next stage of the hierarchy, where are located, for example, qualifications frameworks of activity areas, descriptors of learning outcomes will describe learning outcomes, which are received by bachelor, master and researcher for each of these areas of activity, etc. more detailed.

At each stage of the hierarchy of QF are described learning outcomes for all qualifications levels of education (in European Qualifications Framework [3], as in the National Qualifications Framework of Armenia [4] there are eight of them).
The process of development and practical application of the qualifications frameworks is a quite complex, time-consuming process, so how it assumes joining work of experts, who are responsible for ensuring the quality of education. In this regard, automation of this process becomes an urgent problem, which is designed to accelerate the process of forming and adjusting of qualifications frameworks, which in its turn will facilitate the work of experts in the field of education. To solve the problem above is offered to split it into two periodically updating processes:

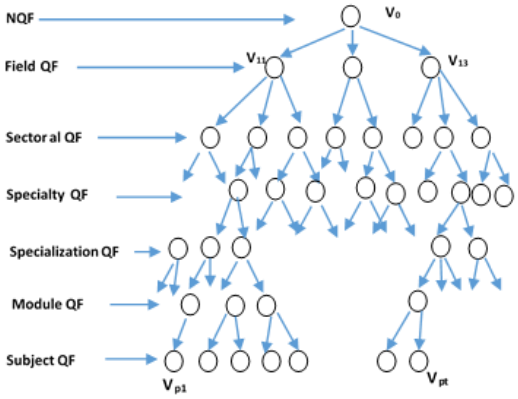
1. Design and pre-filling of qualifications frameworks top to bottom through the hierarchy of qualifications frameworks;
2. Actualization of the content of qualifications frameworks bottom to top, based on feedback from stakeholders.

2. PRE-FILLING OF QUALIFICATIONS FRAMEWORKS
Pre-filling of QF top-bottom is given to the professionals, which are responsible for the development of an appropriate level of qualifications frameworks. It is assumed that during pre-filling of qualifications frameworks experts can be guided by information extracted from various sources, regulatory documents, including the data obtained from the analysis of working market requirements.

Qualifications framework can be represented as a tree graph G(V, U), where V - the **vertices** of the graph, and U - arcs connecting the vertices of the graph.

In its meaning the NQF corresponds to the root node of such a graph V_0, on the second level of the graph will be located the **vertices** (V_{11} …V_{1p}), related to the previous level, describing the second stage of the hierarchy and etc. (pic. 1). At the last level of the graph will be located vertices (V_{k1}

…V_{kt}), describing the subjects to be included in the curricula [5].



Pic. 1. Example of Hierarchic Structure of QF

Each vertex of the graph is proposed to describe by a number of parameters:

V (F, H, E, D (K, S, A)),

where:

F – name of the hierarchy stage of the qualifications framework;

H – name of the qualifications framework appropriate hierarchical level

E - name of the educational level (for example, bachelor, master, researcher);

D (K, S, A) – descriptors of learning outcomes (for example, Knowledge, Skill, Ability).

The names and number of these hierarchical stages and descriptors correspond to the approved in the given country Qualifications Frameworks.

In turn, each of the descriptors of learning outcomes are described as:

$$K = \left\{\bigcup_{i=1}^{n}(k_i,\ w_i,\ r_i)\right\},\quad S = \left\{\bigcup_{i=1}^{m}(s_i,w_i,r_i)\right\},\quad A = \left\{\bigcup_{i=1}^{j}(a_i,w_i,r_i)\right\},$$

where $k_{i\ldots n}$, $s_{i\ldots m}$, $a_{i\ldots j}$ - respectively descriptions Knowledge, Skill, Ability, w_i – the weight of the corresponding learning outcome in this description, r_i – descriptor of the previous level, described by the given descriptor.

Each vertex of the graph can be represented as a table, which name indicates its location in the graph and its content describes the learning outcomes of the current framework of qualifications for all levels of education (pic. 2). Each descriptor is described respectively by the weight (w) and by related descriptor (r) of the previous level.

During the filling of a framework of qualifications from the top to bottom for each descriptor d($k_{i\ldots n}$, $s_{i\ldots m}$, $a_{i\ldots j}$) specialist determine the weight W_{dej}, where d- descriptors of learning outcomes , e- the level of education, described by the given descriptor, j - indicates the next descriptor number of the given stage.

Limit values of the weights of descriptors are set by experts, responsible for filling in qualifications frameworks. The weight of each descriptor is determined by an expert taking into account the relative importance of learning outcomes descriptor and is in the acceptable interval.

Descriptors / Edu. levels	Knowledge	Skill	Ability
E_1	$k_{11}(w_{11},r_{01})$, $k_{12}(w_{12},r_{02})$, … $k_{1n}(w_{1n},r_{0n})$	$s_{11}(w_{11},r_{01})$, $s_{12}(w_{12},r_{02})$, … $s_{1m}(w_{1m},r_{0m})$	$a_{11}(w_{11},r_{01})$, $a_{12}(w_{12},r_{02})$, … $a_{11}(w_{1j},r_{0j})$
E_2			
E_3			
E_4			
E_5			
E_6			
E_7			
E_8	$k_{81}(w_{81},r_{71})$, $k_{82}(w_{82},r_{72})$, … $k_{8n}(w_{8n},r_{7n})$	$s_{81}(w_{81},r_{71})$, $s_{82}(w_{12},r_{72})$, … $s_{8m}(w_{1m},r_{7m})$	$a_{11}(w_{11},r_{71})$, $a_{12}(w_{12},r_{72})$, … $a_{81}(w_{8j},r_{7j})$

Pic. 2. Tabular presentation of graph vertices

The weight of each descriptor of the highest level of the hierarchy of qualifications framework is distributed among the next level descriptors weights, describing given descriptor, and is calculated as:

$$W_{d(e+1)i} = W_{dei}/n * \delta_i,$$

where $W_{d(e+1)}$ – weight of descriptor of the next level of education, W_{dei}- weight of descriptor of the current level, n – number of descriptors, describing descriptor of the next level of education, δ_i – coefficient of the relative importance of the i-th descriptor, satisfying the condition:

$$\sum_{i=1}^{m}\delta_i = 1, \delta_i \geq 0, i = \overline{1,m}$$

So, as a result of the proposed actions are calculated weights of all descriptors describing qualifications framework (pic. 2). The sum of the weights of all descriptors will be the weight of appropriate vertex of the tree graph.

$$W_v = \sum w_{dei}$$

where d – all descriptors of learning outcomes ($k_{i\ldots n}$, $s_{i\ldots m}$, $a_{i\ldots j}$), e - all levels of education.

With the proposed method is possible to fill qualifications framework, to calculate the weights of all vertices at all stages of the hierarchy.

As a result, QF will be formed, presented in tabular form, the contents of which will be the learning outcomes of all levels of education.

Filling qualifications frameworks top-bottom by described hierarchy allows to design the preliminary version of QF, which require further adjustment. Adjustment of the preliminary version of QF will make them actual for a certain period.

3. ACTUALIZATION OF THE CONTENT OF QUALIFICATIONS FRAMEWORKS BOTTOM-TOP, BASED ON FEEDBACK FROM STAKEHOLDERS

Actualization of the content of qualifications frameworks is reduced to the problem of finding an optimal solution. In this case, the optimal solution can be achieved in the case the views of stakeholders will maximum meet the content of

qualifications frameworks [6]. To the group of stakeholders is proposed to include employers' of the relevant fields of activity, faculty, alumni and students of universities, as detailed analysis of their views may lead to the improvement of educational programs and providing educational quality.

To identify the views of stakeholders it is advisable to conduct a survey of stakeholders, which competence corresponds to the stage of hierarchy for which survey is produced. Actualization of qualifications frameworks should start from the lowest stage of the hierarchy (discipline framework). Surveys with stakeholders at the lowest stage of the hierarchy will allow to edit disciplines of descriptors of learning outcomes, which in its turn can lead to necessity to correct related learning outcomes of the previous stage of the hierarchy of the QF.
After survey of stakeholders is necessary to make detailed analysis of the results [5], on the basis of which is formed the weight of each descriptor of learning outcome. In the next step is made the comparison of the obtained weights W'_{pi} with the weights of descriptors W_{pi} , recorded in the preliminary version of the QF, so is calculated the difference of these α weights.

$$\alpha = W'_{pi} - W_{pi}$$

If the value of α is less or equal to the threshold set by the expert, it can be concluded that this descriptor described in the preliminary version of the QF, meets the requirements of stakeholders and in this step there is no need for its actualization. If the difference between weights is greater than the threshold value, the expert responsible for the development of the qualifications frameworks is invited to adjust the content of this descriptor, which in its turn leads to a change in weight of this descriptor.

For actualization of descriptors of the next hierarchical stage may also be produced a survey, but of stakeholders competent at this stage of the hierarchy and is held the actualization of descriptors by the principle described above.
Actualization of descriptors of the i-th hierarchical stage may lead to an actualization of descriptors of (i-1) -th hierarchical stage.

The actualization process of descriptors from the lowest level to the upper one should be carried out until the difference of weights α would be larger than the threshold. If at any hierarchical stage there is no need to adjust any descriptor, that means that the difference of weights α is less than the threshold, we can assume that there is no need to actualize the qualifications frameworks of the next stage of the hierarchy and actualization process can be suspended. Thus formed qualifications frameworks, in principle, will correspond the current requirements of stakeholders and will be relevant in the current period.

For bringing current version of QF to the optimum, when QF are in maximum according to the requirements of the working market, is necessary to conduct surveys of stakeholders with a certain frequency. The frequency of surveys and adjustment of the QF will depend on the dynamics of changes in relevant segments of the working market. Actualization of the current qualifications frameworks, based on the feedback from stakeholders, in turn, may lead to an adjustment of related with them QF of previous and next stages of the hierarchy.

4. CONCLUSION

In order that graduates were maximum demanded in the working market is necessary to produce the actualization of qualifications frameworks quite often. As the frequency of process of the QF actualization depends on the dynamics changes of the working market, it is important to produce this process quite often especially for the fastest growing industries. The automation of the process of filling qualifications frameworks and their actualization on the basis of views of stakeholders will help to speed up the process of actualization of the QF and will facilitate the hard work of specialists who are responsible for the implementation of given process.

Specialists can use the automated system of development of qualifications frameworks as a universal tool, the use of which will make possible the development of qualifications frameworks corresponding to features of national educational systems of different countries.

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