

## Optimization of the Subject Matter of Profile Training Disciplines for Bachelors' Vocational Education on the Basis of Occupational Standards

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### ABSTRACT

Applicability of the issue under study is conditioned by the need in development of principal educational programs by higher education institutions with accounting for requirements of appropriate occupational standards and necessity in reviewing of the requirements of occupational standards and reflecting them within the scope of competences formed. The paper is aimed at substantiation of the subject matter of profile training disciplines for vocational education of bachelors within the context of competence and process approaches and with accounting for occupational standards. The leading method of study of this issue is modeling which allows considering the issue under study as a process of recognized accounting of requirements of appropriate occupational standards wherein employers' opinions are fixed in the regulatory mode. The structural-functional model of selection of the subject matter of profile disciplines for the training program is developed; the following algorithms are developed: 1) of analysis of occupational standards; 2) of comparing of occupational standards with curriculum disciplines; 3) of analysis of the subject matter of labour functions, labour actions, knowledge and skills when developing working programs and assessment resources funds; the model has been successfully tested on the example of profile training of vocational education bachelors. The paper presents the structure-functional model of selection of the subject matter of profile disciplines of the educational program with taking into account of occupational standards requirements which define competences acquired by a graduate, i.e. his/her ability to use knowledge, skills and personal qualities in accordance with the occupational activity; the process approach to implementation of this model is applied.

**Keywords:** bachelor, educational standard, process approach

## INTRODUCTION

### The Relevance of the Research

The following modifications of Federal Law "On education in the Russian Federation" are in effect from July 1, 2016: formation of requirements of federal state educational standards of vocational education (FSSES) to results of acquisition of the principal educational program (PED) of vocational education in terms of professional competence shall be realized on basis of appropriate occupational standards (when available) (Federal Law on education..., 2012). In this connection, higher education institutions shall work out PED with taking into account requirements of respective occupational standards (OS). When working out PED, requirements of occupational standards should be analyzed and reflected within competences formed.

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#### Contribution of this paper to the literature

- The structural-functional model of selection of the subject matter of profile disciplines of the bachelorship educational program has been developed, with accounting for requirements of occupational standards.
- Use of the process approach at developing of the model realization algorithms has been substantiated.
- It has been proved that use of the model will serve to the purpose of optimization of the subject matter of profile training at selecting didactic units of the curriculum on basis of requirements of occupational standards and further monitoring of competencies maturity.

For staff training in the higher education system, higher schools use FSES on basis whereof PEDs are developed. FSESs are worked out, approved and modified by Government of the Russian Federation (On entering changes in Labor Code..., 2015).

FSES is a collection of mandatory requirements to education of a certain level and/or to a profession, specialty and field of study approved by the federal body of executive authorities performing functions on formulation of the state policy and statutory regulation in the educational sphere (Federal Law on education, 2012).

PED is a complex of regulatory and guidance documentation which regulates the subject matter, arrangement and quality assessment of training of students and graduates in a certain specialty (Guzanov et al., 2015).

### Objectives and Tasks of the study

This paper is aimed at substantiating of the subject matter of disciplines of training of vocational education bachelors in profile within the context of competency and process approaches with taking OSs in consideration. The following tasks were defined as major: analysis of OSs reflecting application aspects of training of vocational education bachelors in profile; theoretical elaboration of the model of selecting the subject matter of PED profile disciplines on OS basis; finding requirements to the subject matter of profile disciplines; experimental work on the model approbation.

### LITERATURE REVIEW

To work out the PED efficiently, its general content and the content of the curriculum disciplines should be substantiated in a competent manner. It is evident that a new practice of PED working out is being formed in the educational process, when this or that certain practical problem corresponding to occupational activity types is put into the basis of scope of training, e.g. in papers of Dremina et al. (2016), Yefimova (2016), Shaidullina et al. (2015b), Cai et al. (2017).

New trends conforming to requirements of the modern educational process are becoming more and more discernable: pedagogical modeling, pedagogical monitoring and process approach in course of selection of PED content (Zeer et al., 2016; Dorozhkin et al., 2016; Shaidullina et al., 2015a; Konyshcheva & Ibragimova, 2017; Levina et al., 2017; Shushara & Khuziakhmetov, 2017; Cherdymova et al., 2017).

PED content in profile-oriented training of vocational education (VE) bachelors should be of complex character (Dorozhkin & Zeer, 2014) and allow a graduate to manifest readiness for performing occupational activities within FSES of VE bachelor training, and activities related to application aspects of the training which are defined by the profile and scopes singled out therein (Guzanov et al., 2016b). Topics of application aspects shall be determined by appropriate OSs.

In papers of Western specialists, the modern society is regarded as "learning" and featured with "permanent educational culture" (Field (USA), 2000). The need in constant upgrading of occupational competences, when knowledge are becoming obsolete rapidly, conditioned development of *Life Long Learning* concept which was widely spread in late 1990s. To basic trends of the educational policy of developed countries one may relate: development of specialists' motivation for training for the whole of their lives. Growing needs in pedagogical staff able to realize these educational functions is just a natural consequence of this phenomenon (Fominykh et al., 2016); here we can also note forming its social-occupational significance (Livingstone, 1999), formation of long-term perspective of occupational activity (Malikh et al., 2016). At the same time, we have to admit that the existing system of vocational-pedagogic education cannot properly provide high-quality training of teachers in knowledge-intensive and high-tech branches of economy (Zeer & Streltsov, 2016).

## MATERIALS AND METHODS

### Research Methods

In process of the research, the following methods were applied: theoretical method of modelling – in course of developing the structural-functional model of selection of the subject matter of the educational program profile disciplines; empirical method of studying of the experience of work of educational entities – for development of algorithms of (1) analysis of occupational standards, (2) comparing of occupational standards with curriculum disciplines; (3) analysis of the subject matter of labour functions, labour actions, knowledge and skills when developing working programs and assessment resources funds; experimental method (teaching experiment) – at the stage of approbation of the developed model and algorithms on the example of vocational training bachelors profile training; method of pedagogical observations – when setting the problem of a study; methods of analysis and generalization were also used when studying Russian and foreign scientific-pedagogical literature.

### Research Experimental Facility

Federal State Autonomous Educational Institution for Higher Education “Russian State Vocational Pedagogical University”

### Research Phases

The problem was researched in three stages:

**At the 1<sup>st</sup> stage**, theoretical analysis of OSs was performed which reflected application aspects of profile-oriented training of VE bachelors, analysis of FSESs which matched the training profile and existing methodological approaches in pedagogical special literature, as well as thesis papers in the problem and theories and techniques of pedagogical researches; the problem, target and methods of research were singled out and the experimental research plan was made up;

**At the 2<sup>nd</sup> stage**, theoretical elaboration was performed in relation to the OS-based model for selection of subject matter of profile-oriented curriculum disciplines. As a final result, requirements to the subject matter of profile-oriented disciplines were established which have to be considered when developing working programs and as items to be checked when working out assessment resources funds for assessing the conformance to requirements of occupational standards;

**At the 3<sup>rd</sup> stage**, an experimental work was performed aimed at approbation of the model on the example of training of VE bachelors in the profile “Machine-building and metal processing”, scope “Certification, metrology and quality management in machine-building”; theoretical and practical results were specified, and the obtained results were generalized and systemized.

## RESULTS

### The Model Structure and Content

The proposed model is built with taking into account of the process approach points, according whereto the activity is represented as a total of interrelated process, where an “output” of a previous process is an “input” into the next one. The client’s requirements shall be the starting point for a dedicated process execution, and, as a final result, satisfaction of requirements and consideration of potential changes in their scope shall be defined.

A package of profile-oriented formed competences defined on basis of interrogation of employers, and the list of disciplines of the PED curriculum are taken as the client’s requirements.

As dedicated interrelated processes, the following are proposed:

1. Selection and analysis of occupational standards (OSs) related to the profile (dedicated scope) of training.
2. Comparison of OSs and integrated labor functions (ILF) with the curriculum disciplines (modules).
3. Analysis of the subject matter of OSs labor functions (LF), comparison of OS LFs with the curriculum disciplines (modules).
4. Analysis of the subject matter of working actions, skill and knowledge (WA, S & K) of OSs, detection of “reference units” for formation of the subject matter of training on the profile (dedicated scope) disciplines.
5. Development of working programs and resources funds for assessing on disciplines (modules) with considering of the OS requirements.

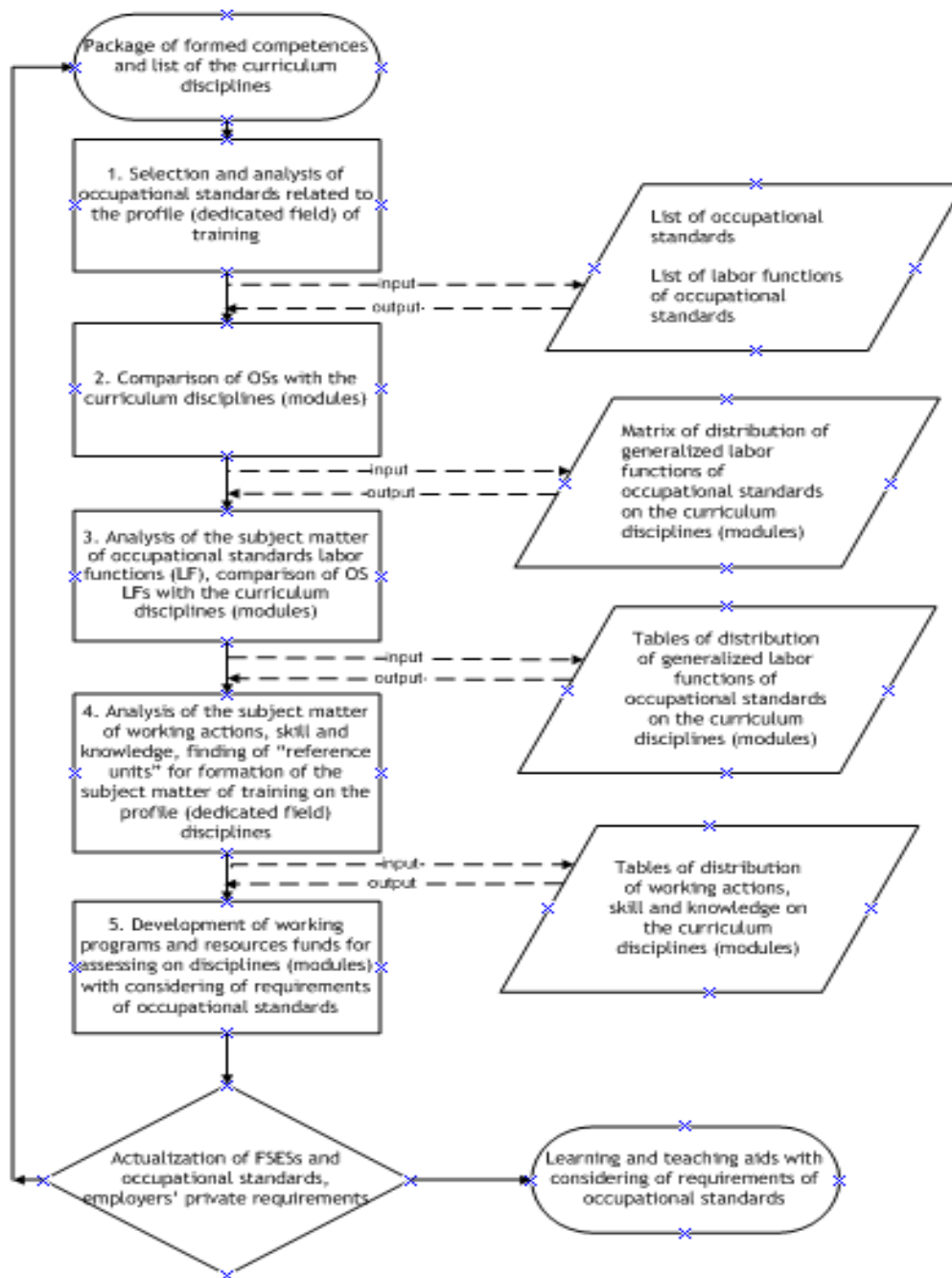


Figure 1. Stages of the model implementation

“Inputs” and “outputs” are defined for each process. To account for possible changes in scope of requirements, the activity on actualization of OSs and FSES shall be utilized. The developed model is shown in Figure 1.

Further on, let us consider utilization of the developed model in course of formation of the subject matter of profile-oriented training of VE bachelors in the profile “Machine-building and metal processing”, scope “Certification, metrology and quality management in machine-building”.

Bachelors are trained in various fields and profiles of training. A certain scope of training can be singled out within a profile. The list of fields of training of bachelors was approved by Order of Ministry of Education and Science of the Russian Federation dd. 12.09.2013 under No. 1061 (On approval of the list of specialties ..., 2013).

The bachelorship FSES is worked out in the field of training without accounting for the profile. However, when PED is worked out, the profile and dedicated scope of training shall be accounted.

The standard establishes competences which reflect preset results of training in all fields. For instance, the FSES of training field 44.03.04 “Vocational training (by industries)” (Federal State Educational Standard ..., 2015)

**Table 1.** Structure of the bachelorship program in the field of training 44.03.04 Vocational training (by industries), within the profile "Machine-building and metal processing"

Structure of bachelorship program		Volume of bachelorship program in points of credit (POC)
Unit 1	Disciplines (modules)	210
	Basic part	96
	Variable part	114
Unit 2	Practical trainings	21
	Variable part	21
Unit 3	State final examination (SFE)	9
	Basic part	9
The total volume of bachelorship program		240

establishes competences of a VE teacher which are common for the entire field. In PED, competences are adapted to the profile by adding supplementary competences to the curriculum, basing on employers' needs reflected in questionnaires for interrogation of employers and in the OS.

Thus, PED is developed by its field in accordance with FSES and the training profile. It is worth mentioning that one profile can integrate multiple scopes of training. For instance, within the profile "Machine-building and metal processing" such scopes can be singled out as "Technology and equipment of machine-building" and "Certification, metrology and quality management in machine-building", etc. The scope shall be also described in the subject matter of PED.

Using the text of the explanatory note to PED (Principal Vocational Education Program ..., 2015), we will present a brief description of basic provisions characterizing the PED of training of bachelors in the field 44.03.04 Vocational training (by industries) in the training profile "Machine-building and metal processing", scope "Certification, metrology and quality management in machine-building".

The objectives of bachelorship PED are development of students' personality qualities and formation of soft universal (general scientific, socio-personal, instrumental) and professional competences necessary for training of workers and specialists in professions and specialties in scopes of activity related to issues of technical regulation, metrology and quality management of machine-building products in education institutions realizing educational programs of secondary vocational education and supplementary vocational education, training course network of enterprises and entities, in centers for training, retraining and advanced training of workers and specialists, plus in employment agencies.

The labor intensity of assimilation of the principal educational program by a student for the whole training period, in accordance with FSES of higher education in the field 44.03.04 Vocational training (by industries) shall be equal to 240 credit points and shall include all types of the student's classroom and independent work, practical work and the time assigned for control of quality of assimilation of the higher education PED by the student, regardless the mode of study, applied educational techniques, realization of the program by multiple entities executing educational activities with use of the network form, realization of training by an individual curriculum, abbreviated training included.

In accordance with FSES of higher education in the field 44.03.04 Vocational training (by industries), the structure of the bachelorship program in the field of training 44.03.04 Vocational training (by industries), within the profile "Machine-building and metal processing" includes units shown in [Table 1](#).

Results of acquisition of bachelorship PED shall be defined by competences acquired by a graduate, i.e. his/her ability to use knowledge, skills and personal qualities in accordance with the occupational activity tasks. Bachelor's competences in the field of training 44.03.04 Vocational training (by industries), within the profile "Machine-building and metal processing" shall be defined on basis of FSES and the analysis of results of interrogation of potential employers.

The following profile-specialized competences (PSC) were defined in result of project planning of PED of training of vocational education bachelors on the profile of interest within the dedicated scope:

- PSC 1: ready to take part in development and realization of technological processes of processing and monitoring of machinery parts in process of training of blue- and white-collar workers and middle ranking specialists in the area of technical regulation of the appropriate qualification level;
- PSC 2: able to take part in practical assimilation of quality management systems at an entity and in an educational institution;
- PSC 3: able to take part in fulfilling tasks on development, revising, actualization and application of statutory documents in the area of technical regulation and quality management in process of training of a worker (specialist) of the appropriate qualification level;

- PSC 4: ready to perform works on metrological support of production and an educational institution;
- PSC 5: ready to take part in preparation and conducting of compliance assessment (Guzanov, Sokolova & Migacheva, 2015).

The above listed competences are the basis for selection of the subject matter of PED application aspects which is reflected in appropriate curriculum disciplines (Principal vocational educational program..., 2015).

By now a curriculum plan has been developed possessing units common for the entire profile and elective modules the disciplines whereof is defined by a dedicated scope of training. See below the description of the curriculum with specifying points of credit (POC) per each unit and module.

A competence-oriented curriculum consists of three large units: disciplines (modules), practical trainings, and final qualification.

A unit of disciplines (modules) consists of the following sections:

- basic part 3420 POC;
- variable part 4468 POC

The basic part shall include:

- module of general scientific disciplines 1404 POC;
- module of general vocational disciplines 1476 POC;
- vocational-qualification module 540 POC

Compliant to the goal of work, we will single out disciplines reflecting the subject matter of training which is specific for the scope of certification, metrology and quality management. Such a subject in the module of vocational-qualification disciplines is “Practical training on profession” 540 POC, as it supposes specific matters for the dedicated scope, i.e. it will change the subject matter related to measuring of parameters of machine-building details.

The variable part shall include compulsory disciplines which are subdivided into:

- general technical module 1728 POC;
- profile module 1116 POC;
- elective disciplines 1624 POC

The general technical module is common for the entire profile and includes disciplines which reveal basics of machine-building and material processing. The profile module includes subjects which reveal the dedicated scope. The following disciplines shall reflect specific matters of the scope:

- Quality management 216 POC;
- Metrology, standardization, certification 108 POC;

The dedicated disciplines are deepened in the section “elective disciplines” wherein subjects within elective modules are contemplated.

The section “elective disciplines” consists of seven elective modules. Each module includes two disciplines from different dedicated scopes. Below disciplines from these modules are listed which conform to the scope “Certification, metrology and quality management in machine-building”:

- Basics of designing of measuring mechanisms 180 POC;
- Metrological support and standardization of production 180 POC;
- Methods and equipment of measurements, tests and control 252 POC;
- Technical inspection in machine-building 216 POC;
- Acknowledgement of compliance of machine-building products 144 POC;
- Qualimetry 108 POC;
- Modern quality management conceptions 144 POC

The unit of practical trainings is of high significance (756 POC), as it fixes up competences which are formed on disciplines of profile and elective modules. In final, one may say that PED of training of vocational education bachelors in the profile “Machine-building and metal processing”, scope “Certification, metrology and quality management in machine-building” includes not only requirements of FSES but also potential employers’ opinions. In accordance with modern requirements of occupational standards, requirements of appropriate OSs should be taken into account in process of PED developing, wherein employers’ opinions are fixed in the regulatory mode.

Thus, the above description, the set of competences formed (PSCs), and the list of disciplines of the curriculum are an input for realization of the processes included into the model. Realization of the dedicated processes – element of the model – will be shown in subsequent sections of our paper.

### **Selection and Analysis of Occupational Standards (OSs) Related to Profile (Dedicated Scope) of Training**

The educational program of higher education covers a number of OSs. That is why analysis and comparison of labor functions will allow more accurate stating of the training results, which will help in planning of the educational process to the chair and in reaching of compliance to requirements of a number of standards and being in demand on the modern labor market.

The following OSs corresponding to the scope of certification, metrology and quality management were chosen for the analysis:

- specialist in metrology (OS 1),
- specialist in product certification (OS 2),
- specialist in product quality (OS 3).

The following criteria were used for selection of OSs: commonality of content of the labor covered by the OSs and of the dedicated scope of training of bachelors; the level of education (bachelorship) and qualification levels integrated into the OSs (Batrova et al., 2008; Guzanov et al., 2016a).

Further on, detailed analysis of integrated labor functions (ILF) and labor functions (LF) of each OS on the 5<sup>th</sup> and 6<sup>th</sup> qualification levels (On approval of qualification levels..., 2013).

Two ILFs are singled out in the occupational standard “Specialist in metrology” (2014). See below the description thereof.

ILF “Metrological recording and performing of simple operations on metrological support of an existing production”.

*Code: A.*

Qualification level: 5.

Requirements to education and training: secondary vocational education; higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles:

- Technician;
- 2nd category technician;
- 1st category technician;
- Metrologist technician;
- 2nd category metrologist technician;
- 1st category metrologist technician.

Now let us single out labor functions LF included into ILF with the appropriate code:

- Performing of precise measurements for determination of actual values of parameters under control A/01.5;
- Record management, maintaining and actualization of production-technical and normative documentation A/02.5;
- Keeping and maintaining in good working order of working calibration standards for reproduction of units of measurement, verifying and calibration instruments A/03.5;
- Verification (calibration) of simple measuring tools A/04.5;
- Metrological recording of tools for measuring, tests and control, working calibration standards, reference specimens, techniques of measuring and testing A /05.5.

ILF “Metrological support of development, production, tests and operation of products”.

*Code: B.*

Qualification level: 6.

Requirements to education and training: secondary vocational education; higher education – bachelorship.

Requirements to practical working experience: higher education without requirements to the employment history, or secondary vocational education and history of employment as 1<sup>st</sup> category metrologist technician for at

least three years, or as other job titles occupied by specialists with secondary vocational education, for five years at least.

Possible job titles:

- Engineer;
- 2nd category engineer;
- 1st category engineer;
- Metrologist engineer;
- 2nd category metrologist engineer;
- 1st category metrologist engineer;
- Specialist in metrology.

LFs included into ILF, with appropriate codes:

- Performing of especially precise measurements for determination of actual values of parameters under control B/01.6;
- Metrological supervision on observance of standards and regulations for provision of uniformity of measurements, of the state and application of measuring tools B/02.6;
- Conducting of works on control and upgrading of the reference base, verification instruments and measuring tools B/03.6;
- Verification (calibration) of measuring tools B/04.6;
- Establishing of verification frequency for measuring tools and plotting of calendar plans and graphs of conducting of verifications B/05.6;
- Metrological expertise of technical documentation B/06.6;
- Development and attestation of techniques of measuring and testing B/07.6;
- Attestation of test equipment and special measuring tools B/08.6;
- Development and implementation of special measuring tools B/09.6;
- Development and implementation of standards and other normative documents in the scope of metrological support B/010.6;
- Certification and tests of measuring tools in purpose of approval of a type B/011.6;
- Composing of local checkout circuits per types of measurement B/012.6.

Two ILFs are singled out in the occupational standard “Specialist in certification of products” (2014). See below the description thereof.

ILF “Performing works on acknowledgement of conformance of products (services) and the quality management system”.

Code: A.

Qualification level: 5.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: Engineer for certification of products (services).

LFs included into ILF, with appropriate codes:

- Performing of measures on results of state supervision, sectoral and cross-sectoral control of implementation and observance of standard and technical specifications in scope of products quality, preparation of products (services) to acknowledgement of conformance and attestation A/01.5;
- Maintaining of records and composing of reports on the entity’s activity in certification of products (services) A/02.5;
- Development of elements of the document circulation system in the entity, statement of requirements to the subject matter and structuring of the technical and organization-managerial documentation A/03.5;
- Development and preparation of measures related to implementation of standards and technical specifications for products manufactured by the entity (services rendered by the entity) A/04.5.

ILF “Organization of performing works on acknowledgement of conformance of products (services) of the entity”.



*Code: B*

Qualification level: 6.

Requirements to education and training: higher education - specialty, magistrate.

Requirements to practical working experience: history of employment in the specialty, including on managerial posts - for three years at least.

Possible job titles: deputy head of division for products (services) certification.

LFs included into ILF, with appropriate codes:

- Organization of works on acknowledgement of conformance of products (services) and the quality management systems B/01.6;
- Organization of works on conducting of an internal audit of the entity's quality management system B/02.6.

This integrated labor function (B) is an exception, as it does not suit the criteria established above (requirements to education, requirements to practical working experience), but it is included into the subject matter of training of bachelors, so we will include it into our analysis.

Four ILFs are singled out in the occupational standard "Specialist in quality of products" (2014). See below the description thereof.

ILF "Performing works on management of quality of products operation".

*Code: A.*

Qualification level: 6.

Requirements to education and training: higher education - bachelorship.

Requirements to practical working experience: None.

Possible job titles: engineer for management of quality of products operation.

LFs included into ILF, with appropriate codes:

Determination and agreeing of requirements to products (services) established by customers, as well as requirements not established by customers but needed for operation of products (services) A/01.6;

- Review of claims and complaints to quality of products, works (services), composing of final conclusions and maintaining of correspondence on results of considering thereof A/02.6;
- Development of corrective actions on management of non-conforming products (services) in course of operation A/03.6.

ILF "Performing works on management of quality of processes of products manufacture and services rendering".

*Code: B.*

Qualification level: 6.

Requirements to education and training: higher education - bachelorship.

Requirements to practical working experience: None.

Possible job titles: engineer for management of quality of processes of products manufacture and services rendering.

LFs included into ILF, with appropriate codes:

- Analysis of reasons which cause deterioration of the quality of products (works, services), development of plans of measures aimed at elimination thereof B/01.6;
- Development of techniques and instructions on current control of quality of works in process of manufacture of products, in tests of finished products and execution of documents certifying the quality thereof B/02.6.

ILF "Performing works on management of quality of products and services projection".

*Code: C.*

Qualification level: 6.

Requirements to education and training: higher education - bachelorship.

Requirements to practical working experience: None.

Possible job titles: Engineer for management of quality of products and services projection.

LFs included into ILF, with appropriate codes:

**Table 2.** Interconnected labor functions of sampled occupational standards

OS 1	OS 2	OS 3
Records management, maintaining and actualization of production-normative documentation	Development of elements of the records management system in the entity, stating of requirements to the subject matter and structuring of the technical and organization-managerial documentation	-
Development and implementation of standards and other normative documents in scope of metrological support	Development and preparation of measures related to implementation of standards and technical specifications for products manufactured by the entity (services rendered by the entity)	Studying of advanced national and international experience in development and implementation of quality management systems, composing of analytical reports on possibility of using such experience in the entity

- Analysis of the data obtained at various stages of manufacture of products, performing works (rendering services) on basis of quality indexes characterizing the designed and manufactured products, works (services) C/01.6;
- Studying of advanced national and international experience in development and implementation of quality management systems, composing of analytical reports on possibility of using such experience in the entity C/02.6;
- Development of measures aimed at prevention of manufacture of products, performing works (services) not conforming to the established requirements C/03.6.

ILF "Performing works on management of entity resources quality".

Code: D.

Qualification level: 6.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: engineer for management of entity resources quality.

LFs included into ILF, with appropriate codes:

- Composing of a final conclusion on conformance of the quality of raw stocks, materials, semi-finished materials, components delivered to the entity to standards and technical specifications, and execution of documents for submitting claims to suppliers D/01.6;
- Development of drafts of procedures and local normative acts on training of the entity's employees in field of quality D/02.6.

Let us analyze the sampled labor functions. It's possible to suppose that some from the selected labor functions of various standards are close in their sense, but there are also specific ones inherent to a certain standard. Let us bring to light those labor functions which are interconnected to each other in the scope "Certification, metrology and quality management", with summarizing the results in [Table 2](#).

Approbation of the conducted analysis of requirements of OSs was performed in framework of proceedings of conference "Technical regulation in United economic space" which was held on May 20, 2016 in Russian State Vocational Pedagogical University. It was found out that LFs similar in their sense are present in two standards at least (from those mentioned above). These are functions related to performing measurements; maintaining, development and actualization of normative documentation; performing certification; management of the entity's employees; reviewing claims and complaints to quality of products; implementation of control of the system of products quality management (Sokolova et al., 2016).

Functions which are determined in one OS only shall be regarded by us as specific labor functions. For instance, such LFs as "Keeping and maintaining in good working order of working calibration standards for reproduction of units of measurement, verifying and calibration instruments", "Verification (calibration) of simple measuring tools" are specific for the standard "Specialist in metrology". For the standard "Specialist in product quality" they will be "Development of corrective actions on management of non-conforming products (services) in course of operation". The standard "Specialist in products certification" shall be specific in scope of such functions as "Maintaining of records and composing of reports on the entity's activity in certification of products (services)".

Results of the conducted analysis should be used in projecting of subject matter of profile disciplines of educational programs, in determination of training results. When developing an educational program, general labor functions should be accounted for in the profile part disciplines, while specific functions should be reflected in disciplines of elective modules. Results of the conducted analysis speak for necessity to use the proposed technique both for development of programs and for identification of the training outcomes.

**Table 3.** Matrix of distribution of integrated labor functions per the curriculum disciplines

Disciplines	Occupational standards							
	OS 1		OS 2		OS 3			
	ILF A	ILF B	LF A	ILF B	ILF A	ILF B	ILF C	ILF D
Practical trainings on specialty	+	+	-	-	-	-	-	-
Quality management	-	-	-	-	+	+	+	-
Metrology, standardization and certification	+	+	+	+	-	-	-	-
Basics of designing of measuring mechanisms	-	+	-	-	-	-	-	-
Metrological support and standardization of production	+	+	-	-	-	-	-	-
Methods and equipment of measurements, tests and control	-	+	-	-	-	-	-	-
Technical inspection in machine-building	+	+	-	-	-	+	+	+
Acknowledgement of compliance of machine-building products	-	-	+	+	-	-	-	-
Qualimetry	-	-	-	-	+	-	+	-
Modern quality management conceptions	-	-	-	-	+	-	+	+

The final result of the process performed in such a way will be an “output”: a list of OSs related to the profile (dedicated scope) and labor functions thereof (common for the profile and specific for the dedicated scope).

### Comparison of Occupational Standards and Integrated Labor Functions with Disciplines of PED Curriculum

Let us analyze interconnections of disciplines of the profile and elective modules and OS ILFs singled out above. Results of the analysis shall be presented in **Table 3** which is an “output” from Process 2.

Reviewing the produced matrix, we come to the conclusion that not each of integrated labor functions will be covered by the subject matter of each discipline (module). In particular, “Practical trainings on specialty” shall cover only ILF 1 of OS. “Quality management” shall cover only ILFs A, B, C of OS 3. The module “Metrology, standardization and certification” shall cover all ILFs of OS 1 and OS 2. The discipline “Metrological support and standardization of production” fully covers the subject matter of OS 1. The subject matter of the disciplines “Methods and equipment of measurements, tests and control” include ILF B of OS 1. The discipline “Technical inspection in machine-building” covers all ILFs of OS 1 and ILFs B, C, D of OS 3. “Acknowledgement of compliance of machine-building products” covers all ILFs of OS 2. “Qualimetry” is included into ILFs A and C of OS 3. “Modern quality management conceptions” is also included into ILFs A, C, D of OS 3.

This matrix shall be an “input” into Process 3.

### Analysis of the Subject Matter of Labor Functions and Their Comparison with Disciplines of PED Curriculum

Now let us perform detailed analysis of the necessary subject matter of disciplines in accordance with OS provisions. We will find out LFs of each OS and distribute them per the curriculum disciplines. Results shall be presented in **Tables 4, 5, 6** which are an “output” from Process 3.

Reviewing **Tables 4, 5, 6**, we come to the conclusion that the same LFs from a certain occupational standard are distributed to different disciplines. To explain why such a distribution exists, it is needed to analyze the LFs subject matters. Let’s examine working actions (WA), necessary skills (S), and necessary knowledge (K) for each labor function and distribute them per disciplines for making the subject matters of raining in disciplines more definite, in the application aspect.

**Table 4.** Distribution of OS LFs “Specialist in metrology” per the curriculum disciplines (fragment)

Discipline	Labor functions included in ILF A	Labor functions included in ILF B
Practical trainings on specialty	A/01.5 Performing of precise measurements for determination of actual values of parameters under control. A/02.5 Record management, maintaining and actualization of production-technical and normative documentation.	B/01.6 Performing of especially precise measurements for determination of actual values of parameters under control.
Metrology, standardization and certification	A/01.5 Performing of precise measurements for determination of actual values of parameters under control. A/02.5 Record management, maintaining and actualization of production-technical and normative documentation.	B/02.6 Metrological supervision on observance of standards and regulations for provision of uniformity of measurements, of the state and application of measuring tools. B/010.6 Development and implementation of standards and other normative documents in the scope of metrological support.
Basics of designing of measuring mechanisms	-	B/09.6 Development and implementation of special measuring tools.

**Table 5.** Distribution of labor functions for “Specialist in product certification” per the curriculum disciplines (fragment)

Discipline	Labor functions included in ILF A	Labor functions included in ILF B
Metrology, standardization and certification	A/01.5 Performing of measures on results of state supervision, sectoral and cross-sectoral control of implementation and observance of standard and technical specifications in scope of products quality, preparation of products (services) to acknowledgement of conformance and attestation. A/02.5 Development of elements of the document circulation system in the entity, statement of requirements to the subject matter and structuring of the technical and organization-managerial documentation.	B/01.6 Organization of works on acknowledgement of conformance of products (services) and the quality management systems. B/02.6 Organization of works on conducting of an internal audit of the entity’s quality management system.

**Table 6.** Distribution of labor functions for “Specialist in product quality” per the curriculum disciplines (fragment)

Discipline	Labor functions included in ILF A	Labor functions included in ILF B	Labor functions included in ILF C	Labor functions included in ILF D
Quality management	A/01.5 Determination and agreeing of requirements to products (services) established by customers, as well as requirements not established by customers but needed for operation of products (services). A/02.5 Review of claims and complaints to quality of products, works (services), composing of final conclusions and maintaining of correspondence on results of considering thereof. A/03.5 Development of corrective actions on management of non-conforming products (services) in course of operation.	B/01.6 Analysis of reasons which cause deterioration of the quality of products (works, services), development of plans of measures aimed at elimination thereof. B/02.6 Development of techniques and instructions on current control of quality of works in process of manufacture of products, in tests of finished products and execution of documents certifying the quality thereof.	C/01.6 Analysis of the data obtained at various stages of manufacture of products, performing works (rendering services) on basis of quality indexes characterizing the designed and manufactured products, works (services). C/03.6 Development of measures aimed at prevention of manufacture of products, performing works (services) not conforming to the established requirements.	

### Analysis of the Subject Matter of Working Actions, Knowledge and Skills

Analysis of the subject matter of WA, K & S is one of the grounds for development of “reference units” when forming the subject matter of training in disciplinem in a dedicated scope. Supporting on the “output” from Process 3 on each of dedicated LFs, let us distribute a standard WA, K & S package per the curriculum disciplines.

Necessary skills and knowledge which are universal for the whole profile shall regarded as profile disciplines. Working actions, necessary skills and necessary knowledge which correspond to the scope “Certification, metrology and quality management” shall be regarded as a part of the subject matters of elective modules.

Results of the analysis shall be presented in **Tables 7, 8, 9** which are an “output” from Process 4.

**Table 7.** Distribution of labor functions subject matters for “Specialist in metrology” per profile disciplines and elective modules (fragment)

Discipline	Working actions	Skills needed	Knowledge needed
Practical trainings on specialty	A/01.5: Preparation for conducting measurements for determining of actual values of parameters to be controlled. Processing of the measurement results. Recording of the measurement results in the documentation.	A/01.5: Using measuring tools, ordinary universal and special measuring equipment necessary for performing measurements. Obtaining, interpreting and documenting the measurement results.	A/01.5: Physical principles of operation, scope of application and principal restrictions of measuring methods and equipment. Technical characteristics, design peculiarities, intended use and application principles of measuring equipment (ME) used in the entity’s field of activity
	B/01.6: Identification of the item parameters influencing section of ME. Identification of allowable error (uncertainty) of measurements. Selection of methods and ME. Selection of variants of using ME and conditions of conducting of measurements. Preparation for conducting measurements for determining of actual values of parameters to be controlled. Conducting of a measuring experiment. Processing of the measurement results. Recording of the measurement results in the documentation.	B/01.6: Choosing optimal methods and measuring equipment. Using the measuring equipment necessary for conducting of measurements. Obtaining, interpreting and documenting the measurement results. Calculating errors (uncertainties) of measurement results.	B/01.6: Normative and methodical documents regulating issues of selection of methods and measuring equipment. Physical principles of operation, scope of application and principal restrictions of measuring methods and equipment. Technical characteristics, design peculiarities, intended use and application principles of measuring equipment.
Metrology, standardization and certification	-	A/01.5: Using measuring tools, ordinary universal and special measuring equipment necessary for performing measurements. Obtaining, interpreting and documenting the measurement results. Executing of production-technical documentation in accordance with current requirements.	A/01.5: Normative and methodical documents regulating issues of selection of methods and measuring equipment. Physical principles of operation, scope of application and principal restrictions of measuring methods and equipment.
	-	A/02.5: Executing of production-technical documentation in accordance with current requirements.	A/02.5: Procedure of composing and rules of execution of technical documents in the entity. Basic terminology and definitions in scope of metrology. Form of submitting of measurement results and errors (uncertainties) thereof.
	-	B/010.6: Developing drafts of standards and normative documents.	B/010.6: Normative and methodical documents regulating issues of developing of standards and normative documents. Requirements to subject matter of standards and normative documents.
Basics of designing of measuring mechanisms	B/09.6: Development of a statement of work for designing of measuring mechanisms. Implementation of special measuring equipment.	B/09.6: Determining of necessity to develop special measuring equipment. Reviewing of methods and equipment for measuring of physical values.	B/09.6: Normative and methodical documents regulating issues of developing of measuring equipment. Physical principles of operation, scope of application and principal restrictions of methods and equipment of measuring. Practical and theoretical basics of realization of phases of measuring equipment designing.

“Practical trainings on specialty” was included into **Table 7**, as it implies specific features for the dedicated scope. The discipline “Metrology, standardization and certification” includes necessary knowledge and necessary skills which will be deepened and broadened in modules “Metrological support and standardization of production”, “Methods and equipment of measuring, tests and inspection”, “Technical inspection in machine-building”.

In **Table 8**, necessary knowledge and skills which are common in their content were included into the profile discipline “Metrology, standardization and certification”. Working actions and knowledge corresponding to them were included into the elective mode “Acknowledgement of compliance of machine-building products”.

**Table 8.** Distribution of the subject matter of labor functions of the occupational standard "Specialist in certification" per profile disciplines and elective modules

Discipline	Working actions	Skills needed	Knowledge needed
Metrology, standardization and certification	-	A/01.5: Executing technical documentation certifying quality of products (services).	A/01.5: Basic concepts of standardization and acknowledgement of compliance.
	-	A/02.5: Developing and executing basic types of normative documents, quality records, as well as package of documents of the entity's quality management system.	A/02.5: Basic provisions of the national and international normative base in scope of document circulation of quality management systems.
	-	A/03.5: Developing and executing basic types of normative documents, quality records, as well as package of documents of the entity's quality management system.	A/03.5: Basic provisions of the national and international normative base in scope of document circulation of quality management systems.
	-	A/04.5: Developing and executing basic types of normative documents, quality records, as well as package of documents of the entity's quality management system.	A/04.5: Basic provisions of the national and international normative base in scope of document circulation of quality management systems.

**Table 9.** Distribution of the subject matter of OS LF "Specialist in product quality" per profile disciplines and elective modules

Discipline	Working actions	Skills needed	Knowledge needed
Quality management	-	A/01.5: Composing technical documentation for provision of consumers' requirements to products (services).	A/01.5: National and international normative base in scope of management of products (services) quality.
	-	A/02.5: Applying actual normative documentation on reviewing of claims and complaints to quality of products, works (services).	A/02.5: National and international normative base in scope of management of products (services) quality.
	-	A/03.5: Applying actual normative documentation on development and use of method of control of (qualitative and quantitative) indicators of quality of products (services) in the entity.	A/03.5: National and international normative base in scope of management of products (services) quality.
	-	B/01.6: Applying actual normative documentation in scope of management of manufacture of products (rendering services).	B/01.6: National and international normative base in scope of management of products (services) quality.
	-	B/02.6: Applying actual normative documentation in scope of management of manufacture of products (rendering services).	B/02.6: National and international normative base in scope of management of products (services) quality.

In **Table 9**, the discipline "Quality management" includes necessary knowledge and necessary skills which will be deepened and broadened in modules "Technical inspection in machine-building", "Qualimetry", "Modern concepts of quality management".

In the presented tables, someone and the same working actions with respective necessary knowledge and necessary skills were included from one LF, which are formed at their studying; it should be taken into account when forming intra- and inter-subject connections of the training subject matter. There are also necessary knowledge which were related to other disciplines of the profile; it can be regarded as a kind of "ordering" for their content.

IFs include WA, K&S. All these characteristics take part in formation of bachelor's competences. Thus, one have to account for each LF of the selected OSs when forming the subject matter of modules.

OS is not the only criterion for selection of the discipline subject matter. We also have to account for pedagogical principles and didactics in part of selecting the content.

"Outputs" of Processes 1-4 are "input" into Process 5 "Development of working programs and assessment resources funds per disciplines with considering of OS requirements".

Thus, following the model, we obtain educational learning materials on disciplines structured with accounting for requirements of the OS. Use of the process approach implies defining of satisfaction of requirements and consideration of potential changes in their scope. For that, the element "FSES and OS actualization" is envisaged in our model which is a decision-making block on necessity of entering modifications into the academic and methodological complex of a discipline. If requirements of OS get changed, it is necessary to enter appropriate changes into educational learning materials.

## DISCUSSIONS

Studying of pedagogical literature allows stating of insufficiency of special researches devoted to the issue of selection of subject matter of disciplines with considering of labor functions in accordance with occupational standards under conditions of real practical working activity.

Selection of subject matter of training is generally accepted on basis of pedagogical approaches of S.I. Arkhangelsky (1980), Babansky (1988), Lednev (1989). At present, the competence approach is applied for selection of the subject matter which is described in papers of Zeer (2003). Provisions of this approach are developed in works of practicing pedagogues, such as Guzanov et al. (2015), Kopylov (2012).

When developing PED, it is also necessary to use the normative-legal base of education: Federal State Educational Standard (2015), Federal Law "On Education in the Russian Federation" (2012).

The necessity to consider the market's demands when developing PED conditioned introduction of OSs and requirement to consider provisions thereof when developing PED: methodical recommendations on development of principal educational programs and supplementary vocational programs with consideration of appropriate occupational standards (2015), the occupational standard "Specialist in metrology" (2014), the occupational standard "Specialist in products certification" (2014), the occupational standard "Specialist in products quality" (2014).

Thus, use of OSs is necessary both in development of FSEs and results of training by PED, and in drafting of educational disciplines, which is proved by researches by Guzanov et al. (2016a), Sokolova et al. (2016).

Resting upon the abovementioned grounds, one can propose the following provisions for discussion.

To identify the actual subject matter of training within the dedicated scope, it is necessary to consider opinions of potential employers. They are established in occupational standards. Three occupational standards were selected for the dedicated scope. From all working functions of the occupational standards those were singled out which can be fulfilled by the personnel with the qualification "bachelor", and their analysis was conducted. Results of the analyses showed that there are functions common for two standards and specific for each of standards. Common functions should be reflected in the profile disciplines as a whole; specific actions should be reflected in disciplines' variable parts conforming to the scope of certification, metrology and quality management in machine-building.

The selected labor functions may be distributed per respective profile disciplines and the curriculum elective modules. After that, knowledge, skills and working actions shall be articulated which are included into the labor functions; to our mind, it should play an important role in formation of the training subject matter.

The provisions set forth above should be taken into account when developing education-methodical complexes of educational disciplines. When occupational standards are revised or modified, the complex of methodical materials shall be subject to respective revision, on accordance with the updated subject matter of the standards.

Having regard to the above, one can suppose that while monitoring results of training, it is necessary to review conformance of knowledge, skills and firm grasping of the PED graduate to requirements of not only educational but also of occupational standards.

## CONCLUSION

As a result of the conducted study, a structural-functional model of selection of the subject matter of profile disciplines of the educational program with taking into account of occupational standards requirements was developed.

The proposed model has been structured with consideration of the process approach provisions.

The following processes were proposed as dedicated interconnected processes necessary at selection of training subject matter, with taking into account of occupational standards requirements:

1. Sampling and analysis of OSs related to the training profile (dedicated scope).
2. Comparison of OSs and integrated labor functions (ILFs) with the curriculum disciplines (modules).
3. Analysis of subject matter of OSs labor functions (LFs), comparison of OS LFs with the curriculum disciplines (modules).
4. Analysis of subject matter of working actions, knowledge and skills (WA,K&S) of OS, finding out of "reference units" for formation of the training subject matter per the profile disciplines (dedicated scope).
5. Development of working programs and assessment resources funds per disciplines (modules) with taking into account OS requirements.

"Inputs" and "outputs" have been identified for each process. Activity in actualization of OS and FSES is used as registration of possible changes in the scope of requirements.

The model was successfully approbated on the example of PED for training of vocational education bachelors in the profile “Machine-building and metal processing” in scope of certification, metrology and quality management in machine-building.

The model is aimed at adaptation of teachers to new conditions of their occupational activity in the sphere of education and is focused on working-out of methodological support of disciplines of the PED curriculum in part of training on profile disciplines in the dedicated scope.

The results submitted herein can be used by leading teachers for sampling of didactical units of the curriculum disciplines; it means that the paper is of practical nature and serves to optimization of the subject matter of profile training on basis of requirements of occupational standards and further monitoring of maturity of competences.

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