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Experimental Analytical Model of Conditions and Quality Control of Vocational Training of Workers and Specialists

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ABSTRACT

The relevance of the study problem is caused by the transformation in professional education on achieving international standards, increasing requirements to the quality of training skilled workers and mid-level professionals, preparing of students for successful employment in high-tech production and well-developed services. The purpose of the article is to develop models of effective organization and quality control of vocational training of workers and specialists on the basis of objective and reliable quantitative and qualitative indicators by using mathematical and statistical methods. The leading method to the research of this problem is analytical modeling, which allows to systematically scrutiny the dynamic processes of professional and personal developments of students in real conditions of theoretical and practical training. At this stage of the studying it can be stated that the proposed model of conditions and quality control of training skilled workers and mid-level professionals have received confirmation of effectiveness. A set of terms and indicators has been developed as instrumentation: percentages of time; individual coefficient and performance indicators by main types of training activities; total individual performance indicator; theoretical and real individual indicators of the number of assessments; GPA; individual coefficients considering attending the additional courses and activities, participation in professional competitions and effectiveness of this participation; integrated individual (group) indicator of the quality of learning; individual (group) rating. The proposed model provides the purposeful and systematic formation of General and professional competences of students. Analytical model conditions and the quality control of training of workers and specialists are tested in educational institutions and designed for practical usage of teaching staff of educational institutions to predict future achievements of professional learning, obtaining intermediate and final analytical results and making timely adjustments to the educational process.

Introduction

Urgency of the problem

The development of the system of secondary professional education, the quality of training skilled workers and mid-level professionals to work in high-tech industries and advanced services represent the actual socio-pedagogical

problem. The growing needs for professional and personal qualities of the modern employee are connected with society's needs and competition. The necessity of the formation of flexible, accountable system of continuous professional education, developing human potential, providing the current and future needs of socio-economic development is specified in regulatory documents: Federal law of 29.12.2012 № 273-FL "On education in Russian Federation", the President decrees of the Russian Federation from 07.05.2012 № 597 and 599, the State program of the Russian Federation "Development of education for 2013-2020", "Development Strategy of system of personnel training and formation of applied qualifications in the Russian Federation for the period till 2020", etc.

The attention of researchers in recent years is drawn to the study of models of professional training (Loboda, 2015; Shaidullina et al., 2015a), possibilities of dual forms of training (Zemlyansky, 2010; Teshev, 2015) and social partnership (Schantz, 2013; Shaidullina et al., 2015c), the design of individual routes of students (Storozheva, 2015) and the trajectories of professional development (Berezhnaya, 2012), the personalization of the educational process (Grachev, 2007; Shaidullina et al., 2015b; Masalimova et al., 2014) and the personification of professional training of students (Rabinowa, 2009), etc.

However, the efficient formation of General and professional competences of students stipulated by the Federal state educational standards, maybe when the subject of the necessary conditions and the systematic evaluation of the quality of the educational process through the effective techniques. To determine reliable intermediate and final results of professional training, monitoring of the dynamics of professional and personal development, determining the individual rating of students and rating of the training group we have developed and in educational institutions of professional education implemented an analytical model of the conditions and evaluation of the quality of education. It is based on mathematical and statistical methods of analysis of quantitative and qualitative indicators that take into account attendance of training sessions, performance in the process and the results of theoretical and practical learning, participation and student achievements in the activities of professional creativity.

Materials and Methods

The quantitative conditions of effective organization of training activities and range of indicators to measure the quality of vocational training skilled workers and mid-level professionals are identified. Among them the initial, intermediate and performance indicators are obtained. Using established mathematical relationships between conditions and indicators the analytical model is developed, allowing to calculate individual and group parameter values for optimal organization of the learning process, formation of General and professional competences of students.

In the experiment by testing the analytical model during the school year 178 students of institutions of secondary vocational education in professions "Master of finishing building works" and "Electrician for repairing and maintenance of electrical equipment in agricultural production", as well as the specialty of "Information systems" and "Technical operation and maintenance of electric and electromechanical equipment" took part.

During research following methods were used: analysis of regulations, psycho-pedagogical and methodological literature; study and generalize of the advanced scientific-pedagogical experience, analysis, systematization and generalization of facts and information; pedagogical experiment; design and modeling; conversation, questioning, testing, observation, qualitative and quantitative analysis of factual material; expert evaluation and analysis the results of students activity; methods of mathematical and statistical processing of the actual data.

Results

The source of analytical data in our studying are indicators of the number of hours by major activities – theoretical training (V_{TT}), training (V_{TP}) and production (V_{PP}) practices specified in the curriculum. Moreover, to the theoretical learning we refer the classroom hours without load, provided for independent work of students. From this information, the calculation of indicators of time is produced:
of indicators of time:

$$V_\Sigma = V_{TT} + V_{TP} + V_{PP} \ ;$$

$$d_{TT} = \frac{V_{TT}}{V_\Sigma} \ ; \quad d_{TP} = \frac{V_{TP}}{V_\Sigma} \ ; \quad d_{PP} = \frac{V_{PP}}{V_\Sigma} \ ;$$

where V_Σ – total hours for the main types of training activities, d_{TT}; d_{TP}; d_{PP} – percentages of time, respectively, theoretical learning, training and work practices.

On the basis of the analysis of researches of V.P. Bespal'ko (1989) we came to the conclusion that it is possible to allocate an individual factor of learning efficiency (Chibakov, 2016):

$$k_i^{EF} = \frac{\sum t}{T} \geq 0{,}7,$$

where t – is the duration of activity (stage class), which ensures to student the achievement of the set educational aims; T – duration of the class.

The coefficient k_i^{EF} establishes the theoretical requirement for effective activities of the individual student, providing the absorption and consolidation of knowledge, acquisition of skills, such as: the duration of such activities will be not less than 70 % of the total teaching time classes. In the real pedagogical process we should take into account also the coefficient significance of effective using of study time (k_S). It adjusts individual efficiency factor, evaluating the risk of failure to comply with state standards for building competencies through independent work or additional (Advisory) classes instead of the main theoretical and practical training. Experimentally, we have determined the values of the coefficient k_S for the main types of educational activities, which depending on the training areas is presented in Table 1.

Table 1. The values of the significance coefficient of effective use of teaching time (k_S) for core activities

Principal training activities	Marking	The training of skilled workers	The training mid-level professionals
Theoretical training	k_S^{TT}	1,1…1,2	1,15…1,25
Training practice	k_S^{TP}	1,15…1,3	1,2…1,35
Production practices	k_S^{PP}		1,43

With the help of individual effectiveness factor (k_i^{EF}) and the relevant coefficients of the effective use of training time (k_S^{TT}; k_S^{TP}; k_S^{PP}) are established individual performance factors for the types of learning activities –

for theoretical training: $k_i^{EF\ TT} \geq k_i^{EF} \cdot k_S^{TT}$;

for training practices: $k_i^{EF\ TP} \geq k_i^{EF} \cdot k_S^{TP}$;

for production practices: $k_i^{EF\ PP} = k_i^{EF} \cdot k_B^{PP}$.

Table 2. shows the values of the individual coefficients of efficiency for the main types of activities in the vocational training of workers and middle level specialists.

Table 2. The values of the individual efficiency factor (k_i^{EF}) for the main types of activities

Principal training activities	Marking	The training of skilled workers	The training mid-level professionals
Theoretical training	$k_i^{EF\ TT}$	0,77...0,84	0,81...0,88
Training practice	$k_i^{EF\ TP}$	0,81...0,91	0,84...0,95
Production practices	$k_i^{EF\ PP}$	1	

Consequently, in the formal educational process of training qualified workers for core activities during theoretical classes should be account at least 77...84 % of time, and in the preparation of specialists – not less than 81...88 %. On the stages of the classes to enable students in the learning-cognitive or objective activity, changing from one activity to another, summing up the message of jobs for self-fulfillment, etc. must be account the remaining 16...23 % and 12...19 %of the time. The integration of this requirement to the system of classes leads to the conclusion that the attendance of theoretical classes students should not be below 77 and 81 %, accordingly.

For teaching practices, the same figures are, accordingly, 81...91 % and 84...95 %. The differences between the values of individual coefficients of efficiency for the theoretical teaching and learning practices are explained by three circumstances. At first, the essence of the concept "competence", this is defined as a set of professional and personal qualities necessary for the worker to have effective employment. Secondly, the index of practical orientation of vocational training on programs of skilled workers preparation is, in General, up to 75 %, and mid-career professionals is up to 50 %. Thirdly, students studying in areas of training specialists pass the certification of the award of qualifications in the trades. Therefore, practical training in the preparing of staff for high-tech manufacturing is been paid attention at present time.

The higher organizational requirements for internship at enterprises (in organizations) are demanded. This type of training is different by the high autonomy and the mandatory full implementation of the curriculum, assignments. Every day of industrial practice is recorded in the diary report showing the scheduled job. Daily the trainees get a mark, certified by the signature of the internship supervisor. In the event of failure of the program of practice for any reason, it will be extended. Therefore, visiting the industrial practice by the students must be 100 percent.

Thus, when performing a set of conditions the left column is for the workers, the right one is for the mid-level professionals –

$$\begin{cases} k_i^{EF\,TT} \geq 0{,}77 \\ k_i^{EF\,TP} \geq 0{,}81 \\ \quad k_i^{EF\,PP} = 1, \end{cases} \quad \begin{cases} k_i^{EF\,TT} \geq 0{,}81 \\ k_i^{EF\,TP} \geq 0{,}84 \\ \quad k_i^{EF\,PP} = 1, \end{cases}$$

− opportunities created for the guaranteed result of training, that is the successful formation of General and professional competences in the training process.

Using the proportional of time indicators (d_{TT}; d_{TP}; d_{PP}) we can convert the corresponding individual coefficients of efficiency ($k_i^{EF\,TT}$; $k_i^{EF\,TP}$; $k_i^{EF\,PP}$) in the individual performance indicators for the main types of training activities:

for theoretical training: $p_i^{TT} = k_i^{EF\,TT} \cdot d_{TT}$;

for training practices: $p_i^{TP} = k_i^{EF\,TP} \cdot d_{TP}$;

for production practices: $p_i^{PP} = k_i^{EF\,PP} \cdot d_{PP}$.

By summing the individual indicators for the main types of activities are determined by the combined individual performance indicator:

$$p_i^{\Sigma} = p_i^{TT} + p_i^{TP} + p_i^{PP}.$$

To aggregate individual efficiency indicator (p_i^{Σ}) you can set the minimum ($p_{i\,min}^{\Sigma}$), optimal ($p_{i\,opt}^{\Sigma}$) and max ($p_{i\,max}^{\Sigma}$) values. The minimum and optimal values are determined by the following dependencies:

$$p_{i\,min}^{\Sigma} = k_{i\,min}^{EF\,TT} \cdot d_{TT} + k_{i\,min}^{EF\,TP} \cdot d_{TP} + d_{PP};$$
$$p_{i\,opt}^{\Sigma} = k_{i\,opt}^{EF\,TT} \cdot d_{TT} + k_{i\,opt}^{EF\,TP} \cdot d_{TP} + d_{PP};$$

where $k_{i\,min}^{EF\,TT}$; $k_{i\,min}^{EF\,TP}$; $k_{i\,opt}^{EF\,TT}$; $k_{i\,opt}^{EF\,TP}$ − the minimum and optimal values of individual coefficients of efficiency for the theoretical learning ($k_i^{EF\,TT}$) and training practices ($k_i^{EF\,TP}$), which are taken on the basis of the data of table 2 −

for training of workers: $k_{i\,min}^{EF\,TT} = 0{,}77$; $k_{i\,min}^{EF\,TP} = 0{,}81$; $k_{i\,opt}^{EF\,TT} = 0{,}84$; $k_{i\,opt}^{EF\,TP} = 0{,}91$;

for training mid-level professionals: $k_{i\,min}^{EF\,TT} = 0{,}81$; $k_{i\,min}^{EF\,TP} = 0{,}84$; $k_{i\,opt}^{EF\,TT} = 0{,}88$; $k_{i\,opt}^{EF\,TP} = 0{,}95$.

Then in areas of training skilled workers:

$$p_{i\,min}^{\Sigma} = 0{,}77 \cdot d_{TT} + 0{,}81 \cdot d_{TP} + d_{PP};$$
$$p_{i\,opt}^{\Sigma} = 0{,}84 \cdot d_{TT} + 0{,}91 \cdot d_{TP} + d_{PP};$$

but in areas of training mid-level professionals:

$$p_{i\,min}^{\Sigma} = 0{,}81 \cdot d_{TT} + 0{,}84 \cdot d_{TP} + d_{PP};$$
$$p_{i\,opt}^{\Sigma} = 0{,}88 \cdot d_{TT} + 0{,}95 \cdot d_{TP} + d_{PP}.$$

The maximum value of the aggregate individual indicator of efficiency (p_i^{Σ}) does not depends on the obtained level of vocational education. The maximum values of individual coefficients of efficiency are corresponded to it ($k_{i\,max}^{EF\,TT}$; $k_{i\,max}^{EF\,TP}$; $k_{i\,max}^{EF\,PP}$), that is 1. Therefore, $p_{i\,max}^{\Sigma}$ is:

$$p_{i\,max}^{\Sigma} = d_{TT} + d_{TP} + d_{PP} = \frac{V_{TT}}{V_{\Sigma}} + \frac{V_{TP}}{V_{\Sigma}} + \frac{V_{PP}}{V_{\Sigma}} = \frac{V_{TT} + V_{TP} + V_{PP}}{V_{\Sigma}} = \frac{V_{\Sigma}}{V_{\Sigma}} = 1,$$

It is indicated to the absence of missing lessons and evidence of active and effective work of the student on each of the theoretical and practical class, achieve all aims.

It should be noted that the percentages of time (d_{TT}; d_{TP}; d_{PP}) for persons training in one curriculum is the same. And individual effectiveness ratios ($k_i^{EF\,TT}$; $k_i^{EF\,TP}$; $k_i^{EF\,PP}$) are common for the General level of professional education – skilled workers or mid-level professionals. While all of the above indicators and ratios are quantitative characteristics and require the addition of a quality parameter, which can be considered learning achievement. The performance is characterized by not only the quality but also the number of ratings.

Based on years of teaching experience, we can state that the occupancy of the training groups up to 25 people allows students to be evaluated not less than once for 5 theoretical lessons. Our study uses the value of the number of hours of theory along with the hours for extracurricular independent work of students that provided by Federal state educational standards. The number of class hours for theoretical training is 2/3 of the total number of theoretical hours. Therefore, the theoretical individual indicator of the students marks received ratings in the study of theory should be not less than

$$\dot{n}_i^{TT} \geq \frac{1}{5} \cdot \frac{2}{3} \cdot V_{TT} \approx 0{,}13 \cdot V_{TT} \,.$$

The duration of training of educational and industrial practices is 6 hours. And each student is evaluated at the lesson. Therefore, the theoretical individual indicator of the number of marks is –

for training practices: $\dot{n}_i^{TP} \geq \frac{1}{6} \cdot V_{TP} \approx 0{,}17 \cdot V_{TP}$;

for production practices: $\dot{n}_i^{PP} \geq \frac{1}{6} \cdot V_{PP} \approx 0{,}17 \cdot V_{PP}$.

Individual theoretical indicators number of assessments ($\dot{n}_i^{TT}$; $\dot{n}_i^{TP}$; $\dot{n}_i^{PP}$) based on individual performance factors by types of learning activities ($k_i^{EF\,TT}$; $k_i^{EF\,TP}$; $k_i^{EF\,PP}$) allow you to go to a real individual indicators –

for theoretical training: $n_i^{TT} = k_i^{EF\,TT} \cdot \dot{n}_i^{TT}$;

for training practices: $n_i^{TP} = k_i^{EF\,TP} \cdot \dot{n}_i^{TP}$;

for production practices: $n_i^{PP} = k_i^{EF\,TP} \cdot \dot{n}_i^{PP}$.

As a result, the areas of training of workers:

$$n_i^{TT} = k_i^{EF\,TT} \cdot \dot{n}_i^{TT} \geq (0{,}77 \dots 0{,}84) \cdot 0{,}13 \cdot V_{TT} \approx (0{,}1 \dots 0{,}11) \cdot V_{TT} \,,$$
$$n_i^{TP} = k_i^{EF\,TP} \cdot \dot{n}_i^{TP} \geq (0{,}81 \dots 0{,}91) \cdot 0{,}17 \cdot V_{TP} \approx (0{,}14 \dots 0{,}15) \cdot V_{TP} \,.$$

But in areas of training mid-level professionals:

$$n_i^{TT} = k_i^{EF\,TT} \cdot \dot{n}_i^{TT} \geq (0{,}81 \dots 0{,}88) \cdot 0{,}13 \cdot V_{TT} \approx 0{,}11 \cdot V_{TT} \,,$$
$$n_i^{TP} = k_i^{EF\,TP} \cdot \dot{n}_i^{TP} \geq (0{,}84 \dots 0{,}95) \cdot 0{,}17 \cdot V_{TP} \approx (0{,}14 \dots 0{,}16) \cdot V_{TP} \,.$$

For production practice the individual indicators of marks number from the level of professional education are independent and determined by the expression:

$$n_i^{PP} = k_i^{EF\,PP} \cdot \dot{n}_i^{PP} \geq 1 \cdot 0{,}17 \cdot V_{PP} = 0{,}17 \cdot V_{PP} \,.$$

The total numbers of student marks is the sum of:

$$n_i^{\Sigma} = n_i^{TT} + n_i^{TP} + n_i^{PP} \,.$$

So, the number of marks (n_i^{TT}; n_i^{TP}; n_i^{PP}; n_i^{Σ}) as percentages of time (d_{TT}; d_{TP}; d_{PP}), are due to the number of hours for key types of learning activities (V_{TT}; V_{TP}; V_{PP}). However, the demands of real individual indicators of marks

number are in the leftmost column for the workers, in the right one are for mid-level professionals (almost identical) –

$$\begin{cases} n_i^{TT} \geq 0{,}1 \cdot V_{TT} \\ n_i^{TP} \geq 0{,}14 \cdot V_{TP} \\ n_i^{PP} = 0{,}17 \cdot V_{PP} \, , \end{cases} \quad \begin{cases} n_i^{TT} \geq 0{,}11 \cdot V_{TT} \\ n_i^{TP} \geq 0{,}14 \cdot V_{TP} \\ n_i^{PP} = 0{,}17 \cdot V_{PP} \, , \end{cases}$$

–they present the required conditions of efficiency and quality of vocational training, along with the previously mentioned conditions for individual coefficients of efficiency ($k_i^{EF\ TT}$; $k_i^{EF\ TP}$; $k_i^{EF\ PP}$).

The average mark of the i-th student is a measure of the effectiveness and quality of education is the arithmetic average of the estimates:

$$\bar{b}_\iota = \frac{1}{n_i^{\Sigma}} \cdot \sum_{j=1}^{s} c_j \, ,$$

where c_j is the pupil's marks from the first to the last.

Integrated individual indicator of the quality of learning for an individual student (r_i) when performing the above-mentioned sets of conditions – individual coefficients of efficiency and the minimum number of marks we consider the product of the individual cumulative performance indicator (p_i^{Σ}) and the average score of his marks ($\bar{b}_\iota$):

$$r_i = p_i^{\Sigma} \cdot \bar{b}_\iota.$$

Moreover, this ratio is in the range:

$$p_{i\ min}^{\Sigma} \cdot \overline{b_{\iota\ min}} \leq r_i \leq p_{i\ max}^{\Sigma} \cdot \overline{b_{\iota\ max}}.$$

The dependence for the minimum value of the individual performance indicator ($p_{i\ min}^{\Sigma}$) was previously installed. And the maximum value of this indicator ($p_{i\ max}^{\Sigma}$) is 1, which is also substantiated above. In its turn, the smallest and largest value of average score (b_i) when 5-point rating system for the time the student is:

$$\overline{b_{\iota\ min}} = 3; \ \overline{b_{\iota\ max}} = 5.$$

Then we get:

$$p_{i\ min}^{\Sigma} \cdot 3 \leq r_i \leq 5.$$

The optimal value of an individual indicator of the quality of learning ($r_{i\ opt}$) is the important information for teachers and masters of vocational training has integrated. It is computed on the optimal value of the aggregate of the individual performance indicator ($p_{i\ opt}^{\Sigma}$) and the lowest average score corresponding to the qualitative evaluation ($\overline{b_{\iota\ min\ qual}} = 4$):

$$r_{i\ opt} = p_{i\ opt}^{\Sigma} \cdot \overline{b_{\iota\ min\ qual}} = p_{i\ opt}^{\Sigma} \cdot 4.$$

We have found that when the values of $r_{i\ opt} \leq r_i \leq 5$ is guaranteed the formation of General and professional competences of the student. When the values of $r_{i\ min} \leq r_i < r_{i\ opt}$ opportunities to build competence are good, but systematic control and correction of pedagogical influence on the personality of the student is required. In cases where $r_i < r_{i\ opt}$, the situation is unfavorable and may be associated with a lack of motivation to getting this profession (specialty) or even deviant student behavior.

On the basis of individual parameters we can obtain the indicators for the study group, course or educational institution (r^{Σ}) that allows to specify

pedagogical aims, to diagnose, to determine the effectiveness of the implementation of pedagogical technologies and methods, to compare different number of students study groups or links. The calculation of the average group index is calculated as follows:

$$\bar{r} = \frac{1}{M} \cdot \sum_{i=1}^{M} r_i.$$

In addition, from the integrated individual indicator of the quality of learning (r_i) using the number of coefficients you can back to the individual rating of the student at this stage of learning (R_i):

$$R_i = r_i \cdot k_i^{ADD} \cdot k_{100}.$$

In this expression k_i^{ADD} is an individual coefficient of additional indicators that reflect the visiting clubs and extracurricular activities of professional orientation, including an independent project or research activity of the student. This coefficient takes into account the participation in competitions of professional skill and the results of such participation. The coefficient of dependence:

$$k_i^{ADD} = 1 + k_i^{AA} + k_i^{AP} + k_i^{AS},$$

where k_i^{AA} is an individual coefficient of visiting additional courses and activities. It takes values from 0 to 0.05. The maximum value corresponds to the presence of 70 percent or more of the additional classes, as well as the systematic independent research or project work;

k_i^{AP} is an individual coefficient of participation in professional competitions. The value of the coefficient is in the interval from 0 to 0.1;

k_i^{AS} is an individual success rate of participation in professional competitions. The limiting values of the coefficient are from 0 to 0.25. Positive values are assigned in case of winning or prizes.

The values of the coefficients k_i^{AP} and k_i^{AR} depending on the level of the event is shown in the table 3 and represent a progressive scale, designed to stimulate activity and creativity of students. In addition, there are coverings between the values of the coefficients that is explained by the conditions of organization and holding of events. Because there are cases to earn the prize may be easier in regional competition, than in-person regional event.

Table 3. The coefficients values of participation (k_i^{AP}) and impact participation (k_i^{AS}) of students in professional competitions

Level competitive events	The value of the participation rate (k_i^{AP})	The value of the coefficient of success of participation (k_i^{AS})
The level of educational institutions	0,01…0,03	0,01…0,05
Regional level	0,02…0,05	0,03…0,1
Interregional or national level	0,03…0,1	0,05…0,25

Specific values of the coefficients k_i^{AA}, k_i^{AP} and k_i^{AS} are set by the experts depending on the activity and the relationship of the student to additional activities, forms of (full-time, part-time) and participation (individual, team), status and prestige events. The coefficients k_i^{AP} and k_i^{AS} are assigned according to the principle "more value overrides the lesser". For example, the assigned coefficient for participation in regional competition $k_i^{AP} = 0.05$ cancels a similar

factor for participation in competition of educational institutions $k_i^{AP} = 0.03$. If the student is not involved in the clubs, creative activities, is not engaged independently or under the guidance of the curator of research or projects, then the coefficients k_i^{AA}, k_i^{AP} and k_i^{AS} are set to 0.

The ratio k_{100} converts the value to map the result on a 100-point scale. k_{100} is calculated by the maximum of individual values of integrated indicator of study quality (r_i) and the coefficient of additional indicators (k_i^{ADD}).

Since

$$r_{i\,max} = 5;\ k_{i\,max}^{ADD} = 1 + 0,05 + 0,1 + 0,25 = 1,4;$$

then

$$k_{100} = \frac{100}{r_{i\,max} \cdot k_{i\,max}^{ADD}} = \frac{100}{5 \cdot 1,4} \approx 14,29.$$

By analogy with the integrated indicator of quality of training group, there may be a rating of level, group of students or the institution as a whole:

$$\bar{R} = \frac{1}{M} \cdot \sum_{i=1}^{M} R_i = k_{100} \cdot \frac{1}{M} \cdot \sum_{i=1}^{M} (r_i \cdot k_i^{ADD}) \approx \frac{14,29}{M} \cdot \sum_{i=1}^{M} (r_i \cdot k_i^{ADD}).$$

As an example, imagine evaluating the quality of learning obtained on the basis of the described analytical model for our students for the profession 35.01.15 "Electrician for repair and maintenance of electrical equipment in agricultural production" and specialty 09.02.04 "Information systems".

Table 4. The distribution of time (V_{Σ}) for the main types of educational activities in accordance with the basic professional educational programs

Directions training	The number of hours				Percentages of time		
	on theoretical training, V_{TT}	on training practice, V_{TP}	on professional practice, V_{PP}	just for vocational training, V_{Σ}	theoretical training, d_{TT}	training practices, d_{TP}	production practices, d_{PP}
35.01.15 "Electrician for repair and maintenance of electrical equipment in agricultural production"	1107	648	576	2331	0,47	0,28	0,25
09.02.04 "Information systems"	3636	612	288	4536	0,8	0,14	0,06

Table 4 presents the time performance in the designated training areas, and table 5 presents the individual performance indicators.

Table 5. Individual performance indicators (p_i) the main types of training activities

Directions training	Individual performance indicators			Total individual performance indicators, p_i
	theoretical training, p_i^{TT}	training practice, p_i^{TP}	professional practice, p_i^{PP}	
35.01.15 "Electrician for repair and maintenance of electrical equipment in agricultural production"	0,36…0,39	0,23…0,25	0,25	0,84…0,89
09.02.04 "Information systems"	0,65…0,7	0,12…0,13	0,06	0,83…0,89

The minimum and optimal values of the individual cumulative performance indicator for future electricians are, respectively, $p_{i\,min}^{\Sigma} = 0.84$ and $p_{i\,opt}^{\Sigma} = 0.89$, for technicians information systems are $p_{i\,min}^{\Sigma} = 0.83$ and $p_{i\,opt}^{\Sigma} = 0.89$.

Table 6 summarizes the requirements for the minimum number of current student assessments.

Table 6. Individual indicators minimum number of ratings (n_i)

Directions training	Individual indicators number of ratings			
	theoretical training, $n_{i\,min}^{TT}$	training practice, $n_{i\,min}^{TP}$	professional practice, $n_{i\,min}^{PP}$	total number of ongoing assessments, n_i^{Σ}
35.01.15 "Electrician for repair and maintenance of electrical equipment in agricultural production"	111	91	96	298
09.02.04 "Information systems"	400	86	48	534

The integrated values of individual indicators of quality education in the implementation of programs of vocational training of skilled workers in the profession 35.01.15 "Electrician for repair and maintenance of electrical equipment in agricultural production" correspond to the numeric interval:

$$2,52 \leq r_i \leq 5 ,$$

And for specialty 09.02.04 "Information systems" correspond:

$$2,49 \leq r_i \leq 5$$

The optimal value of the integrated individual indicator of the quality of teaching in our educational groups matches and was as follows:

$$r_{i\,opt} = 0,89 \cdot 4 = 3,56 .$$

We present the individual performance of our student of specialty 09.02.04 "Information systems" by Tatiana B., which were positively changed during her study from 2012 were, due to monitoring of professional and personal growth based on the analytical model of the conditions and evaluation of the education quality.

In the graphs (Figures 1 and 2) the dynamics of the individual integrated indicator of study quality (r_i) and individual rating of students (R_i) are shown for the period from the first to the fourth course.

The increase of effective indicators for student (r_i and R_i) in the second year happened mainly due to the increase of mean score of achievement ($\bar{b}_i$) from 4.5 to 4.8. In the third year, Tatiana is actively involved in the project activity, became the winner of the correspondence of creative national and International competitions in Krasnoyarsk, Kurgan and the prize-winner in Moscow, which is reflected in the individual factor of additional indicators (k_i^{ADD}), which increased from 1.1 to 1.3. Therefore, with little change in average score ($\bar{b}_i$) from 4.8 to 4.86 the integrated individual indicator of the quality of learning (r_i) remained almost the same, and the individual rating of the student (R_i) significantly increased from 73.19 to 86.67. In the fourth year the average score peaked ($\bar{b}_i = 5.0$). And the diploma of the Winner team of the institution in the all-Russian contest "IT-the Polyathlon" (Kirov) and the diploma of the winner of the interregional scientific-practical conference (Cheboksary) raised k_i^{ADD} to 1.35. Thus, during training time the value of effective indicators with different

dynamics has steadily increased: r_i from 4.32 to 4.8; and R_i with 64.82 up to 92.60. The graphics reflect the intensity of growth in different periods. The graphics reflect. It is also important that total individual indicator (p_i^Σ) did not fall below 0.96.
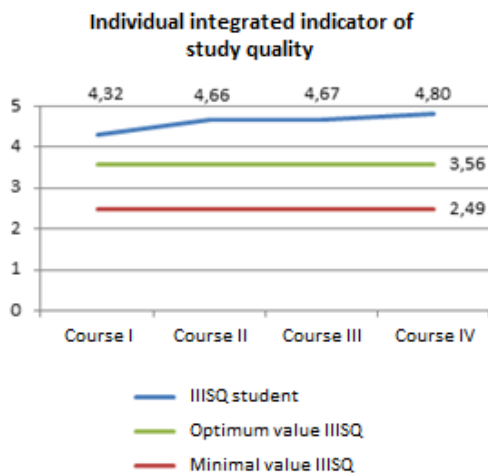
Figure 1. Schedule of changes of individual integrated indicator of study quality (*IIISQ*) Tatiana B. from I till IV course
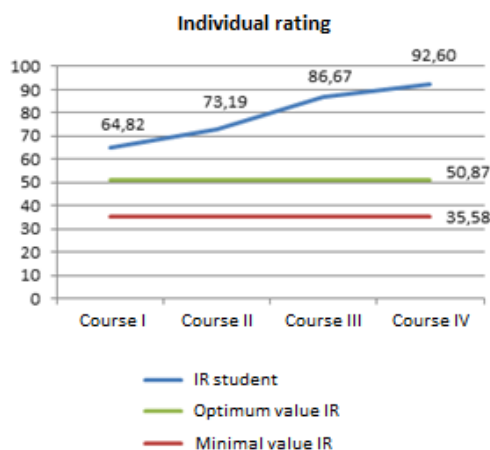
Figure 2. Schedule of changes of individual rating (*IR*) Tatiana B. from I till IV course

Discussions

The problem of effective organization of educational process and assessment the teaching quality is the active interest of scientists, educators, practitioners and the public. For this reason, it is natural the emergence of international organizations assessing of the education quality, in particular EAOKO, all-Russian system of education quality assessment (OSOCO) (Bolotov et al., 2013); the national monitoring of education quality (Waldman, 2015); the emergence in the pedagogical vocabulary the concept of "evaluation" – integrative category of assessment-analytical activity in the management of the education quality (Zvonnikov & Mel'nikova, 2007). Based on the evaluation of quality are often taken by the students ' test results, complemented by data of questionnaires and other methods of verification, control and examine the experimental materials. Theory and practice of testing are constantly being improved based on new approaches and concepts, including Item Response Theory (IRT) and Rasch model (Rasch Measurement) (Kim, 2007).

However, it is necessary to estimate the quality of teaching by a set of interrelated academic and creative personality indicators covering a sufficient length period of time, with the subsequent processing of the data mathematical and statistical methods. Proposed model represents one alternative approach to solving this problem in conditions of vocational training skilled workers and mid-level professionals. The integrated of individual and group performance training (r_i and $\bar{r}$) and individual and group rating (R_i and $\bar{R}$) are productive indicators of the model. In addition to the quality indicators there are analytical

organizational and pedagogical conditions of efficiency of vocational training that combine requirements on individual factors of learning efficiency ($k_i^{EF\ TT}$; $k_i^{EF\ TP}$; $k_i^{EF\ PP}$) and the individual number of evaluations (n_i^{TT}; n_i^{TP}; n_i^{PP}; n_i^{Σ}). And test tasks, as well as other forms of knowledge and skill control, together with the study of products of students activity, expert assessment are a part of a comprehensive evaluation of the education quality.

Conclusion

The developed model of conditions and the quality control of vocational training of workers and specialists combines: a) the quantitative conditions of the organization of the main types of educational activity (theoretical training, training and operational practices); b) complex of analytical indicators to establish the individual and group settings for the intermediate and final results of the educational process and independent creative activity of students.

Percentages of time (d_{TT}; d_{TP}; d_{PP}); individual coefficients for the main types of training activities ($k_i^{EF\ TT}$; $k_i^{EF\ TP}$; $k_i^{EF\ PP}$); theoretical ($\dot{n}_i^{TT}$; $\dot{n}_i^{TP}$; $\dot{n}_i^{PP}$) and actual individual rates of assessments (n_i^{TT}; n_i^{TP}; n_i^{PP}; n_i^{Σ}); individual rates to attend additional courses and activities (k_i^{AA}) participation in professional competitions (k_i^{AP}) and the impact of participation in these contests (k_i^{AS}) are the original parameters of the model. Intermediate settings are: performance indicators by types of learning activities (p_i^{TT}; p_i^{TP}; p_i^{PP}), cumulative individual performance indicator (p_i^{Σ}), average score ($\bar{b}_i$) and an individual factor visit for more courses and events (k_i^{AA}). On the basis of their Effective indexes are calculated on their basis: integrated individual and group performance training (r_i; $\bar{r}$); individual and group rankings (R_i; $\bar{R}$). However, the indicators of time and amount of marks due to the number of hours of theoretical training (V_{TT}), study (V_{TP}) and work practices (V_{PP}). So they are the same for all students studying the same curriculum. We have established by experimental way individual factors of learning efficiency and they depend on the level of education – skilled workers or mid-level professionals. The strategic planning, design the training process, the correction and refinement of technology and methods of professional education is provided on the basis of performance indicators at the end of the semester or academic year, identified the dynamic indicators of professional and personal development and, as a consequence, the optimality of forming general and professional competences of individual students and in study groups (institutions).

Further studying of the methods of effective organization and evaluation of quality professional learning requires the creation of automated system of information processing that will allow us to obtain the necessary information for optimal implementation of pedagogical tasks. Electronic journals can serve as databases and modern computer networks are able to provide mobility.

Analytical model of conditions and the quality control of professional training of qualified workers and mid-level professionals is of practical value to the heads of educational institutions, methodologists, teachers, trainers, Tutors, supervisors, as well as social partners and employers.

Disclosure statement

No potential conflict of interest was reported by the authors.

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