Model of Professionally Important Qualities of Bachelor Degree Students of Higher Technical Educational Institution for the Admission to Master's Course

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ABSTRACT. The analysis of professional training activity of Bachelor degree student was performed and the main factors affecting the PIQ of future magistracy graduates were defined. The minimum PIQ level of future master's was experimentally investigated and substantiated. A graphic model of the PIQ in the polar coordinate system was offered to assess the suitability of the Bachelor degree student for the admission to the magistracy.

Introduction. The modern system of higher technical education in higher education institutions (HEIs) of Ukraine is aimed at creating appropriate conditions for training of competent professionals focused on continuous professional development, self-improvement, which will provide further high level of competitiveness, professional mobility, performance of professional activities and as a result, career growth and self-realization [1]. In addition to successful mastering the necessary knowledge base and skills, according to the specifics of the chosen specialty (Bachelor degree), is also important to possess professionally required qualities and skills that are a prerequisite for the effective exercise of professional functions at any stage of professional development of the individual [2].

Formulation of the problem. In this regard, there is an urgent need for expanding the systematic study of the integrity of the future expert at maturity (Bachelor student) while his individual, personal and subjective and active properties are considered in the unity of all relationships. The abovementioned qualities of future specialist in a technical college are formed while getting the master's degree in the fields of the chosen specialization. Therefore, the selection of students according to their bachelor professionally important qualities (PIQ) when entering the magistracy is important and timely.

In addition, nowadays the automation of knowledge control is a global trend. Computer support for learning and knowledge control has more than 30-year history. Today there is a large number of knowledge control systems developed as separate software, and embedded in the educational system. Therefore, design model of PIQ master in the future will automate the process of selection of Bachelor students.

Analysis of recent research. Professional activities, their structure and selection of professionally important qualities for future technicians in various fields of training were discussed in theoretical and practical pedagogies.

Works of V.F Bessarab [3], E.F Zeyer [4], V.G Kuntysh [5] and others are devoted to issues of development of professional skills of future engineers-teachers.

V.A Yadov devoted his research to creation of social and psychological portrait of future design engineer [6].

Determination of the features in formation of professionally significant qualities of future engineers-navigators are the main area of studies of A.F Shiyan [7], V.O. Yakunin [8] and others.

The development and construction of model of professionally important qualities of future graduates of Magistracy as professionals towards technical training in universities are neglected.

The latest research on the necessary qualities of Bachelor and Master degree students are presented in papers [19, 20].

The purpose of the work: the development and justification of professionally important qualities of a Bachelor degree student at a technical college for the selection to the Magistracy.

To achieve the goal, we solved the following problems:

1. To analyze the professional activity and training of Bachelor degree student at a technical college, literature, regulations and to formulate PIQ required for admission to the Magistracy.

2. To analyze and select methods for determining the quality of each formation and expert PIQ complex.

3. To evaluate Bachelor degree students suitability using PIQ model to enter the magistracy.

Presentation of basic material. Each kind of professional activity sets its demands to the prospective specialist. Any Bachelor student of technical college should: know the status and prospects of engineering and technology in the industry and in the related industries; master modern methods of job evaluation, modern design; have a clear idea of the subject of scientific methodology, the problem of the industry, forecasting methods and development of technology; be familiar with the basics of production, labor and management, with the economy sector; be able to understand the issues of health and safety, proved control of measuring and office equipment [9].

According to Professor S.E. Yachyn, the mainstream of technical education in the XXI century is not typical of natural scientific laws, but to economic, environmental, cultural and political realities. [10].

Nowadays, the operation of technical devices and human operations with them are considered in interrelationship, which caused to be formed the concept of "human - machine" cooperation (HMC) [11, 12].

Based on system approach, V.D Shadrykov [13] clarifies that system is a structure which is considered in its relation to certain functions and that specialist's professional activities should be performed in unity of its three aspects: subject-effective, physiological and psychological. He considers "human - machine" to be a system where the operation of machines and human activity are related to a single loop control. However, the main attention should be paid to the specifics of the mechanisms of human reflection of reality and the regulation of its activities.

As for Bachelor students' PIQ, they are formed during the training and educational process by external conditions that can speed up this process and make it more successful. Regardless of specialization and the nature of future professional activity, any junior specialist should have a fundamental knowledge and professional skills. The creative experience and research will allow the future Master's determine his position on a particular issue or problem professionally.

Based on expert survey (questionnaire survey of experts in the field of technical education and employers in technical field) and processing of regulatory documents [2], we have marked the most significant PIQ for the Bachelor student of a university, as a future professional (Figure 1).

Analyzing the results and conducting their ranking, we have found that Bachelor student who wants to get the Master's degree should have the following professionally important qualities (according to experts in %): mathematical ability - 95%; good spatial imagination - 91%; creativity - 84%; creative approach to solving technical problems - 79%; dedication - 73%; desire for constant new knowledge

- 68%; responsibility for the results of work - 65%; organizational skills, required for management of staff - 60%.

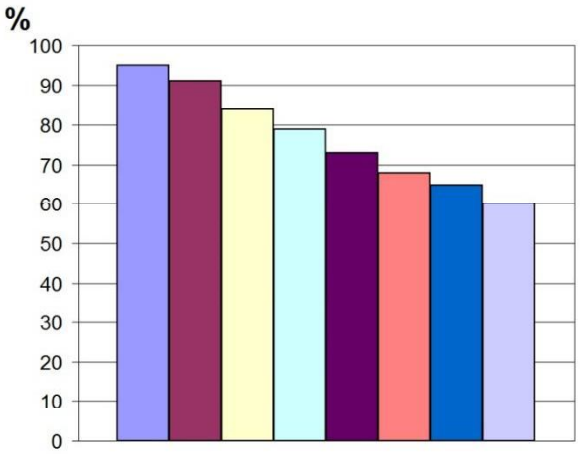

Fig. 1. Diagram of the most significant PIQ of Bachelor degree student.

As the model is a formal description of the real system, it can be set analytically, graphically (block diagrams, graphs) and in charts. Having analyze their suitability and usability to display Bachelor student's PIQ for enrollment to Magistracy graphic representation was elected, namely a graphical diagram system of polar coordinates as a visual way of representing objects and processes in the form of graphics [14, 15]. It represents the value of each category along a separate axis that starts in the center of the diagram and ends on the outer ring. Each category of charts in polar coordinates system has its own axis of coordinates and a description. The order of the values can not be changed on this bar chart.

Thus, the diagram in polar coordinates system acts in this case as visualization of the results of expert survey (reflects the basic level of PIQ) the results of testing bachelor student at Technical Universities (reflecting the level of student's PIQ).

Polar coordinates system chart enables us:

- to show clearly and comprehensively the basic (the minimum required) level of student's PIQ development degree and level of PIQ required for admission to the magistracy;

- to compare visually and identify the Bachelor student's PIQ that are poorly developed;

- according to the basic results, make adjustments to vocational training of students in undergraduate Bachelor;

- provide individual approach to the educational process.

In order to develop the basic model of Bachelor student's PIQ of a technical college for enrollment to the Magistracy we have conducted experimental research that made it possible to clarify and determine the importance of each quality for future expert.

During the research, we have conducted two expert surveys:

- survey on the V.N. Mashkov's methodology aimed to identify expert opinion regarding the definition of the qualities that should be included in a set of future Masters' PIQ [16];

- the method of expert assessments to determine basic level (the minimum required level) of each PIQ.

Teachers of technical departments who have over 10-year-teaching experience (including experience of preparing Masters) took part in the survey.

When asked whether they had the Masters who had low level PIQ, 100% of respondents answered positively. For example, undergraduates are not often responsible (are late for consultations, do not always perform tasks in time, etc.), not all of them are ingenious and organized.

It is hard for the head to work with these postgraduates and the results of their work do not always meet expectations.

In order to conduct a survey all PIQ were systematized and described:

1. Mathematical ability - is the human ability to capture the order of items required for mathematical proof. The presence of this kind of intuition is the main element of mathematical creativity, and it relies not only on knowledge and experience, but spatial imagination as the main condition for mathematical thinking is of paramount importance for the future scientist. Model of Master's mathematical skills is defined as a system of thinking qualities that shows progress in the development of higher mathematics necessary for future research activities

2. Spatial imagination - is the ability of person to create mental images of objects in his mind based on their drawings or descriptions. It is essential for the future Master to be able to create and read drownings and schematic symbols.

3. Resourcefulness – is a human property to find a way out in difficult situations. As for Master, it is the ability to respond to questions quickly, find the correct answers and use this knowledge in practice.

4. A creative approach to problem solving (creativity). The creativity of an individual is a synthesis of features and traits that characterize the degree of compliance with certain type of educational and creative activities that define to the level of effectiveness of this activity. Future scientists need to be inclined to organizational creativity in order to organize successful research in their field. Human is able to create peculiar and independent theory.

5. Commitment is a person's ability to subordinate their actions to the objectives to be achieved, a mobilization of forces to identify correctly the ways, methods and techniques of its activities is the aim of the decisions and their implementation, persistence in achieving the desired result.

6. The pursuit of new knowledge is a quality which can lead to the best results, the desire to get new information will broaden students' outlook and make him a more valuable employee in the future.

7. Responsibility is a person's ability to anticipate events or actions when they are committed or when they are implemented. It is also the ability to respond not only for themselves but also for other people, by nature of their relationship with them. Future Masters should have such traits as diligence, perseverance and persistence.

8. Organizational skills is the ability to organize their own activities and the activities of subordinates, create a team as a collective tool for solving current problems and personal development, the future Masters ability to manage a team.

In order to organize expert survey, the questionnaires were worked out by means of which necessary information was collected. A clear and meaningful question wording and description of PIQ were especially important. The questionnaire also used the open-ended questions where the expert expressed his opinion on any of them.

The reliability of examination also depends on the number of experts in the group and their individual competence. The number of experts in the expert group depends on many factors and conditions. As a result, the expert group included 10 people, according to the regulation that the defining number of experts should be not less than the number of objects ranging (in this case we have 8 PIQ).

The list of PIQ and their description were offered to experts according V.N. Mashkov's expert survey methodology and each expert had to put a number 2 - if this PIQ is necessary for the future Master; 1 - if it is desired; 0 - if it does not matter.

Processing of the results is based on a calculating points that are put for each criterion, i.e. the idea of the expert group is expressed as an arithmetic mean. The calculation is as follows:

$$\frac{AN_0 + BN_1 + CN_2}{K} = Z, \quad (1)$$

where A, B, C – the point appropriate to each response options (0; 1; 2);

N_0, N_1, N_2 – the number of experts who chose this answer;

K – the total number of respondents who answered the questionnaire, and answered the questions (K=10).

This condition is verified:

$$1{,}6 \le Z \le 2 \quad (2)$$

If the average expert assessments lie within these limits, then we can talk about the need for selected professional important qualities.

The results of processing expert opinions are presented in Table 1.

Table 1. Experts on the Evaluation of selected PIQ

PIQ	Number of respondents			Grade point average
	0	1 point	2 points	
1. Mathematical ability	-	1	9	1,9
2. Spatial imagination	-	1	9	1,9
3. Resourcefulness	-	3	7	1,7
4. A creative approach to problem solving (creativity)	-	4	6	1,6
5. Commitment	-	2	8	1,8
6. The pursuit of new knowledge	-	2	8	1,8
7. Responsibility	-	1	9	1,9
8. Organizational skills	-	3	7	1,7

Since the average expert assessments are provided within a given method, then we talk about PIQ selected. Thus, after analyzing and processing the results of the expert survey, final set of PIQ future Masters was approved.

The second survey (expert survey) was conducted to determine the basic level (the minimum required) of PIQ, which a future Master should have. Experts had to assign the minimum required score to each PIQ, which a future master should have on a scale of 1 to 5 (5-point scale chosen as the most convenient and familiar, and it can be changed in the future).

Based on the results of the expert survey matrix of experts group benefits was formed (Table 2).

Table 2. Matrix of experts group benefits.

PIQ	Experts									
	e_1	e_2	e_3	e_4	e_5	e_6	e_7	e_8	e_9	e_{10}
a_1	4	4	3	4	4	4	3	4	4	5
a_2	4	3	3	4	4	3	4	4	4	4
a_3	3	4	3	3	2	3	3	3	2	3
a_4	4	5	5	4	4	4	4	4	4	4
a_5	4	4	5	5	4	4	3	4	4	4
a_6	4	4	5	4	4	3	5	4	4	4
a_7	5	5	5	4	5	5	5	5	4	5
a_8	4	4	4	4	5	4	4	5	4	4

A mathematical processing of the results have been performed, to determine the consistency of expert's opinions [17, 18]. First, the average of experts views R_{av} was calculated according to the formula:

$$R_{av} = \frac{\sum_{i=1}^{m} R_1}{m} \tag{3}$$

For each value R_{av} is determined. The consistency of expert opinion is determined by the method of expert evaluations. The variance for each PIQ is determined by the formula:

$$D_i = \frac{\sum_{i=1}^{m} (R_{av} - R_i) \cdot 2}{m-1} \tag{4}$$

The standard deviation for each PIQ is determined by the formula:

$$\sigma_i = \sqrt{D_i} \tag{5}$$

Then determine the coefficient of variation for each PIQ by the formula:

$$\nu_i = \frac{\sigma_i}{R_{avi}} \cdot 100\% \quad (6)$$

All calculations were performed in the MS Excel application package.

Thus, mathematical processing of opinions was made, which allowed to judge the consistency of the panel. Since the coefficient of variation is less than 33% of all PIQ, it means that the distribution corresponds to a normal appropriate law, i.e. most thoughts are grouped around the avarage, and polars constitute an absolute minority. All results of the expert survey processing are shown in Table 3.

Table 3. The results of mathematical processing of expert opinions

PIQ	Rav	Rgr	D_i	σ_i	v_i,%
a1	3,9	4	0,322222	0,567646	14,55503
a2	3,7	4	0,233333	0,483046	13,05529
a3	2,9	3	0,322222	0,567646	19,57401
a4	4,2	4	0,177778	0,421637	10,03898
a5	4,1	4	0,322222	0,567646	13,84503
a6	4,1	4	0,322222	0,567646	13,84503
a7	4,8	5	0,177778	0,421637	8,784105
a8	4,2	4	0,177778	0,421637	10,03898

Based on these results, the basic (minimum required) PIQ level of a future Master has been identified. PIQ reference model for candidates for Magistracy is shown in Figure 2-1.

Figure 2 is an example of a comparison reference model for PIQ student with options when: student PIQ meet reference model (Figure 2-2); student PIQ does not meet the reference model (Figure 2-3).

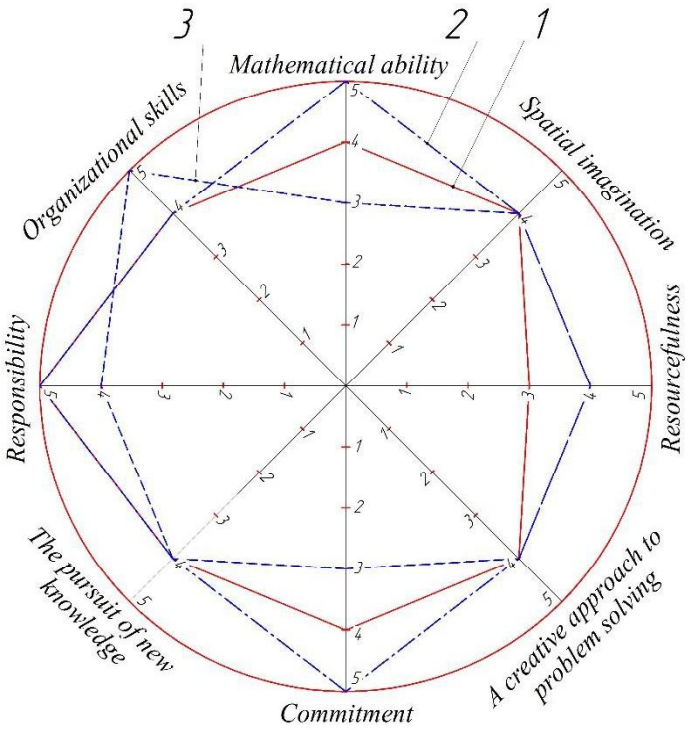

Fig. 2. PIQ reference model personality of the future Master. 1 – PIQ reference model; 2 – PIQ student meet the reference model; 3 – PIQ student does not meet the reference model.

Thus, the model can be further used as the basis for an automated system of selection of Bachelor degree students to graduate Master that will make the process more transparent, effective and objective.

Summary. Today the selection of bachelor students according to their professionally important qualities (PIQ) at the stage of entry into the Magistracy is an important and urgent task.

1. Based on the analysis and synthesis of the literature, and the requirements for future master's PIQ complex was formed which is necessary for the admission the Magistracy.

2. In order to display information in a system of polar coordinates, the convenient method was proposed to build a model of future development of Master's PIQ.

3. PIQ Complex was reasonable and basic (minimum required) level of PIQ for future Masters was defined. Based on expert survey, was reference PIQ model was constructed. It allowed:

- to consider all PIQ necessary for modern Master according to Ukrainian and world trends of higher education;

- to increase the objectivity of the evaluation in the selection of students (excludes subjective factors);

- to provide a detailed picture of PIQ of the students entering the Magistracy (comparing the student's PIQ model and reference model).

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