

A Model of Technical University Students' Creative-Project Activities' Systemic Commitment to Their Self-Development and the Experimental Verification of Its Effectiveness

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Abstract

The urgency of the need to develop a model of the systemic commitment of creative-project activity of technical university students to their self-development is due to the fact that the reserve possibilities of this type of teaching, research and professional activities from the perspective of the systemic commitment to self-development of the students' competitiveness remain insufficiently investigated in the theory and practice of teacher education. In this regard, the article presents the main components of the model of systemic commitment of the creative-project activity of technical university students to their self-development, as well as the results for its implementation in practice of higher professional education. The presented components of the model in the article (objectives, contents, methods, learning and educational environment) are working for the ultimate goal – for self-development of professional creativity, self-development of the competitiveness of a student as a prospective specialist. The results of the article can be used by administrators and faculty members of higher education institutions.

Keywords: *creative-project activities, self-development, students, model, competitiveness.*

1. Introduction

The problem of quality control of engineering-technology education, the increase of engineering technologists' competitiveness is due to socio-economic factors, as well as to the goals of modernizing higher, including the engineering- technology, education in Russia, as the quality of engineering-technology education is ultimately determined by the competitiveness of Russian goods and technologies. It should be noted that the task of improving the efficiency of the engineering-technology education in our country has always taken a leading role (Khairullina et al., 2015; Gumerov et al., 2015).

The aim of modern politics for modernizing the education over the medium term is to ensure the competitiveness of

Russia globally. This goal is achievable, if in the coming years to ensure the optimal ratio of cost and quality in education and science (Merzon et al., 2015). For this it is necessary to implement new organizational-economic mechanisms in the education system to ensure effective use of the available resources and contribute to raise additional funds, to improve the quality of education on the basis of renovation of its structure, content and teaching technologies, to attract qualified professionals to education, to enhance its innovation potential and investment attractiveness.

However, to increase innovation in training modern graduates at institutes and universities of technology – means to increase even during academic training the quality and efficiency of their creative-project activity, to refocus this activity to continuous development and self-development of students' – the prospective engineering technologists' competitiveness.

2. Methodological Framework

2.1 Key concepts

The concept of "self-development" is revealed as a complex system quality of self-consciousness, characterizing the effectiveness of "self-processes" directed by self-consciousness of a subject in the direction of their improvement based on solutions of increasingly complex creative-project tasks and assignments.

Professional creative-project engineering-technology activity is regarded as one of the professional activity types, which in a generalized form aims to search, detect and solve creative-project engineering-technology problems and tasks on the basis of professional knowledge system, competencies and creative abilities, which are improving and self-developing in the context of this activity (Kazantsev, 2000; Bolotov & Serikov, 2003; Agapov, 2001; Masalimova & Sabirova, 2014; Shaudullina et al., 2014; Torkunova et al., 2014).

Competitiveness of a student – a prospective engineering technologist is a dynamic open system, developing on the basis of personal self-determination and self-development program and making it possible for a university graduate to effectively adapt to the world of work (Andreev, 2003; Andreev, 2005; Chuchalin & Pokholkov, 2004; Sakhieva et al., 2015).

2.2 Historical background of engineering-technology education development in Russia

The first period – is the origin of engineering. Formation of professional engineering education in Russia is associated with the era of Peter the Great, with his decrees of 1701, in which the king-the reformer decided to create schools to prepare professional personnel in a short time, "jacks of all trades." The emergence of higher technical educational institutions can be considered as the first indication of the origin of engineering activities in Russia. The second and most important indication is that in those exactly years individuals from the country's broadest layers of population were being involved in the process of technical training.

The second period, which can be called "the formation of engineering activity", falls within the beginning of the 90s of the XIX century and the end of the 20s of the XX century. What features characterize this period? First of all – it is the rapid development of the technology itself, associated with the invention and introduction of fundamentally new technological processes in the production process.

The third period in the history of engineering in Russia is extremely complex and contradictory. It was connected with the late thirties of the XX century and was getting quite rapid development by the end of the seventies. This is a problem of quantity and quality of preparing specialists. The basic requirements for vocational education were formulated this way: it must be sufficiently broad and solid, not having the character of "artisan", should be associated with general and polytechnic knowledge, meet the requirements of scientific and technological progress, based on the combination of studies with production labor.

The fourth period – was a period of engineering activities extensification. It refers to the end of the 50s and early 60s of the twentieth century. The main feature was – a significant increase in the number of engineers graduating from technical higher institutions. The second feature of this period – was the development of particular engineering majors. These measures could not but lead to a sharp decline in the quality of training and, consequently, the prestige of engineers.

The engineering conversion process and improvement of engineering education continues at the present time, as well. Since the mid 80s, we have been witnessing the beginning of a new, the fifth period in the history of engineering education in Russia – the ever-increasing humanization of engineering (Danyluk, 2000; Garayev, 2006; Safin, 2001).).

With regard to the Republic of Tatarstan, it is considered one of the economic, cultural and educational centers of

the Russian Federation. When viewed from the perspective of educational potential, it can be noted that in the region there is a comprehensive system of general, further and vocational education. There are institutions functioning in Kazan that train specialists for almost all spheres of human activity. Many higher education institutions are among the best public educational institutions of Russia, which are characterized by national trends in improving the qualities of modern higher engineering education.

2.3 A model of creative-project activity's systemic commitment to an engineering technologist's self-development

For the commitment system of creative-project activity to the engineering students' competitiveness self-development it was important that all the components (objectives, contents, methods, learning and education environment) were working for the ultimate goal – self-development of professional creativity, self-development of the competitiveness of a student as a future specialist. With this approach, it is clear that primarily the system-target principle shall operate which at the same time does not exclude, but presupposes the systematic structural analysis and synthesis of the basic elements of the newly designed system that can, in our view, be represented in a form of a structural model as follows (see. fig.1).

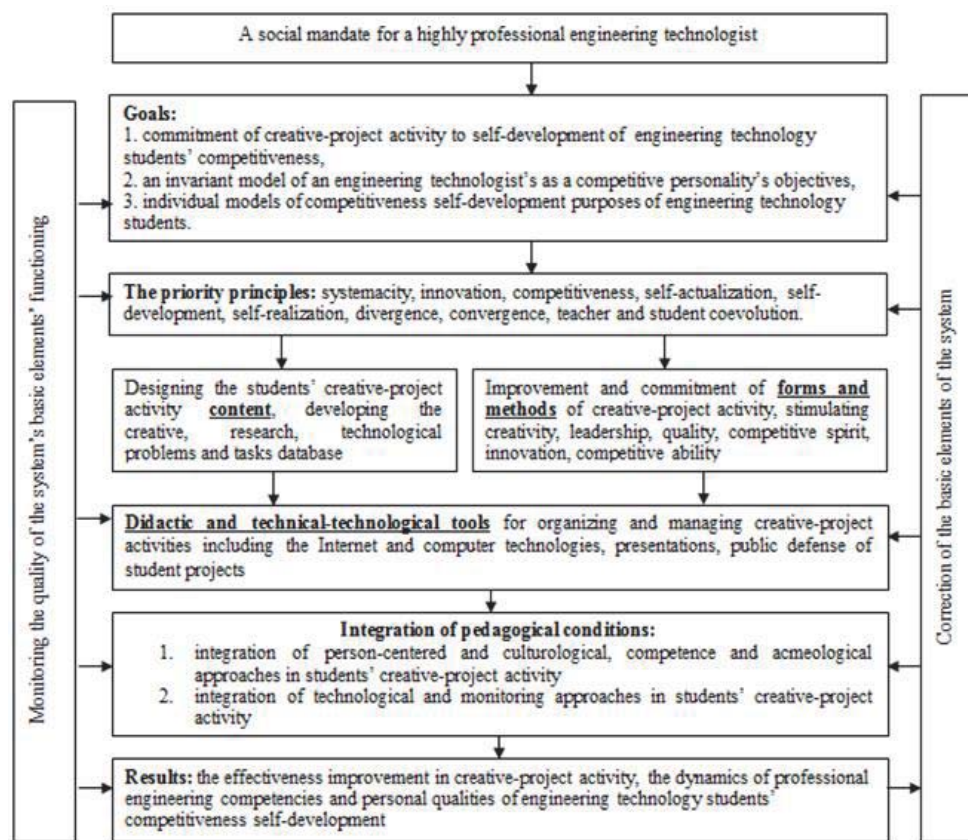


Fig.1. The model of systemic commitment of creative-project activity to engineering technology students' competitiveness self-development

In this structural model there are ten subdivided clusters:

- 1) the social mandate cluster;
- 2) the creative-project activity goals cluster;
- 3) the priority principles cluster;
- 4) the content cluster;
- 5) the forms and methods of vocational training cluster;
- 6) the didactic and technical-technological tools cluster;
- 7) the integration of pedagogical conditions cluster;

- 8) the teaching monitoring of creative-project activity qualities cluster;
- 9) the results cluster;
- 10) the cluster of correcting the basic elements of creative-project activity commitment to self-development of the engineering technology students' competitiveness.

Given the identified "clusters", it is manageable to structure and build up a "Model of systemic commitment of technical university students' creative-project activity to their self-development (see Fig. 1).

3. Materials and Methods

The pedagogical experiment was conducted to test the effectiveness of the model of systemic commitment of the creative-project activity to engineering technologists' self-development. The effectiveness of this model was tested using specially developed proprietary assessment and self-assessment techniques "self-conception of students' competitiveness self-development", questionnaires-surveys for higher education teachers, which allowed to evaluate and identify the significance rating, as well as the dynamics of the formation of personal and professional qualities that characterize the process of self-development of students'- future engineering technologists' competitiveness. In the pedagogical experiment there were widely used methods of participant observation, expert evaluations of university teachers in the field of light industry. At various stages of the pedagogical experiment there were more than 400 students involved. Special pedagogical "knowledge check tests" (diagnostics of the students' creative-project activities efficiency, assessment of development and self-development of personal and professional qualities that characterize the formation of their competitiveness) were mainly conducted at the 1st, 3d and also 5th years of study. This was done in order to trace the dynamics of both the newly designed didactic system and its results.

4. Results and Discussions

During the processing of the pedagogical diagnostics results, the normality testing of the features' results distribution by calculating the indicators of the arithmetic average, of median and mode with the help of the Microsoft Office Excel product was carried out. The Student t - test was used to determine the significance of differences between the average values of the indicators.

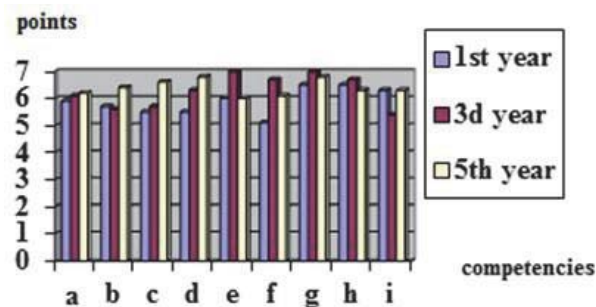


Fig. 2. Students' self-assessment of professional-creative competencies levels

Further the pedagogical diagnostics results of the greatest scientific interest are offered.

The horizontal scale – is the competencies: a) the ability to see and formulate an engineering problem; b) the ability to generate ideas; c) the ability to find adequate methods for solving an engineering problem; d) the ability to accurately plan the solutions to a creative engineering problem; d) the ability to design everything, calculate; e) the ability to formally establish the solution to a creative engineering problem; g) the ability to use computer equipment; h) the ability to carry out information search of the necessary data; i) the ability to organize the defense and presentation of the project.

It is determined that students of all the years of study highly evaluate their ability to use computer equipment (1 rank in all the years: 6.5; 7 and 6.8 points)

Based on fig. 2, there is shown the dynamics of changes of the students' formed professional competencies.

Thus, in the first year the students highly evaluate their abilities to use modern information technologies: the abilities to carry out information search of the necessary information (6.5 points), to organize the defense and presentation of the project (6.3 points – rank 2), as well as the ability to design and calculate everything (6 points), the

application consistent with the 10-point scale.

By the third year the students, except for the ability to organize the defense and presentation of the project, also note a sufficient level of the skill to formally establish the solution to a creative engineering problem (6.7 points – rank 2).

In the fifth year the competencies assessment picture is radically different with a shift on the content richness of these competencies. Among the important and highly valued professional competencies the students distinguish: the ability to accurately plan the solution to a creative engineering problem (6.8 points – rank 1), the ability to find appropriate methods for solving an engineering problem (6.6 points – rank 2) and the ability to generate ideas (6.4 points – rank 3).

Notable is the fact that the students mark their weaknesses in the ability to formally establish the solution to a creative engineering problem (in the 1st and 5th years of study) and in the ability to present their project (3d year), which has determined the direction for the necessary pedagogical correction in the course of vocational training.

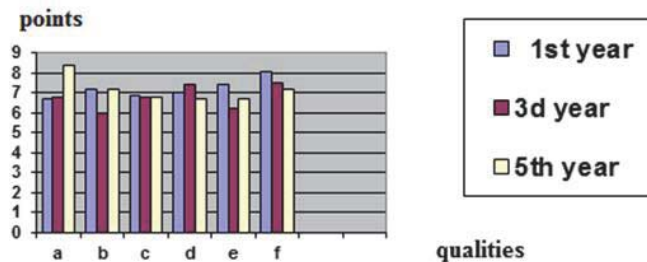


Fig. 3. Self-assessment of capabilities for self-development of professional qualities

The horizontal scale – is qualities: a) creative attitude to work;

b) high professional competence; c) ability to take responsibility in a difficult situation; d) high working capacity;

d) progressive views

e) teamwork ability.

Students of 1 - 3 years attribute the teamwork ability to highly valued real professional qualities (8.1 points and 7.5 points), by the 5th year this quality does not lose its significance and students assign the second rank to it – 7.2 points (fig.3).

Freshmen to their professional qualities also refer: progressive views (7.4 points) and high professional competence (7.2 points), which indicates the lack of students' adequate professional self-esteem.

In the 3d year, according to the students, they have a high working capacity (7.4 points) and a creative attitude to work (6.8 points).

In the 5th year the students are focused on the evaluation of the professional qualities as such, namely, creative attitude to work (8.4 points) and high professional competence (7.2 points).

The least significant professional qualities for self-development in the 1st year are creative attitude to work (6.7 points), in the 3d year – high professional competence (6 points), and in the 5th year – progressive views (6.7 points).

Thus, the analysis of the obtained data on self-assessment of capabilities for self-development, leads to the conclusion that the most significant dissonance between the real qualities and students' potentialities manifested itself in the 3d year, in the 1st year the self-esteem inflation of students' potentialities was revealed. The fifth year is characterized by adequate self-esteem of professional and personal qualities, testifying to the productivity of designing the "Self - conception" at the courses of different disciplines, which was being realized during the pedagogical experimental process.

Let's range the value orientations (fig. 4).

For the 1st year of study, health (8.4 points), material values (8.4 points), family values (7.9 points), professional priorities and values (7 points), creative self-realization (7 points), social values (6.8 points) and humanistic values (6.2 points) are important.

For the 3d year students, family values (8.9 points), health (8.5 points), material values (8.5 points), professional priorities and values (8.2 points), social values (7.5 points), creative self-realization (7.4 points), humanistic values (6.5 points) are important.

For the 5th year students the value orientations are the following: family values (8.5 points), material values (8.4 points), professional priorities and values (8.2 points), social values (7.5 points), creative self-realization (7.4 points), health (7.4 points), and humanistic values (6.7 points).

Thus, for the full-time tuition students the most important values are, first of all, family values and material values. At the same time humanistic values are not completely formed. But it is very important that the "professional priorities and values" have shifted in the students' assessment from the 4th place to the 3^d, indicating a positive impact on the students' systematic involvement in the creative-project activities.

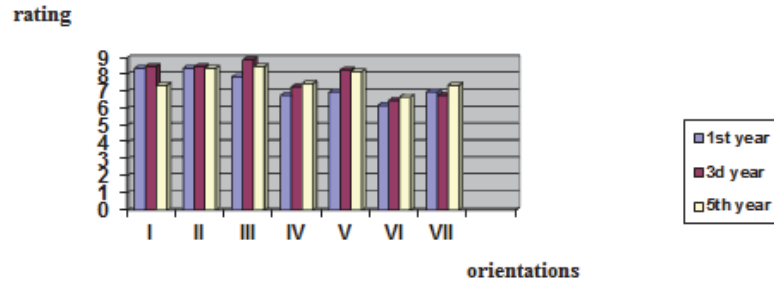


Fig. 4. Assessment of the value orientations and priorities of students

The horizontal scale – is the value orientations and priorities:

- I. Values of physiological type (it is important to have good health, to feel complete safety).
- II. Material values (financial independence is important, confidence in the future).
- III. Family values (it is important to be loved: I want to have a family and my circle of friends).
- IV. Social values (it is important to feel recognition of colleagues and respect of the surrounding company).
- V. Professional priorities and values (it is important for me to succeed in life, to have stable position and career development).
- VI. Humanistic values (social welfare, social justice, et cetera).
- VII. Creative self-realization (it is important for me to make the most of myself and my creative engineering abilities).

The experiment was attended by experts – heads of Kazan light industry enterprises, which are the representatives of the Board of Trustees of the Kazan State Technological University. This group of experts, on the one hand, are interested in raising the level of professional culture and competitiveness of today's engineering technologists, on the other hand – are concerned about improving the quality of education of future professionals. The second group of experts was the faculty members, the members of the State Attestation Commission.

We will especially note that the experts from the two groups during the interview were given equal time to respond and equal psycho-emotional conditions were created, excluding the impact of external factors on the respondents.

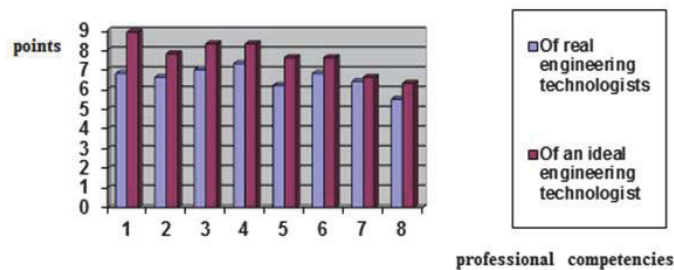


Fig. 5. Evaluation of a competitive engineering technologist's professional competencies distribution by heads of the enterprises

The horizontal scale – is competencies:

1. Developed engineering thinking; the ability for professional self-development.
2. The critical analysis ability in their professional activity
3. The ability to think logically.
4. Developed intuition.
5. The ability to integrate ideas.
6. The ability to allocate the primary from the secondary.

7. Healthy ambitiousness.
8. Creativity.

Among the important real professional competencies the heads of the enterprises distinguished: developed intuition (7.3 points), the ability to think logically (7 points) and the development of engineering thinking: ability for professional self-development (6.8 points).

Interesting is the fact, according to the experts – top managers, that an engineering technologist may not have highly developed creative abilities (5.5 points).

This situation is convenient for the administration from the perspective of authoritarian leadership, when an engineer is able to quickly and logically competently offer various solutions to professional problems without creative initiative.

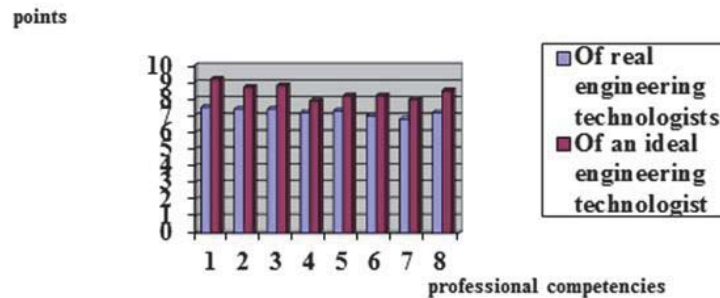


Fig. 6. Evaluations of a competitive engineering technologist's professional competencies distribution by the members of the KSTU State Attestation Commission

To the most important professional competencies of an ideal engineering technologist the heads of the enterprises refer: developed engineering thinking: the ability for professional self-development (8.9 points), the ability to think logically (8.3 points), developed intuition (8.3 points), and the ability to critical analysis of professional activities (7.8 points).

It is interesting that the heads of the enterprises have not changed their views on the need for high creative abilities of a competitive engineering technologist (6.3 points).

However, the biggest gap in the assessment of professional competencies was acquired by the basic quality – developed engineering thinking: the ability for professional self-development (2.1 points).

The horizontal scale – is the competencies:

1. Developed engineering thinking: the ability for professional self-development.
2. The ability to critically analyze in their professional activity
3. The ability to think logically.
4. Developed intuition.
5. The ability to integrate ideas.
6. The ability to allocate the primary from the secondary.
7. Healthy ambitiousness.
8. Creativity.

As it can be seen from fig. 6, members of the KSTU State Attestation Commission evaluate these real professional competencies of an engineering technologist fairly equally because of the notion of professional competencies that characterize graduates.

Among the most important real professional competencies the experts point out: developed engineering thinking: the ability for professional self-development (7.5 points), the ability to critically analyze in their professional activities (7.4 points) and the ability to think logically (7.4 points).

On the basis of the experimental data it has been identified that the evaluation of the professional competencies of a real and ideal engineering technologist was higher among the experts – the members of the KSTU State Attestation Commission owing to the orientation of the teachers to a perfect model of a competitive specialist.

At the next stage of the experiment the correlation relationships between the priority professional and personal components of the Self-conception of a competitive engineering technologist's self-development were revealed.

The calculation of the Pearson correlation coefficient was performed using the statistical software SPSS.

The Pearson's correlation coefficient was calculated with the following formula:

$$r_{xy} = \frac{S_{xy}}{S_x \cdot S_y} = \frac{n \cdot (\sum x_i y_i) - (\sum x_i) \cdot (\sum y_i)}{\sqrt{[n \cdot (\sum x_i^2) - (\sum x_i)^2] \cdot [n \cdot (\sum y_i^2) - (\sum y_i)^2]}}$$
, where

S_{xy} – is the covariance of X and Y indicators, the value of which does not depend on the average values and on the volume of the sampling and is equal to:

$$S_{xy} = \frac{\sum_{i=1}^n (x_i - x_{cp}) \cdot (y_i - y_{cp})}{n - 1}$$
, where

x_i, y_i – individual values of the i - tested.

The significance test of the correlation coefficient was carried out according to critical values of the sampling coefficient of linear correlation with the confidence level at $p \leq 0.05$ and $p \leq 0.01$.

The discovered correlation relationships were presented in a form of galaxies, as reflected in fig. 7.

The long-term pedagogical experiment allowed specifying the priority purposes for development and self-development of students' competitiveness in improving the efficiency of the engineering-technology education, as reflected in the hypothesis of the research, which basically was confirmed.

As a result of the pedagogical experiment a number of provisions, conclusions were formulated in a generalized way. Their essence is that in the process and as a result of the pedagogical experiment a steady dynamics of personal and professional qualities of students is traced in the innovative system of students' creative-project activity.

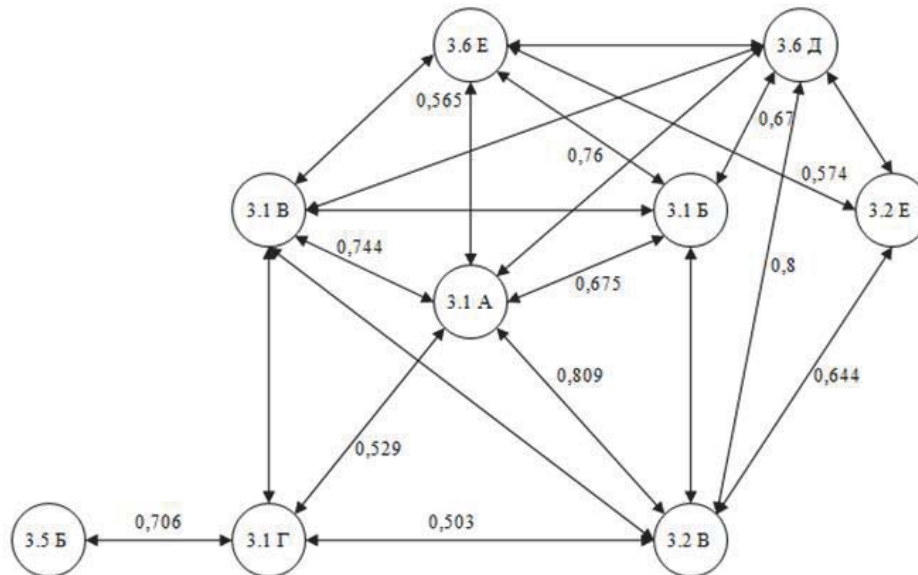


Fig. 7. Correlation relationships of qualities and competencies of the students' competitiveness invariant model

- 3.1.a – a creative approach to business,
- 3.1.b – high professional competence,
- 3.1.c – ability to take responsibility in a difficult situation,
- 3.1.d – high working capacity,
- 3.1.e – teamwork ability,
- 3.2.f – creativity,
- 3.2.g – intuitiveness,
- 3.5.h – responsibility,
- 3.6.i – tolerance to a different opinion,
- 3.6.j – progressive views.

Higher education teachers, who participated in the organization of students' creative-project activity, have a positive attitude to designing and implementing an innovative pedagogical system.

It should be noted that in recent years there has been a steady dynamics of student projects defenses with a grading of "excellent": in 2003 – 45%, in 2004 – 48%, in 2005 – 50%, in 2006 – 53%.

5. Conclusion

Thus, in the process of systemic monitoring of qualities and efficiency of creative-project activities of students in the assessment and self-assessment of their personal and professional qualities both the students themselves, and university teachers were participating, as well as independent experts – representatives of businesses and organizations of light industry employers.

Most of the 1st year students in the evaluation of both personal and professional qualities that characterize their competitiveness have self-esteem inflation, which becomes more and more adequate by the 5th year.

The monitoring approach to assessing personality traits and core competencies of creative-project activities of students allows obtaining reliable feedback and implementing effective educational support and correction in the development and self-development of students' – the future engineering technologists' competitiveness.

The students - prospective engineering technologists more often underestimate the role and importance of the moral qualities of citizenship and patriotism for self-development of their competitiveness.

The employers acting as experts in the evaluation process of personal and professional qualities underestimate the role and importance of creativity in the context of evaluating the competitiveness of an engineering technologist, which means that so far for an employer more important is a docile performer, than a person with a high creative potential.

We regret to note that even the experts – the university teachers underestimate the moral qualities such as honesty, justice and patriotism in the context of preparing a competitive engineering technologist.

The correlation analysis of the pedagogical experiment results has revealed the core personal and professional qualities: dedication, creative attitude to work, high professional competence and ability to take responsibility in a difficult situation, high working capacity, teamwork ability, responsibility, progressive views, tolerance to a different opinion, and others.

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