LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
2016, VOL. 11, NO. 16, 9239-9254

Structural and Functional Model of Organization of Geometric and Graphic Training of the Students

Valery B. Poluyanov[a], Zhanna A. Pyankova[a], Marina I.Chukalkina[a] and Ekaterina S. Smolina[b]

[a]Russian State Vocational Pedagogical University, Ekaterinburg, RUSSIA; [b]Samara State University of Economics, Samara, RUSSIA

ABSTRACT

The topicality of the investigated problem is stipulated by the social need for training competitive engineers with a high level of graphical literacy; especially geometric and graphic training of students and its projected results in a competence-based approach; individual characteristics and interests of the students, as well as methodological approaches to the design of training and methodological support of the process of individualization of geometric and graphic training. The purpose of the article is to develop a structural and functional model of organization of geometric and graphic training of students of a technical University and its approbation. The leading method of research of this problem is a pedagogical modeling, which allows to consider this issue as a process of developing students readiness to operate spatial objects in the study of geometric and graphic disciplines. The article presents the structural and functional organization model of geometric and graphic training of students in technical university, consisting of interrelated components: a target, theoretical and methodological, technological, diagnostic and effective; we developed an algorithm for the implementation of this model. The article can be useful for the organization of the geometric and graphic training in universities, with appropriate adaptation in educational institutions of secondary vocational education in specialized classes in secondary schools.

KEYWORDS
Structural and functional model, geometric and graphic training, the ability to operate spatial objects, higher technical education

ARTICLE HISTORY
Received 12 May 2016
Revised 24 June 2016
Accepted 12 July 2016

Introduction

The core of the engineering profession based on different types of professional activity is research, design, engineering, and technological training and production, its implementation. Each stage is associated with the development and implementation of a variety of graphic documents: sketches,

CORRESPONDENCE Zhanna A. Pyankova ✉ zhanna.pyankova@mail.ru

drawings, diagrams, flow charts, etc. Accordingly, the training of engineering bachelor's degree in a technical university as a specialist, which supports, maintains, modernizes created objects, processes, products, should cover the whole work cycle "from idea to product» (Shekhova et al., 2016; Andryukhina et al., 2016; Shikhova & Zhuykova, 2013; Zhuykova, Shikhova & Shikhov, 2015; Khuziakhmetov & Naumova, 2016; Dorozhkin et al., 2016; Khuziakhmetov et al., 2016). Along with this we distinguish graphic culture as a basic, integral quality of a person, which manifests itself in a high level of knowledge, ability to analyze and predict the manufacturing process, the use of geometric and graphic knowledge to deal effectively with professional tasks, as well as awareness of the value of graphic training for the professional future (Brykova, 2011).

P.A. Ostrozhkov (2009) most fully reveals the concept of graphic competency, saying that it is a precondition to the development of scientific research activities, it encompasses the opportunity for the successful solution of professional tasks, based on spatial thinking developed with the help of computer technology and it promotes the development of creative abilities.

"Geometric and graphic training" under the narrower concept is referred to the study of disciplines geometric and graphic component, which includes the school disciplines "the figurative arts ", "Geometry", "Drawing" disciplines of higher education " Descriptive Geometry", "Engineering Graphics", " Computer graphics ", special disciplines related to the work on the creation or use of finished drawings, graduate qualification works accomplishment (Rukavishnikov, 2009). This specification can be explained by the desire to concretize the broader concept of "graphic training" and to limit its scope of application of the drawing tools and programs.

Geometric and graphic training is an integral part of technical education. In the study of geometric and graphic disciplines in accordance with the Federal state educational standards of higher vocational education in training specialty 08.03.01 "Construction" the study of the geometric formation laws, building and mutual intersection of planar and spatial models are necessary for successful reading and executing of buildings, structures drawings, and design documentation preparations. However, as practice shows, the development of these competencies is difficult without the development of readiness to operate spatial objects. In this regard, the development of this readiness is seen as competence, supplementing the list of professional competencies, and aimed at the development of readiness for analysis and synthesis of spatial images and shapes (Poluyanov&Pyankova, 2016).

Materials and Methods

Research methods

During the research the following methods were used: theoretical: studying and analysis of psycho-pedagogical, philosophical, scientific and methodical, literature on research, comparison, systematization, synthesis, generalization, the theoretical modeling; empirical: experimental research work, conversation, questionnaire, pedagogical observation, analysis and processing of the results of experimental work using a Ryulona methods Cronbach's and Spearman-Brown methods and mathematical analysis software products to determine the reliability and validity of a modified test.

Experimental base of the research

Experimental and research work was carried out at the Russian State Vocational Pedagogical University and the Ural State University of Railway Transport. The experimental and research was attended by 283 students, training in the speciliaty 270800 "Construction", as well as 10 lecturers.

Stages of research

The study of the problem was conducted in three stages:

The first step is a review of the studied problem in psycho-pedagogical and methodological literature. We studied the state of the problem in the pedagogical theory and practice, we defined the essence, characteristics and structure of the geometric and graphic training of students, the contents of the geometric and graphic disciplines was researched, ways to design the content was carried out, method of experimental and research work was determined.

At the second stage the approaches to design the content of geometric and graphic disciplines at the university were selected, profile specialized competencies, developed in students during the course of study of these disciplines were distinguished, developed structural-functional model of organization of the geometric and graphic training of students was developed, didactic conditions of readiness development to operate spatial objects were determined.

At the third stage we defined performance indicators and criteria of the system organization of geometric and graphic training; experimental research examination of its performance was conducted; statistical processing of experimental research work data was performed; we summarized, analyzed the results, and drew the conclusions.

Results

The structure and content of the model

The structural-functional model of organization of the geometric and graphic training based on consistency and mutual subordination of its components, such as target, theoretical and methodological, technological, diagnostic and result. Each component performs a specific function, ensuring the integrity of the model as a system (Figure 1).

Theoretical and methodological component reflects the social order to higher technical education and determines the bases of readiness development in students to operate spatial objects within geometric and graphic training represented by such factors as: the social need for training competitive engineers with a high level of graphic literacy, including a high level of readiness to operate spatial objects; especially geometric and graphic training of students in a technical university; expected results of geometric and graphic training in terms of competences, established on the basis of the analysis of the FSES higher vocational education; methodological approaches to the design of training and methodological support of geometric and graphic training.

To study the structural and functional models of organization of geometric and graphic training of students a set of complementary principles was used, the choice of them is due to the necessity of the determination of the structural components of the model and the result of its operation.

Principle of consistency establishes the relationship and interdependence of all elements of geometric and graphic training; this principle is implemented through the organization of a system of geometric and graphic training, combining theoretical and practical problems, individual and collective work of students, integrating educational and informative, professional, research, creative activity of students, aimed at the development of the system of graphic literacy.Also, the consistency is expressed in the need to study the material strictly sequentially from the basics to more advanced topics within the discipline, as well as between the individual disciplines.

Integrity principle provides for the integration of professionally significant information, studied in some disciplines of geometric and graphic component, while students performing different levels of professionally oriented tasks.

The principle of interactivity in the organization of the geometric and graphic training of students provides their collaboration and cooperation, exchange of information not only with a teacher, but also with each other. The implementation of this principle is possible if in the course of the geometric and graphic training establishing the direct contact with all participants of the educational process through dialogue communication, active use of electronic educational environment that leads to mutual understanding, interaction, to joint addressing common and important tasks for each student.

The principle of individualization assumes pedagogical maintenance of geometric and graphic training, taking into account the individual level of the school graphic training of students. The implementation of this principle allows the student to regulate the planned self-sustained work with the possibilities of its implementation, to use personal time more functionally and fully and thus, to quickly adapt to the conditions of a university curriculum.

The principle of professional orientation of the training involves conversion of educational and informative activities to professional reflecting the main objects of the future professional activity of the technical university graduates. This principle is implemented in the ability to combine an integrated research, design-and-engineering activity with graphic literacy, and possession of methods of engineering creativity.

Motivation principle assumes awareness of the usefulness of the geometric and graphic training in the framework of technical education, the presence of motives that contribute to activation of learning and cognitive activity. The implementation of this principle is carried out through the use of information technology and testing results of geometric and graphic work encourage the students for their achievement, the pursuit of competitiveness, which in itself is a strong motivational factor in their self improvement.

The principle of self-organization assumes purposeful management of geometric and graphic training, where students are subjects of cognitive activity. Qualitative characteristics of self-organization is the activity, discipline, the interest of students towards their work, self-improvement. All of this requires certain attention from the teacher, his refusal to micromanagement of self-sustained activity of students and its excessive regulation, but in the constructive cooperation with the students and clear determination of control timing.

These principles reflecting the systematic and professional orientation of geometric and graphic training, personal approach towards their students work are interrelated and determine the contents of all the stages of its organization.

The basis of the model of geometric and graphic training organization of students is a technological component which provides an input control, classroom and self-sustained work of students, as well as tools for their implementation.

Diagnostic component of the developed model defines the criteria and procedures for assessing the quality of geometric and graphic training of students.

The functioning effectiveness of the proposed model of geometric and graphic training organization ensured compliance with specially created didactic conditions, organizing educational activities.

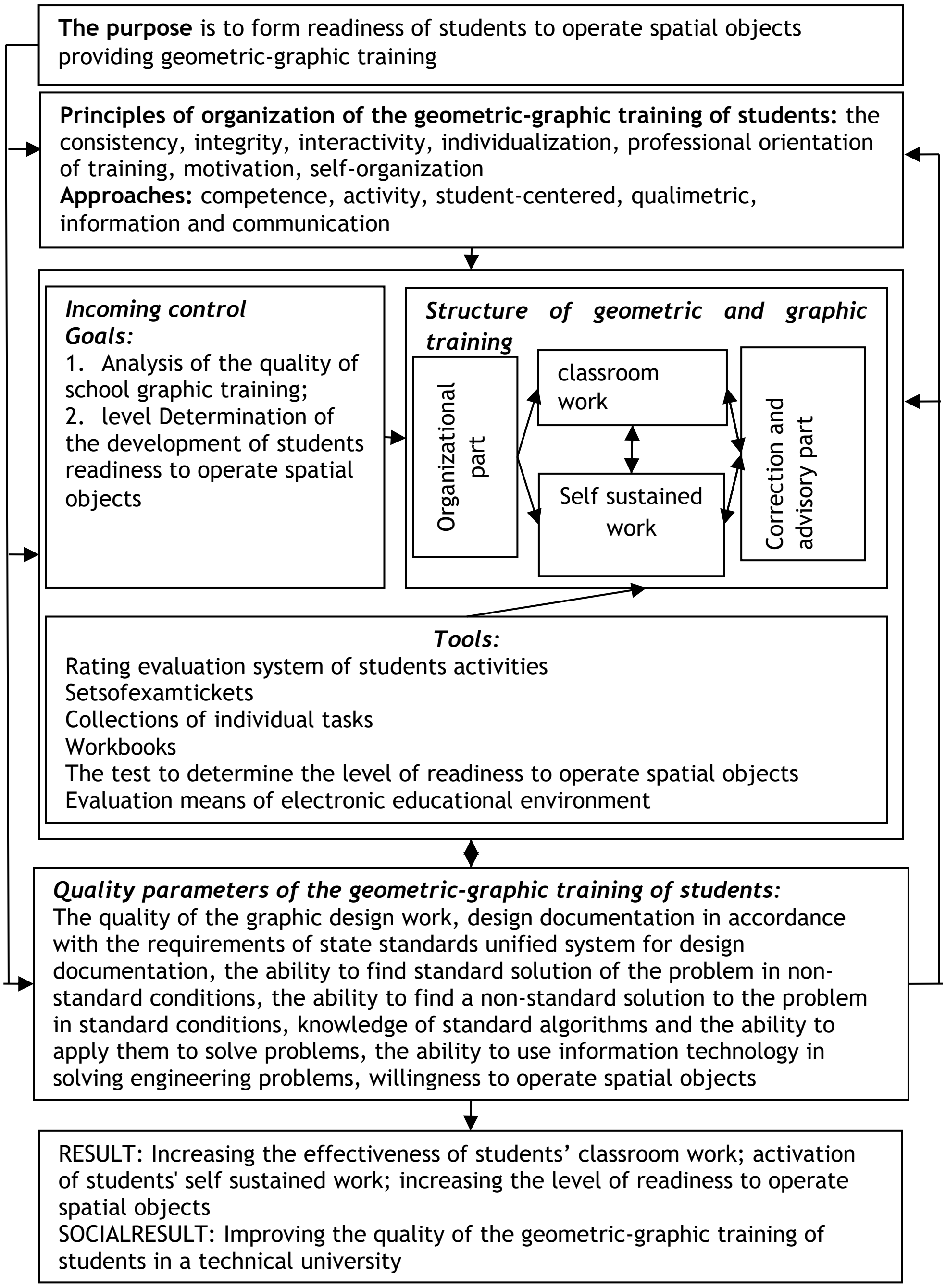

Figure 1. Structural and functional organization model of geometric-graphic training of students

Stages of implementation of the model

The introduction of this model suggests carrying out the following steps:

1. To examine the state of the problem in the modern pedagogical theory and practice of vocational training, to identify trends, patterns, contradictions in

the geometric and graphic training of students of a technical university, to determine the initial basis for the study.

2. To substantiate and develop scientifically the structural and functional organization model of geometric and graphic training of students.

3. To determine the didactic implementation conditions of the model of organization geometric and graphic training of students.

4. To check the effectiveness of the structural and functional model of organization of geometric and graphic training of students in experimental research.

First stage of ascertain experiment

Experimental research work was carried out in three stages: two ascertain experiments and formative pedagogical experiment.

At the first stage of ascertaining experiment 2009-2010 academic year, 58 students of the first course of specialty 270102 "Industrial and Civil Engineering" were tested at the beginning and in the end of the study of geometric and graphic discipline consisting of "Descriptive Geometry", "Engineering Graphics" and "Com-puter graphics" using the test by B. Serebryakov (2001) (70 tasks in 50 minutes), which consists of three types of tasks: to determine readiness to operate with two-dimensional (first type) and three-dimensional (second type) objects, to determine readiness to identify algorithms (the third type).

In determining the level of development of students' readiness to operate spatial objects test results were taken into account as follows:

- insufficient level - less than 70% of points for all types of jobs;

– threshold - more than 70% of points inclusive of any of one type and at least 70% of the reference points for the other two types;

–a sufficient level of - more than 70% of points inclusive of any two types, and at least 70% points for one type of job;

– an advanced level - more than 70% points inclusive of the assignments of all three types.

In the figure 2 there is a diagram, showing the results of two tests of the first ascertaining stage. According to the data presented in the diagram, after studying the disciplines aimed to the development of readiness to operate spatial objects, the group average increase was 3.2%, the maximum result had one student in the second test. In other words, the results do not reject scientific statements about the level of the original geometric and graphic training in a comprehensive approach to the study of the theoretical part and the development of practical skills has no effect on improving the level of preparedness development to operate spatial objects in the study of the geometric and graphic disciplines, but also such a small performance cannot be an indicator of quality geometric-graphic training of students.

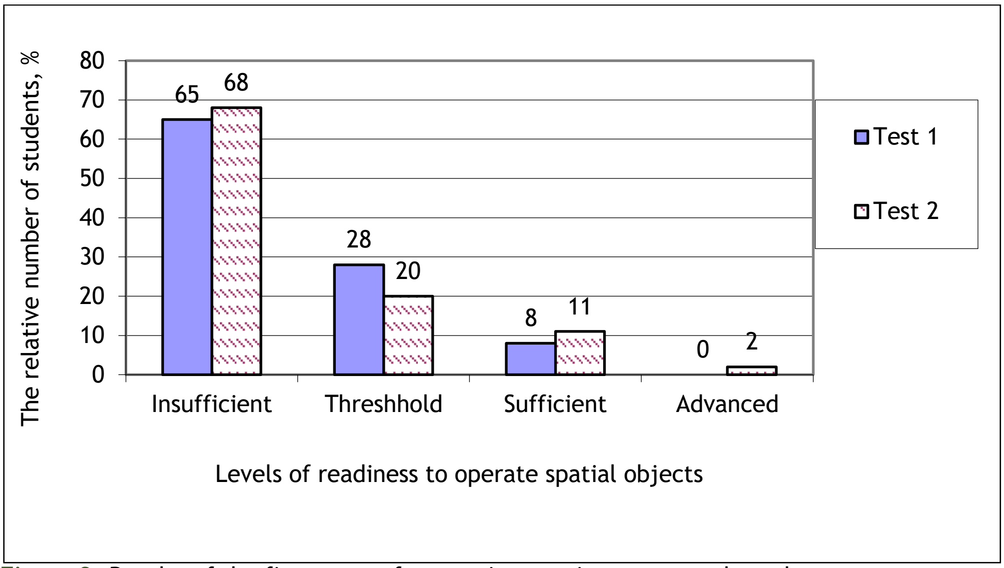

Figure 2. Results of the first stage of ascertain experiment research work

Second stage of ascertain experiment

At the second stage of ascertaining experiment research work it was decided to make the following changes: to reduce the number of tasks in the test and the time allowed for the test procedure (48 tasks in 40 minutes); to change some of the wording of tasks to make them concise and understandable for students; to include intermediate tests conducted in the first class of the second semester. Innovations in the system of methodological support of the geometric and graphic training was not applied.

At this stage, the test results of 56 first-year students mastering specility 270102 "Industrial and Civil Engineering» were analyzed (Figure 3).

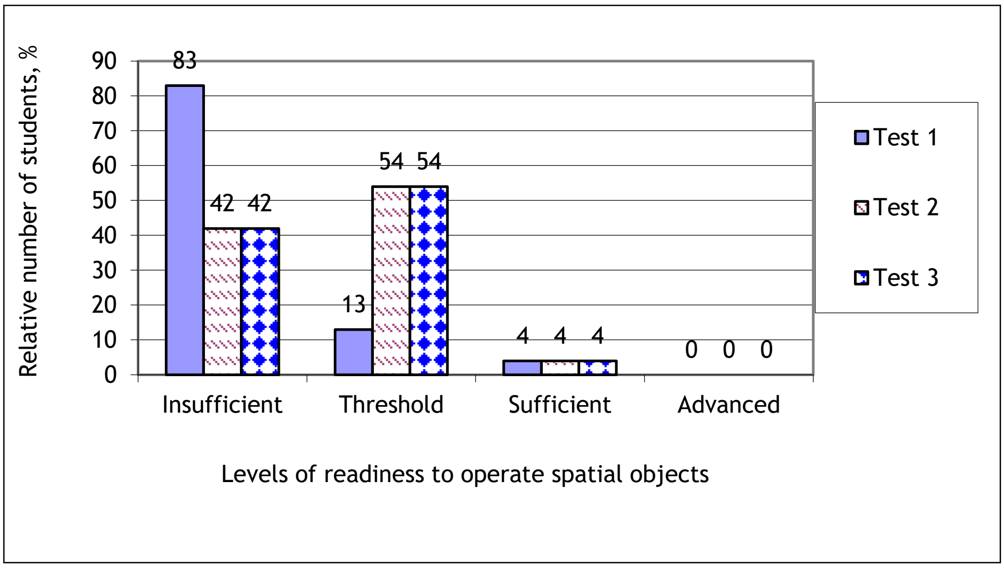

Figure 3. Results of the second phase of ascertain experimental research work (specialty)

From the above diagram we can see that with a slight change in the original testing towards the reduction of tasks and time allocated to the testing procedure, the results are still the same: after a year of studying disciplines positive dynamics is small, there is randomness of the results of the first and second testing in overall, the average for the group increase is 4.3%.

Due to the changes relating to introducing the FSES higher vocational education that occurred during the time of the experimental research work, it was decided to repeat previous stage in order to verify the possibility of comparing the results obtained from the testing of students of specialties and Bachelor's programme. The results of the triple testing of Bachelor’s programme students (57 students) are shown in Figure 4. The average level of readiness to operate spatial objects increase for the year was 1.5%.

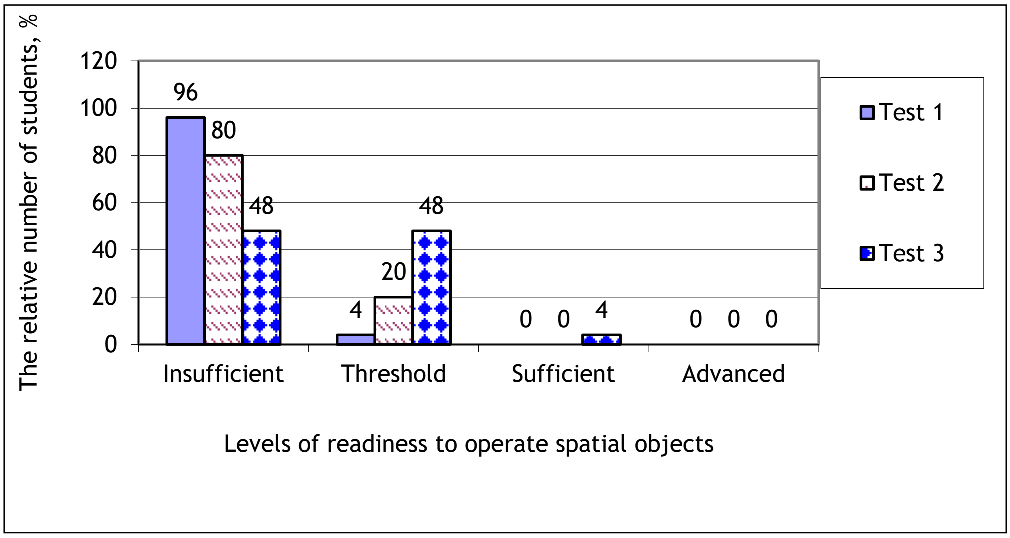

Figure 4. Results of the second stage of ascertain research work (Bachelor’s programme)

Comparing the three-year study results we can say that every time in the first test the results are comparable with each other that can be explained by the following factors: the inalterability of the conditions of training in general school level; graduates of different schools have different levels of geometric and graphic training. Maintenance of the initial conditions allows us to compare the results of the tests of different students (every year there are new first-year students).

After receiving the first test results, the authors were able to verify the tests for reliability and validity. Validity of test tasks was checked on model compliance by G. Rasch (1980). Data were analyzed using the software tool RUMM (Rasch Unidimensional Measurement Model), developed by B. Andrich et al. (2000).

As a result of data processing the tasks non corresponding to the measurement model of G. Rasch (1980) were determined, it was also defined that the there was not enough of advanced tasks in the test.

Excluding tasks that do not match the model of G. Rasch (1980) and developing tasks, similar to advanced, the authors obtained three variants of modified test of 36 tasks for 40 minutes in each variant. Checking the test results of 47 people showed that these variants are valid.

Then, a three-time calculation of the reliability of the test was carried out using the methods of Ryulon, Cronbach and Spearman-Brown. These methods are connected by the possibility to express the accuracy of the results of testing as the ratio of the variances of the true and total evaluations. As a result of this study the reliability of indicators were evaluated: the method of Spearman-Brown - 0.95; method of Ryulona - 0.95; Cronbach's method - 0.97.

In the formative stage the new management system of the organization of geometric and graphic training of students was used,concurrently the willingness to operate spacious objects was measured, as before, three times with three variants of modified test.

In 2013/14 academic year electronic educational environment was implemented as an instrument of self sufficient work of students in the study of disciplines of geometric and graphics component. As an experimental group a group of 65 students training at the speciality 270800 "Construction" (two academic groups) was considered. The performance indicators of the group of 58 students of a speciality 270102 "Industrial and Civil Engineering" (two academic groups 2009/10 academic year) were admitted as a control group. In both cases the same order of study disciplines was used: "Descriptive Geometry" in the first semester, "Engineering Graphics" and "Computer Graphics" in the second semester. In the experimental group, in contrast to the control, new management system for the geometric and graphic training based on a combination of classical forms of the educational process, and electronic educational environment was applied.

Study effectiveness of each discipline is measured by rating evaluating the activity of students. The experimental group was given the opportunity to get acquainted recurrently with the studied theoretical material, placed in the electronic educational environment (brief lecture notes and presentations to them, a glossary), also thematic training tests are developed and presented for self-assessment, their results did not affect the current rating, and intermediate tests, which had time limits (a week after the lecture) and passing time (1.5-minutes per question), the number of attempts (three attempts, for each subsequent 33.3% of the total assessment were subtracted), the results of this test were taken into account in the rating evaluation of students' activities.Students in the control group had only their own lecture notes and textbooks.

It seems necessary to give initial control results (Figure 5), according to which it can be concluded that the original two student groups, beginning to learn the discipline of geometric and graphic unit were comparable distribution of students by level of geometric and graphic training. In evaluating the results of the initial control with a standard scale "Unsatisfactory" ratings, "Satisfactory", "Good" and "Excellent."

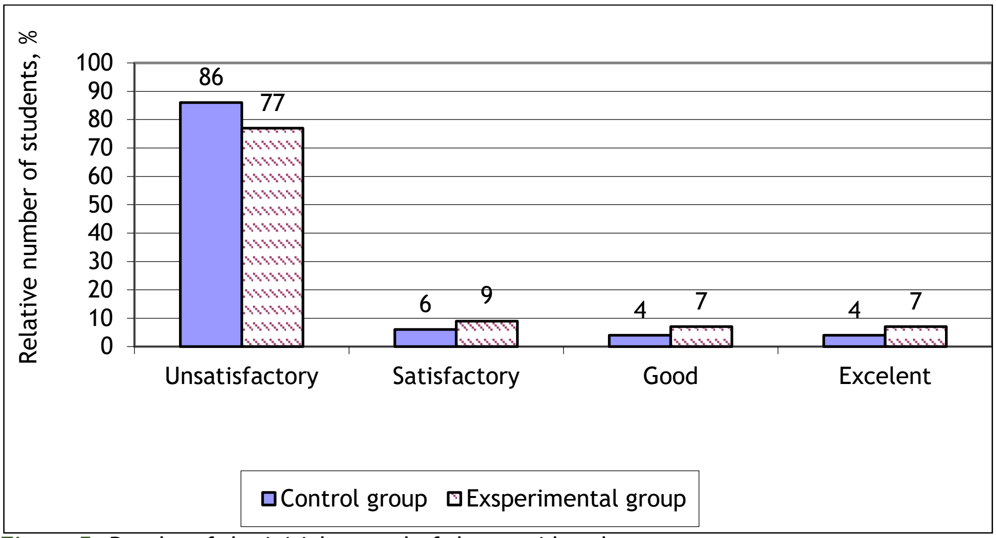

Figure 5. Results of the initial control of the considered groups

In the study of integrative disciplines "Engineering Graphics" and "Computer Graphics" in the experimental group, it was possible to combine the two disciplines with common goal: high-quality implementation of technical documentation through a graphical editor. Previously drawings rules without involving graphic editors were studied for making the engineering graphics, which were done manually. In computer graphics, the aim was to learn to work in graphics editor, but the probability of use in future training activities was implicit, there was strong motivation for further study of the program's features.

Formative pedagogical experiment

The implementation effectiveness of the proposed system of training according to a structural model of the geometric and graphic training organization are shown in Figures 6 and 7, where the results of students' training in control and experimental groups are presented in the form of final assessment.

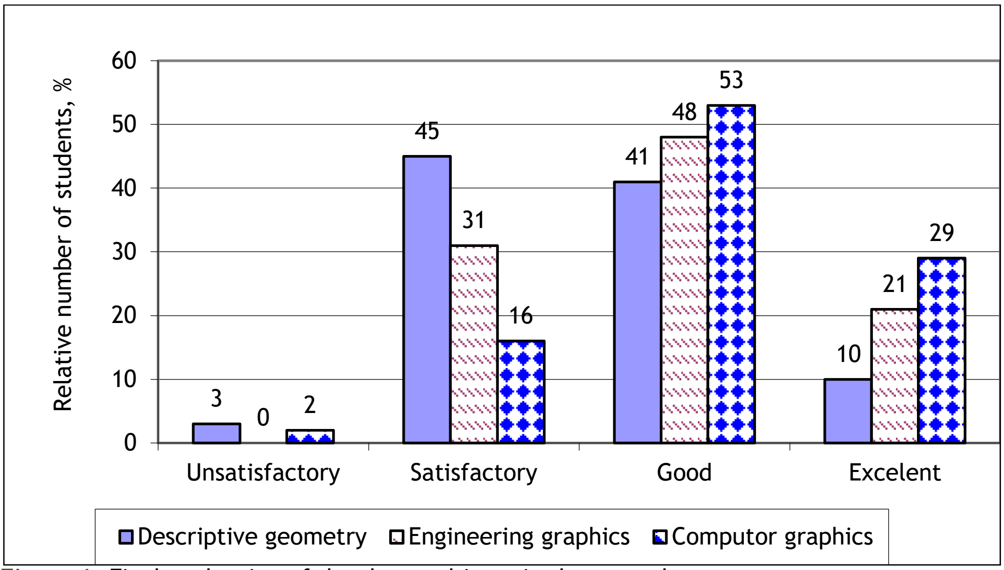

Figure 6. Final evaluation of the three subjects in the control group

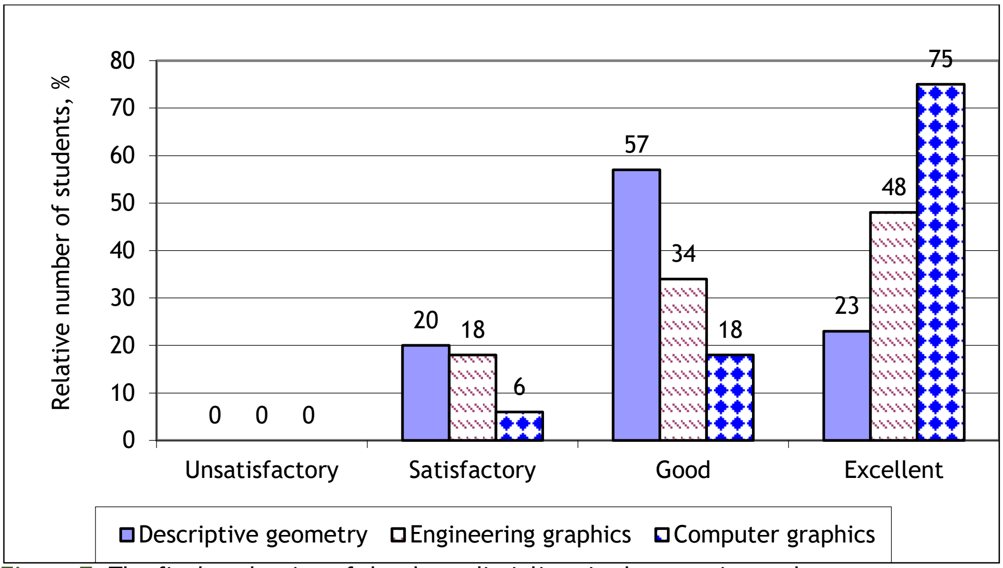

Figure 7. The final evaluation of the three disciplines in the experimental group

After the introduction of electronic educational environment for the management and control of students' self sufficient work students testing to determine the dynamics of development of preparedness level to operate spatial objects was carried out (Figure 8).

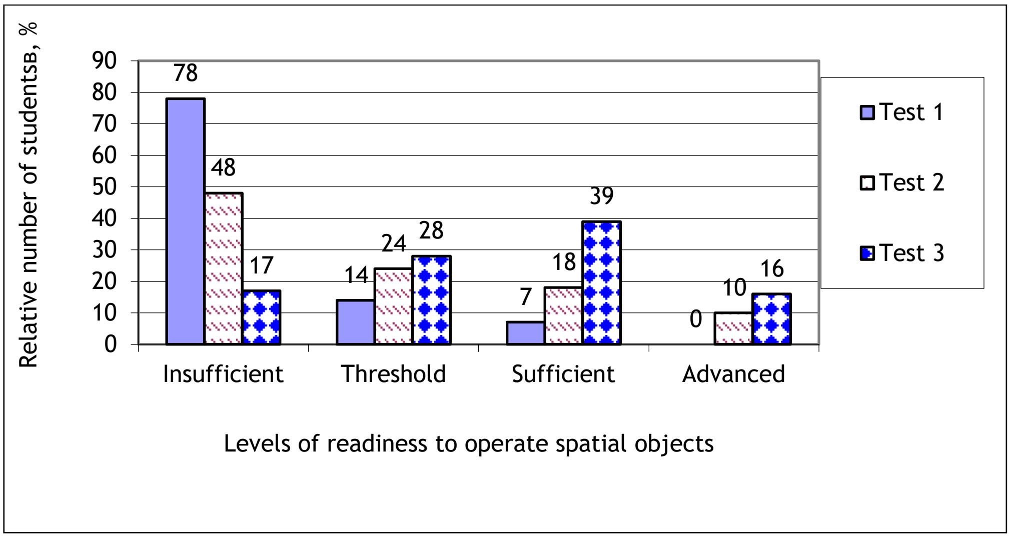

Figure 8. The results of the formative stage of experimental research work

At the formative stage we dealt with the test results of 65 students on the speciality 270 800 "Construction". The diagrams show that the results of the first test are approximately the same with the results of the first test on the stage of ascertaining experiment. The increase in the average level of readiness for the group to operate spatial objects was 27%.

Thus, all this points to the fact that the used didactic conditions and structural and functional model of organization of the geometric and graphic training of students of a technical university are effective and can be used as a basis for training and methodological support for the training of students in universities to the future professional activity.

Discussions and Conclusion

Analysis of work on the issue of the implementation of the competence approach in education has proved that our scientists (Baydenko, 2004; Zeer, 2005; Zimnyaya, 2003; Tatur, 2004; Khutorskoy, 2013; Ronzhina et al., 2016) regarded competence as a target of education. After analyzing the competence development within the geometric and graphic training allocated competences in the Federal educational standard of higher professional education in the speciality 08.03.01 "Construction", it is proposed to expand the list of students' readiness to operate spatial objects.

Investigators considering the development of spatial thinking (Gamenyuk, 2013; Goncharov & Kosterina, 2012; Goncharov, Stepanov & Stepanova, 2004; Goncharov, 2014; Kaplunovich, 2002; Krieger, 1989; Nemov, 2003; Yakimanskaya, 1989), pointed out that spatial thinking is has a stage of more intensive development - the children of primary school age are making great strides in learning ways to operate spatial objects with minimal effort, but the development of spatial thinking is possible at later stages, under certain conditions, as was shown in this article.

In the context of accelerating the pace of society information it becomes relevant to use information technologies in the field of education, one of the most vivid examples is the use of electronic educational environments (Ivanova, 2015; Klekovkin, 2014; Krasavina & Al Akkad, 2014; Shteinberg, Vakhidova & Davletov, 2014;).

In the context of the implementation of the EFAE of higher education the development of structural and content model of organization of geometric and graphic training based on creating conditions to develop students' abilities to operate spatial objects by intensifying their self-sufficient work through the use of electronic educational environment MOODLE.

It was determined that the process of development of readiness to operate spatial objects in students of technical university will be successful if:

1. A structural model of organization of the geometric and graphic training, the algorithm for its implementation, providing the application of information technology to enhance student-centered self sufficient work of was substantiated and developed;

2. Topics of geometric and graphic disciplines, directly determining the need for manipulating spatial objects were specified;

3. Academic and methodological support for geometric and graphic training , taking into account the relationship of geometric and graphic discipline and determining the possibility to operate the spatial objects (the electronic courses, different levels of professionally-oriented tasks, test tasks, training manuals) were developed;

4. The method and tools for the assessment of readiness of students to operate spatial objects were developed.

Recommendations

The contents of this article can be useful for teachers focused on the development of educational programs and educational software of geometric and graphic disciplines.

This study is not a comprehensive solution of this problem, the direction for its further development may be related to the identification, definition and justification of scientific-theoretical and methodological grounds for the possibility of using the developed system of geometric and graphic training organization, with appropriate adaptations, both in other areas of higher technical education, and educational organizations of the system of secondary vocational education in specialized classes in secondary schools.

Analysis of the experimental research data suggests that performance in the experimental groups of students, in which additional tasks were introduced innovation, became statistically better than in control groups, indicating that the greater effectiveness of training took place in terms the development of readiness to operate spatial objects, in comparison with traditional training in the educational institution.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Valerij B. Poluyanov is PhD, professor of Russian State Vocational Pedagogical University, Ekaterinburg, Russia.

Zhanna A. Pyankova is an applicant of Russian State Vocational Pedagogical University, Ekaterinburg, Russia.

Marina I. Chukalkina is student of Russian State Vocational Pedagogical University, Ekaterinburg, Russia.

Ekaterina S. Smolina is associate professor of Samara State University of Economics, Samara, Russia.

References

Andrich, B., Sheridan, B., Lyne, A. & Luo, G. (2000). *RUMM: A windows-based item analysis program employing Rasch unidimensional measurement models (Perth: Murdoch University)* Direct access: http://www.rummlab.com/.

Andryukhina, L.M., Dneprov, S., Sumina, T.G., Zimina, E.Y., Utkina, S.N. & Mantulenko, V.V. (2016). The Model of Monitoring of Vocational Pedagogical Competences of Professors in Secondary Vocational Education. *International Journal of Environmental and Science Education, 11(14),* 7016-7034.

Baydenko, V.I. (2004). Competence in vocational education (to the development of competence-based approach). *Higher education in Russia, 11,* 3-13.

Brykova, L.V. (2011). Formation of graphic culture of the future engineer. *The research note. Electronic Journal of the Kursk State University, 17*. Directaccess: scientific-notes.ru/pdf/018-022.pdf.

Dorozhkin, E.M., Tarasyuk, O.V., Lyzhin, A.I., Krotova, O.P. & Sherstneva, N.L. (2016). Structural and Functional Model of Training Future Masters of Vocational Training for the Organization of Teaching and the Production Process in Terms of Networking. *International Journal of Environmental and Science Education, 11(15),* 8323-8334.

Gamenyuk, T.N. (2013). Problems of diagnostics of spatial thinking at younger schoolboys. Direct access: http://nsportal.ru/vuz/psikhologicheskie-nauki/library/2013/02/26/problemy-diagnostiki-prostranstvennogo-myshleniya-u.

Goncharov, C.Z. (2014). Culture as a creatıve base of educatıon. *The Education and science journal, 1(2),* 73-84. DOI:10.17853/1994-5639-2014-2-73-84

Goncharov, S.Z. & Kosterina, A.B. (2012). The Basics of Art Education (Based on I. A. Ilyin's Works). *The Education and science journal*, *3,* 46-63. DOI:10.17853/1994-5639-2012-3-46-63.

Goncharov, S.Z., Stepanov, A.V. & Stepanova, T.M. (2004) Drawing philosophy. *The Education and science journal*, *6(30),* 36-45.

Ivanova, E.O. (2015). Electronic textbook - objective information and educational environment of students' self sufficient work. *The Education and science journa*l, *5,* 118-128.

Kaplunovich, I.Ya. (2002). Levels of cognitive activity. Direct access: http://www.distedu.ru/mirror/_fiz/archive.1september.ru/mat/2002/36/no36_1.htm.

Khutorskoy, A.V. (2013). *Competence approach in training: scientific-methodical manual*. Moscow: Publishing house "Eidos"; Publishing House of the Institute of Human Education, 73 p.

Khuziakhmetov, A.N. & Naumova, M.V. (2016). Diagnostics of Pupils' Meta-Subject Competence During Lessons on Mathematics in Secondary Schools. *International Journal of Environmental and Science Education, 11(9),* 2333-2342. doi: 10.12973/ijese.2016.609a

Khuziakhmetov, A.N., Belova, N.A., Kashkareva, E.A. & Kapranova, V.A. (2016). Future Teachers' Training for Learners' Individual Projects Management. *International Journal of Environmental and Science Education, 11(3), 237-244.* doi: 10.12973/ijese.2016.307a

Klekovkin, G.A. (2014). Educatıonal problems ın the context of the open ınformatıonal envıronment. *The Education and science journal, 7*, 4-23. DOI:10.17853/1994-5639-2014-7-4-23

Krasavina, Y.V. & Al Akkad, M. (2014). Developıng professıonal ınformatıon and communıcatıon skılls through e-projects. *The Education and science journal*, *10,* 93-104. DOI:10.17853/1994-5639-2014-10-93-104.

Krieger, V.F. (1989). *Spatial and graphical modeling and development of creative abilities of students.* Voronezh: Publishing house of Voronezh State University, 184 p.

Nemov, R.S. (2003). *Psychology. General principles of psychology.* Moscow: Vlados, 688 p.

Ostrozhkov, P.A. (2009). *Organization technology of self-sufficient work of students of technical universities in the course of graphic training*: PhD Abstract. Tambov: Tambov state. thec. University, 24 p.

Poluyanov, V.B. & Pyankova, Zh.A. (2016). Organization of geometric and graphics training of students using electronic educational environment MOODLE. *Innovational projects and programs in education*, *3,* 21-29.

Rasch, G. (1980). *Probabilistic models for some intelligence and attainment tests*. Chicago: Chicago Press, 199 p.

Ronzhina, N.V., Romantsev, G.M., Piskunov, V.A. & Vrbka, J. (2016). Economic Laws of Division and Changing the Labor in the System of Contemporary Vocational Education Determination. *IEJME-Mathematics Education, 11(7),* 2788-2799.

Rukavishnikov, V.A. (2009). Geometric and graphic engineer training: the role and place in the education system *The Education and science journal*, *5*, 32-37.

Serebryakov, B. (2001). *Universal IQ tests*. Moscow: Eksmo-Press, 128 p.

Shekhova, N.V., Kireeva, E.E., Nazarov, M.A., Peskova, D.R., Gusakova, E.P. & Dorozhkin, V.E. (2016). Issues of financial Assurance of Economy Greening in the Regions. *International Journal of Environmental and Science Education, 11(15),* 8211-8227.

Shikhova, O.F. & Zhuykova, O.V. (2013). Individual Educational Ways of Independent Engineering Graphics Training in Technical Higher School. *The Education and science journal, 9,* 56-70.

Shteinberg, V.B., Vakhidova, L.V. & Davletov, O.V. (2014). Dıdactıc modelıng:dıdactıc multılevel technology and personıfıed ınformatıonal educatıonal envıronment. *The Education and science journal*, *1(4),* 69-90. DOI:10.17853/1994-5639-2014-4-69-90

Tatur, Y.G. (2004). Competence approach in the description of the results and designing standards of higher vocational education: *Matters to the 2 meeting of methodological seminar: author's version. Moscow: Publishing House of the Research Center of challenges the quality of training specialists,* 16p.

Yakimanskaya, I.S. (1989). *Age and individual characteristics of the image thinking of students*. Moscow: Pedagogy, 224 p.

Zeer, E.F. (2005). Competence approach as a methodological attitude to renewal of vocational education. *Journal of Educational and Methodological Association on vocational teacher education, 1(37),* 5-46.

Zhuykova, O.V., Shikhova, O.F. & Shikhov, Y.A. (2015). Professionally oriented course of engineering-graphical training. *The Education and science journal, 3,* 46-61.

Zimnyaya, I.A. (2003). Competence of a person - a new quality of education results. Education quality problems. Bk. 2. Competence of a person - a new quality of education results: *Materials XIII All-Russian meeting. Moscow; Ufa Research Center of quality problems of training specialists*, 4-15.