

**HPEPA 2019****Humanistic Practice in Education in a Postmodern Age 2019****VECTOR MODELING IN ASSESSMENT OF TEACHERS'  
READINESS TO TUTOR SUPPORT OF STUDENTS**

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***Abstract***

The article presents the use of vector modeling and the project method when assessing the readiness of a future teacher to the tutor support of students. The project paradigm in methodological training of future teachers is implemented within personality-oriented and subject-activity approaches. Students' readiness for tutor support includes their ability to identify resources of the educational environment and design individual educational routes of learners. This readiness is assessed on the basis of the results of methodological projects completed by future teachers. The leading research method is modeling by means of multidimensional vectors. The components of the vectors describe the actions at the informational-planning, practical and reflective-evaluative stages of the project activity. A vector has been introduced characterizing the social, subject and anthropological aspects of tutor support when students carry out a methodological project. The article presents the implementation of the project method in the methodological training of future mathematics and computer science teachers. The method of vector modeling for qualitative and quantitative assessment of the formation process of competences through absolute (vector modulus) and relative (direction cosines) characteristics is developed. Indicators for assessing students' actions are indicated and the process of assessing their competences is presented. Through the module of the resulting vector, the effectiveness of the methodological preparation of students for tutor support of learners is evaluated. Direction cosines characterize the degree of manifestation of the cognitive, action, and value components of competences. Comprehensive assessment of the professional education results is carried out using vector modeling.

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**Keywords:** Diagnostics, methodological training, tutor support, project method, vector modeling.

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## 1. Introduction

The socio-economic conditions of the 21st century, when most of the professional knowledge acquired by university graduates quickly becomes obsolete, predetermines their constant updating. The Declaration of the UNESCO's World Conference on Higher Education states that teaching the ways to acquire knowledge is prioritized. The educational paradigm is changing in terms of a new view, on the one hand, the view of the mission of education, and on the other, the view of the subject and ultimate goal of education. Education is "inherent-worth and the sphere of production of the highest value and the main capital - a person, his or her features and qualities, in its entirety, as harmoniously and comprehensively developed personality, and not only an expert" (Ilinsky, 2012, p. 3). The problem of understanding and the fact that understanding should be taught is updated. What does it mean "to teach a future teacher?" and "how to teach future teachers to understand?". The role of methodological knowledge, inherently social-humanitarian, is increasing. A teacher who is aware of his or her mission in the educational process and understands the possible resources of the educational environment is able to develop students' creative abilities in new realities.

Methodological knowledge in teacher training involves the use of pedagogical technologies aimed at enhancing the independent cognitive activity of students. Many productive teaching methods have been accumulated in pedagogy. It is relevant to appeal to tutor support and interactive methods of problem-based learning in the method of projects. In the context of informatization of education, there are innovations that combine traditional methods and project activities (Knoll, 1997). The project method involves individual, pair and group activities of students. The purpose of the project method is a detailed development of a problem and obtaining a practical result. The project is based on an idea, a problem and a pragmatic focus on the result, which can be seen, comprehended and applied in real practice (Rybina & Popova, 2014). A teacher, first of all, is an experienced mentor for students and his or her skills in tutor support are in demand. What is the specificity of tutoring and its difference from another type of pedagogical activity?

Institute of tutoring appeared in the XIV century during the foundation of the first classical universities of Oxford and Cambridge. A tutor accompanied a student in training, assisted him or her in choosing lecture courses and quality exams preparation. In secondary modern school, the methods of tutor support are no less relevant, as it is important for a teacher to be able to analyze, predict and design the formation processes of subjectivity of a student (Roscoe & Chi, 2007). The tutorial position of a teacher involves the formation of a favorable sociocultural environment to provide assistance and support to students in the implementation of their individual learning path. Establishing a relationship between teacher and student is the basis of tutor support (Fernandez-Toro & Furnborough, 2018). It is important to form the willingness of a future teacher to provide feedback that is appropriate to the needs and expectations of a student. The methods of dialogue interaction between a teacher with students in individual and group classes were studied in the work (Hardman, 2015). By analyzing the discursive practices of tutors, we note their focus on creating the conditions for a student to consciously choose different educational areas and plan individual educational programs. This is confirmed by studies in which significant personal qualities for tutoring a student are the motivation and level of development of his or her mental abilities (Deny & Potts, 1998). A teacher with a pronounced tutorial position is able to predict student achievements. The

tutorial position of a teacher is, in fact, the answer to the question: "How to apply the results of educational activities and a personal education program in the process of targeted development of a student?"

There are different models of tutor support for students (Fomenko, 2017). In methodological models, philosophical categories and principles of a particular system of tutor support and its elements are identified and fixed. In functional ones - scientific concepts, analysis of successful practices, categories, terms and description of tutoring, indicating the differences between this type of pedagogical activity and the rest. Technological (structural) models indicate stages of tutoring activity - from identifying interests and educational needs to creating a development infrastructure, situations of productive action and student self-determination in opening a new space of opportunities. It is possible to form the readiness of a future teacher for tutor support by means of a methodological project due to the solution of a specific problem of educational practice. The project is executed in the form of a methodological product. The project is aimed at independent acquisition of knowledge by students in the process of solving practical problems. A teacher is both an expert and a consultant here.

The process of formation a future teacher's readiness for tutor support assumes the conditions, promoting his or her intellectual and spiritual and moral development, instilling the will for self-education. The student analyzes effective learning strategies and "tries on" them for later use in professional activities (Wood & Tanner, 2012). In the work (McFarlane, 2016) it is noted that the formation of readiness for tutoring activity is influenced by the observation of students over the educational strategies of other teachers. The implementation of the methodological project enriches the individual experience of a future teacher in terms of comparing educational strategies and effective practices.

The project method is successfully applied at Aalborg University, where it is envisaged to complete projects in all courses and specialties of the Faculty of Engineering Sciences and Medicine (Kolmos, Fink, & Krogh, 2006). About half of the training time is allocated for lecture and seminar classes, and the second half is for work on projects in small groups. For the application of the project method in the readiness formation of a future teacher to carry out tutor support of students, experimental studies are important. It is impossible to project the future of complex open systems, and therefore it is necessary to manage constantly their development through design, problematization, and research (Schedrovitsky, 2007). The implementation of the methodological project guides students towards mastering a certain sequence of actions (Polat, 2006; Soloviev & Stepanyan, 2009).

Building the capacity of a future teacher to innovative and project activities is the basis of his or her methodological training. In the work (Dorofeev & Arslanova, 2018) invariants of methodological training are identified which are appropriate to the cognitive, social-humanitarian, operational action-related, research and methodical methodological directions. A student who solves professional problems independently in the project paradigm acquires his or her own system of semantic orientations, knowledge, skills and experience. The vector modeling method allows to evaluate the student's professional training from a variety of positions and to correct the problem areas of his or her methodical methodological (Dorofeev, Chirkina, Gagloev, & Savina, 2018). Competencies are a multidimensional result of education. For their diagnostics, it is quite natural to use three-dimensional vectors, components of which characterize the knowledge, activity and value components of competencies.

## **2. Problem Statement**

The teacher as a tutor performs activities aimed at supporting the learning process of students. The subject of student's educational activity is sign systems and action programs. This qualitatively distinguishes it from the subject of the teacher's professional activity, when information in the context of production processes and situations is transformed into means of regulating activity. As a part of professional training, it is necessary for a future teacher to master the means of action aimed at identifying the individual characteristics, interests and difficulties of students in order to subsequently carry out pedagogical support of individual educational routes. In particular, in selection and adaptation of pedagogical tools, supporting the reflection of students to analyze their results. The problem is identified: what are the conditions for the implementation of the project paradigm for a future teacher to actively master the basics of tutor support of students? What are the features of the method of diagnosing the level of competence formation in project and methodological activities?

## **3. Research Questions**

The subject of the research is the process of diagnosing the competencies of a future mathematics teacher in design and activities. Methodological projects involve students' mastering the experience of tutorial support in the implementation of mathematical education of school children. The subjects of the projects are focused on the organization of the game and creative activities of secondary school students, on the development of their self-organization and self-education skills, on the pedagogical support of mathematical education, on the use of different forms and methods of conducting individual and group consultations.

## **4. Purpose of the Study**

The purpose of the article is to present the use of vector modeling to diagnose the readiness of a future teacher to provide tutorial support for students in the process of mathematical education. The implementation of the project paradigm in the professional training of students involves the development of a method for the quantitative assessment of the project activities results.

## **5. Research Methods**

Tutor support is associated with the design of individual educational routes for students and the organization of the educational environment. The readiness of a future teacher for tutor support is evaluated by the results of the implementation of methodological projects, based on the following actions:

- identify the interests and possible problems of a student;
- select pedagogical means and evaluate the potential of the educational environment;
- provide pedagogical support to student in the implementation of the individual educational route and maintain its reflection in the assessment of educational results;
- advise the student on issues of the organization of project activities;
- conduct business games;

- analyze educational resources inside and outside the educational organization.

The leading method for diagnosing the readiness of a future mathematics teacher for tutoring students is vector modeling. The sequence of actions at the information-planning, practical and reflective-evaluative stages of the methodical methodological project is described by the vectors I (i1, i2, i3), P (p1, p2, p3), R (r1, r2, r3). Their component composition stands out in accordance with the triad “cognition - experience - assessment” (Steinberg & Manko, 2017). The indicated categories reveal the main components of a student’s readiness for tutoring:

- knowledge of the basics of tutoring, methodology of pedagogical research, the specifics of innovative activity in education, methods of self-education;
- the ability to use tutorial practices, choose research methods and adapt them to the conditions of the educational environment;
- personal-value attitude to pedagogical activity, assessment of specific professional tasks, understanding of problems and possible solutions.

Now imagine the component composition of vectors. The information-planning stage of the project activity corresponds to the vector I, through the components of which the abilities are evaluated:

i1 - describe the categorical apparatus of the study; identify the problem field and formulate the problem;

i2 - set the goal of the project and analyze the situation; put forward different approaches to solving the problem;

i3 - create a working research model, describe tasks and methods; search for the necessary data, establish semantic connections between them.

The vector P components characterize the practical stage of the project activity and indicate the abilities of a future teacher:

p1 - carry out structural analysis of the situation; systematize information resources and analyze the data;

p2 - identify possible solution strategies; evaluate each of the proposed options;

p3 - choose and implement the optimal action strategy; to check the solution.

The vector R is responsible for the actions at the reflexive-evaluation stage, through the components of which the abilities are diagnosed:

r1 - identify alternative solutions; justify the optimal solution;

r2 - to formulate results and conclusions from the solution process; to put forward new research problems;

r3 - draw up the final result, prepare an abstract of the project activities; conduct a presentation and present the project.

The components of the vectors I (i1, i2, i3), P (p1, p2, p3), R (r1, r2, r3) are evaluated on a three-point scale: 0 points — absence of a sign, 1 point — partial use of a sign; 2 points - the complete presence of a sign. The components of the vectors take values from 0 to 4. The project assessment scale quantitatively expresses the degree of manifestation of abilities, which are based on the acquisition, application and transformation of experience in the implementation of tutor support. The approximate orientation of the methodological projects is as follows:

Example 1. “The work of a teacher is multifaceted. Along with the traditional roles of educator and methodologist, a teacher has to fulfill the roles of manager and tutor. How is the maintenance process different from the processes of formation and training? What are the features of the tutor position of a math teacher? What personal and age-related characteristics of students should a mathematics teacher consider when developing and implementing their individual educational routes? What successful practices of tutor support for students in the field of mathematical education are implemented in Russia and in other countries?”

Example 2. “The transition from primary to secondary school involves greater independence of students in the organization of educational and extracurricular activities. The problem of determining their individual cognitive interests is being mainstreamed. How can a teacher identify the cognitive interests of a student? What is the peculiarity of the position of a mentor who organizes the discussion of means of knowledge and difficulties? What directions of tutor support of individual educational routes can be identified in the subject area of “Mathematics?” What are the features of the question-answer technology of tutor support in the development of mathematical abilities of students?”.

Example 3. “An important role in mathematical education is assigned to the forms of interaction of the subjects of the educational process. What are the characteristics of subject to subject teaching? How can a mathematics teacher use such forms of group interaction as mutual teaching and group analysis effectively, and what place can be reserved for individual and group counseling methods? What is the peculiarity of the transition from reproductive pedagogy to interactive? What is the potential of group educational events in the mathematical education of schoolchildren?”

The implementation of the methodological project involves the development of specific solutions to the problem from the practice of mathematical education. By I, P, R vectors, mainly, student's mastery of actions at the stages of project activities are diagnosed. To assess readiness for tutor support, the vector T (t1, t2, t3) was introduced, the components of which express the social, subject, and anthropological aspects of tutoring activity (Kovaleva, 2010).

The social aspect of tutoring activity is related to the analysis of educational infrastructure proposals. So, the student, when moving from elementary school to secondary school, may not even think about the infrastructure capabilities of the school or district. In this case, the tutor's position of a teacher assumes that he or she analyzes the resources of the educational environment for a student to implement successfully his or her individual educational program.

The subject aspect of tutoring activity indicates the appeal to the "subject" side of a student's cognitive interest. The subject boundaries of the natural science, information-mathematical and humanitarian field of knowledge at the initial stages of training in mid-level are often rather relative, and the tutor position of a teacher is to expand the boundaries of subject knowledge to adjust the student's individual educational program.

The anthropological aspect of tutoring activity is associated with the student's awareness of the requirements imposed on him or her by the individual educational program, and personal qualities that can serve as a support for its implementation. The tutor position of a teacher is to help to see the anthropological requirements and discuss them within individual educational program. The choice is always up to the

student, who can accept these requirements or change the educational program in accordance with personal qualities.

The methodological project provides the development of the author's case with a description of a specific situation that requires tutor support. Students should offer their recommendations for solving the case. The assessment of the readiness of a future teacher to tutor support is possible with the help of components of the vector T, the indicators of which indicate the ability:

t1 - conduct an analysis of educational resources within an educational organization; analyze educational resources outside the educational organization; assess the potential of the educational environment; to select pedagogical means of individualization of education; to ensure the interaction of subjects of the educational environment; to develop individual educational routes for students;

t2 - advise students on the organization of project activities; conduct business games; apply methods of pedagogical diagnostics to identify mathematical abilities; support the reflection of students in assessing educational results; use remote technologies in the organization of collective work;

t3 - determine the interests and inclinations of the student, identify possible problems and difficulties; provide pedagogical support of an individual educational route; advise the student in the process of his professional self-determination; organize game and creative activities of students of different ages; select methodological tools for the formation of an open, varied and redundant educational environment.

The quantitative filling of the coordinates of the vector T is issued on a three-point scale (0 points - the absence of the sign, 1 - partial use of the sign; 2 - the complete presence of the sign) in accordance with the developed evaluation criteria. The components of the vector can take a value from 0 to 12.

## 6. Findings

The results of testing the vector modeling method in determining the readiness of future mathematics teachers for tutor support of students in the implementation of methodological projects are as follows:

- In the induction session, students are divided into groups (2-3 people in each). Each group receives a text describing the pedagogical situation on the organization of mathematical education. Students get acquainted with the assessment matrix compiled by indicators of the components of the vectors I (i1, i2, i3), P (p1, p2, p3), R (r1, r2, r3) and T (t1, t2, t3).

- Within a month, future teachers develop methodological projects, issue them in the written version, and prepare presentations.

- At the final lesson, the defense of methodological projects is carried out. The results are evaluated. The findings of the methodological project are issued by the resulting vector W (w1; w2; w3), where  $w_1 = i_1 p_1 r_1$ ,  $w_2 = i_2 p_2 r_2$ ,  $w_3 = i_3 p_3 r_3$ . The components of the vector W, indicating students' mastering the actions at the stages of the project activity, take values from 0 to 12 like the vector T. This is done for convenience and correctness in interpreting the results.

Vector modeling allows us to characterize the educational process from the standpoint of "intensity" and "orientation" (Dorofeev et al., 2018). By the vector modules W, T it is confirmed the degree of "intensity" of the process of students' competencies formation in the field of methodological activity. The maximum value of the module is 20.78. By value  $|W|$  the conclusion is made about the results of mastering

the actions at the stages of the project activity. The magnitude of the  $|T|$  module indicates the student's willingness to comprehend and take into account the social, subject and anthropological aspects of tutor support in project activities. The high level of manifestation of competencies corresponds to the value of the module, which differs from the maximum by no more than 20%. If the value of the module differs from the maximum by 20-40%, then we have an average, 40-60% - sufficient, and more than 60% - a low level of manifestation of competencies.

Direction cosines are necessary for analyzing the orientation of vectors relative to components. The first component of the vector  $W$  denotes the cognitive component of competencies, the second – activity orientated, the third - value. The direction cosines of the vector  $T$  characterize the manifestations of the social, subject, and anthropological aspects of tutoring activity. If the direction cosines of the vectors  $W$  and  $T$  are close to 0.58 (each of the component competencies is represented approximately equally), then the optimal level of mastery of the competencies of the project and methodological activities of students is ascertained (Dorofeev et al., 2018). Any two of the relative characteristics are minimized, which means that the corresponding vector is oriented along the third component, and this indicates the formation of competencies at a low level. When only one of the relative characteristics is minimized, the vector is oriented along the other two components, which indicates the average level of manifestation of competencies.

The results of methodological projects are presented by the components of the resulting vectors  $W(w_1;w_2;w_3)$  and  $T(t_1, t_2, t_3)$  for each student and the entire academic group. Table 1 shows the totals for a group of 20 students.

You can draw the main conclusions about the process of formation of students' readiness for tutor support of learners:

The values of the vector modules  $|W| = 14.78$ ,  $|T| = 14.30$  are differ from the maximum by 29% and 31%, which indicates the average level of mastering by future teachers of competencies in the field of project and methodical methodological activities.

**Table 01.** Characteristics of the resulting vectors based on the results of the methodical methodological project

Components of the W vector			Module	Direction cosines			Components of the T vector			Module	Direction cosines		
$w_1$	$w_2$	$w_3$	$ W $	$\Omega(w_1)$	$\Omega(w_2)$	$\Omega(w_3)$	$t_1$	$t_2$	$t_3$	$ T $	$\Omega(t_1)$	$\Omega(t_2)$	$\Omega(t_3)$
7.6	8.4	9.5	14.78	0.51	0.57	0.63	8.7	9.3	6.5	14.30	0.61	0.65	0.45

2. The value of the relative characteristic  $\Omega(w_1)$  of the  $W$  vector is minimal, while others are close to the value of 0.58, which indicates the average level of mastery of competence in the field of project activities. Future teachers are least likely to show such actions that are associated with the ability to identify the problem field, organize information resources, analyze data and identify alternative ways to solve the problem. This is due to the lack of students' mastery of the complex of actions at the information and planning stage. This circumstance should be taken into account in the subsequent correction of the process of methodological training of future teachers.



3. One of the relative characteristics of the T vector is minimal –  $\Omega(t_3)$ , which indicates the average level of manifestation of abilities for tutor support in organizing the mathematical education of schoolchildren. The anthropological aspect of tutoring activity is less expressed. It implies the readiness of students to accompany learner's individual educational route, organize game and creative activities, select methodological tools to create an open, varied and redundant educational environment.

The vector modeling method can be used to build an individual profile for each student, and according to the average values of the components of the resulting vectors W and T - to evaluate the process of methodological preparation.

## 7. Conclusion

The study allowed us to identify problem areas and directions in the formation of the readiness of future mathematics teachers for tutor support of students. The vector modeling method, like any other modeling, should not be absolutized. In expert assessments, there is a certain proportion of conventionality. The advantage of the method is the qualitative and quantitative assessment of the professional formation process of a teacher through absolute (vector module) and relative characteristics (directional cosines of vectors). By the absolute values of the vectors the intensity of the student's methodological preparation for tutor support is assessed, and the relative ones show the manifestation of the cognitive, activity and value components of competencies.

The results of vector modeling are significant for both the teacher and students. The teacher, analyzing the prospects of a subject area for the development of professional competencies of a student, can adjust the educational process to strengthen any of its components. The quantitative characteristics of vectors are correctly integrated into a rating system for assessing the results of educational achievements of students in order to stimulate them to master professionally significant knowledge and activities. Methodological projects demonstrating professional competencies are included in the student portfolio.

Project training develops critical and creative thinking, communication culture, the ability to perform different social roles in joint activities and contributes to the formation of one's own reasoned point of view. The proposed method is advisable to apply in the comprehensive diagnostics of the results of vocational education. The Fund of assessment tools is brought into compliance with component structure of the formed competences on each module of disciplines. Vector modeling is also applicable in the design of individual educational path of a future teacher. Making out the results of mastering competencies in the disciplines of variable modules of the educational program by multidimensional vectors, we obtain an individual profile of professional training of each student.

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