

## Forming Analytical Competency of Higher School Students

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### ABSTRACT

The urgency of the problem, stated in the article, is prompted on the one hand by the needs of modern society in professionally competent people, who are able to act in situations of uncertainty, to think “outside the box”, to successfully solve life and professional problems, and on the other hand - by the presence in the pedagogical theory and practice opportunities for solving this problem, in particular, through the development of analytical competency of students. The purpose of the article is to develop a model of forming analytical competency of higher school students. The methodological basis of the research is a systematic approach and methodology of selecting the content of education, which allowed to consider the analytical competency as a system, to carry out the design of forming analytical competency of higher school students on the basis of the developed model and justify the content of education, ensuring the formation of the analytical competency. The article presents a model of the analytical competency of higher school students, while teaching special mathematical disciplines with the help of information and communications environment through the integration of mathematical, information and pedagogical knowledge. The article introduces conditions for effective formation of students’ analytical competency, which provides them with the opportunity to work and continue their vocational training.

### KEYWORDS

Competency-based model of teaching; analytical abilities and skills; analytical competency; student’s analytical activity

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## Introduction

### *Urgency of the problem*

At present, demands to the human capacity for self-improvement and self-development, to professional and social mobility, to the level of his intellectual development are ever increasing, because these qualities define his value as a

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personality and as a professional in today's society. Therefore, the higher education system must ensure the formation of these qualities in order to ensure further self-improvement of higher school graduates. This can be done with the help of the competency-based approach, which the Federal Law "On Education in the Russian Federation" defines as the main practical method of modernizing higher education, used to improve its quality and to respond to the labor market requirements. Many research papers are devoted to theoretical underpinning of modernization of education and improvement of students' training system for professional activity in modern conditions (Bushmeleva & Razova, 2014).

A professional specialist's success in any area is largely determined by his willingness and ability to find, interpret, critically evaluate and integrate into his professional activities new information, to compile and manage information flows, as well as to produce new information, using modern information technology. To become a professional in modern society, graduates must possess a number of skills, analytical ones being very important among them. Therefore, one of the main objectives of the professional training is to create among the students the necessary base and professional experience of the analytical level.

Scientific research of many scientists are devoted to the issues of forming analytical competency. They study the analytical competency in the structure of the professional activity of the agrarian profile (Abramova, 2008), management profile, pedagogical profile (Toporovsky, 2011; Umerova, 2014). However, these works do not have a universal character, as researchers associate the analytical competency with some specific training areas or a specific area of its application.

Knowledge of a student – a future professional should be complete and systematic. A graduate should be able to analyze and interpret unknown phenomena in the theory and practice, when dealing with life and professional problems, is trained in methods of theoretical and applied research, is able to draw the right conclusions from the research. These requirements are relevant to the student's professional development of any training area, including mathematics.

Analysis of the traditionally developed forms, methods and means of organizing and conducting training sessions at the university shows that a college education is not fully consistent with the trends of modern mathematical education, there is a lot of reproduction in mastering the learning material. Under this approach, many higher school graduates are not able to work effectively under the development of innovative technologies, since the fact, that success in learning mainly depends on student's mental activity, is being overlooked.

Such students do not feel the need to understand theoretical mathematical facts, are not able to seek new scientific mathematical information, are not critical in examining the proof of the allegations, and as a result, they find it difficult to guide themselves in their profession, do not have the ability to innovate, to be creative. One of the ways to solve this problem is to realize the fundamental importance of forming analytical competency in students' training.

The analytical competency is seen as a set of special mental actions aimed at the identification, evaluation and generalization of knowledge, its analysis and transfer to a new qualitative state (Toporovsky, 2011).

With some gaps in forming analytical abilities as professional ones, a future specialist will have some difficulty in the course of their professional activity in the real production process.

The educational standards of the third generation do not speak about the formation of a professional analytical competency. And this gap is the problem of higher education. In addition, analysis of the research and educational practice show that the process of forming student's analytical competency has not been adequately studied at the theoretical and technological level, and therefore it is not very actively, mainly spontaneously, introduced into the practice of teaching.

### **Background and Theoretical Framework**

At present scientists express different views on the competency-based approach in education. Besides, the analysis of sources leads to the conclusion that there is no single, universally accepted definition of the concept of competence, as well as there is different interpretation of the terms "competence" and "competency". To differentiate the meanings of these concepts we will stick to the point of view A.V. Khutorskoy (2013), who under the competency understands "some alienated, pre-assigned requirement for educational training of students, and under the competence – one's personal qualities (set of characteristics) and a minimum of experience in relation to the activities in a given field» (Khutorskoy, 2013).

Many papers (Komarova, 2008) highlighted different approaches to the concept of analytical competency: it is seen as both an integrative quality of a person, and as a special property of an individual, and as the ability to research activities. Its fundamental elements are a sum of knowledge, abilities and skills of the student in a particular subject area and the ability to independent cognitive activity.

Several authors (Khutorskoy, 2013; Abramova, 2008) offer a classification of educational competencies according to three levels, corresponding to the content of education: subject, general subject and meta subject competencies, related to the total content of education.

Competency as a result of professional training includes a certain essence of the four-year educational process (Gordukalova, 2015). It must comply with:

- the requirements of employers;
- time adjustment of the labor market;
- a set of relevant skills, forming the profession;
- generalized understanding of working conditions with the resolved discrepancies of narrowly focused nature.

Analytical competence is an example of meta subject competence. It includes a whole range of educational competencies directly related to the

cogitative, research, logical, exploratory, creative processes of students' cognition. It is characterized by an indication of the purpose and general analytical technology or the scope of analytical skills.

The essential conditions of forming analytical skills are: creating motivational basis for the formation of analytical skills; gradual formation of analytical skills.

E. A. Suleymanova (2014) notes that the process of forming analytical competencies represents an activity consisting in the development, creative application, creating new ways of analytical work and gaining experience of this activity, which results in changing not only the object of activity, but also the subject of this activity - the person.

In our view, spontaneous instilling students with the analytical skills during the traditional training sessions and even by means of extracurricular activities cannot serve as a basis to form this competence.

Only the systematic use of several modern pedagogical technologies (research, project-oriented, information and communication, etc.) can provide a solution to the problem.

Many scientists say there is huge potential in the formation of analytical competency on a material of different areas of mathematics and computer science.

To solve the problem of efficient formation of the analytical competency among the students of the mathematical profile it is necessary:

1. to clarify the concept of analytical competency of higher school students, to determine its structure, features and possibilities of development in the system of vocational training in higher school;
2. through a systematic analysis of the structure of analytical competency to choose the methodological and methodical substantiation of its formation;
3. to build a model of analytical competency based on the integration of the systematic, activity, competency and the hermeneutical approaches. This integration would reflect functional relationships of its structural units (target-related, content-related, technological, assessment and scientific-theoretical);
4. to choose traditional and innovative technological strategies that will immerse students in analytical work;
5. to develop and test methodology of students' analytical competency in higher school, which would provide consistent implementation of the model and a complex of pedagogical conditions in the process of training;
6. to formulate criteria to evaluate the formation of analytical competency among the students of a mathematical profile.

## Methodology

### *Methodological basis of the research*

The methodological basis of the study is:

– a systematic approach, which has allowed to consider the analytical competency as a system; to design a learning process based on the model of analytical competency, understood as a system of interconnected components; to substantiate the theoretical and methodological prerequisites to form higher school students' analytical competency; to develop measurement and evaluation system of analytical competency in teaching university students;

– information approach in education, which characterizes the information and analytical bases of activity of today's professional; to carry out the design of forming analytical competency of higher school students on the basis of the developed model of analytical competency of university students;

– methodology of selecting educational content, the use of which helped to justify the content of education, ensuring the formation of analytical competency; present the results of research in the form of pedagogical knowledge, which is the theoretical generalization of research on the theoretical and methodological level.

### *The analytical competency components*

The components of the analytical competency are competency profiles, which relate to the management of information and knowledge, as well as profiles of competencies, which relate to the analysis and synthesis of real work situation.

Analytical competency includes:

1. the ability to give reasonable assessment about the effectiveness of the proposed system of information resources;
2. the ability to evaluate and classify data, ability to transform information into knowledge, analyze it, store, share, and effectively apply the knowledge obtained;
3. the ability to objectively assess the positive and negative aspects of each component of the information resources system;
4. the ability to give rapid analytical assessment of information flows, received from each component of the information system;
5. the ability to quickly and efficiently produce an analytical comparison of information flows, coming from each component of the information resources system;
6. the ability to formulate complex analytic reports on the basis of the received information;
7. the ability to interpret, organize, critically evaluate and use the information in the context of the management task or problem being solved.
8. the ability to a complex theoretical and situational analysis of pedagogical, socio-economic and cultural processes in the educational environment;
9. the ability to independently master new means of communication and work with information streams;

10. the ability to combine analytical tools from various disciplines, which can be applied to solve a particular theoretical problem;
11. the ability to effectively search for information on the Internet,
12. to understand the basic principles of development of the information environment,
13. the ability to conduct effective discussions on the Internet, to present and defend their written work, including work in the online communities of other languages;
14. the skills to regularly monitor advanced scientific achievements in the field of specialization; the skills to work with basic statistical packages and network analysis programs.
15. the ability of the comparative analysis and synthesis;
16. the ability to independently expand their portfolio of analytical tools;
17. the ability to visualize the obtained data, the ability to scientifically interpret the data, obtained in the analysis;
18. the ability to identify and develop performance indicators of educational communities, and to build their own assessment systems on their basis.

The enumerated above components of the analytical competency expand analytical capabilities and professional competence of a person, who act as a professional. This confirms the need to form the analytical competency on a high-level at all levels of higher education: bachelor, master and postgraduate.

Analysis of the structure of the students' analytical competence shows that it is impossible to form the elements of all the components of the competency by means of only one educational technology

Social Partnership of college and company is based on the following principles: equality of the parties, democracy, allowing any party to take the initiative, to justify its position; regulatory support of the participants' activities; voluntary acceptance of obligations by the parties and the mandatory of their implementation.

### ***The model of forming analytical competency***

The model of analytical competency formation is based on the principles of continuity, consistency and systematicity, awareness, activity and availability of education and reflects the process of its development in the context of decision-making in the unity of tool-based and content-based aspects.

1. Objective: to develop the analytical competency of higher school students.
2. This objective is based on the state and social order to the system of higher education to form a personality, who is able to adapt to life conditions in the information society, as well as a specialist, who is able to apply the technology of analytical activity in their future professional work.
3. Contents: the process of forming the analytical competency of higher school students during the study of various disciplines (general professional disciplines, disciplines of specialization, educational internship and industrial work placement, diploma projects) represents the development of some structural component of the analytical competency of higher school students. It is necessary to reconsider the content of academic disciplines in the context of the desired goal.

4. Technological strategies to immerse students in analytical work: research, project-oriented, information and communication, didactic multidimensional technology in the educational process (methods, forms and means of organizing the educational process aimed at developing the analytical competence of students in higher school). The main forms of training are the traditional forms (lectures, practical classes, students' independent work, counseling, scientific research and others.) with the use of reproductive techniques, problem statement, heuristic and research methods

### Conditions for an effective model of forming analytical competency

1. provide students with the techniques of analytical activity, that is, basic knowledge and skills for analytical work, which are relevant to the decision-making stages;
2. enhance students' learning activities;
3. introduce into the educational process practical tasks that contribute to the balanced development of the differential and integral cognitive styles of students' perception;
4. use special analytical packages in the learning process;
5. create a positive motivational environment to form analytical competency;
6. take into account interdisciplinary connections in teaching professional disciplines.

It should be noted that these conditions are interrelated and complement each other. On the one hand without positive motivation it is not advisable to start the process of learning, on the other hand increased educational activity of students can generate a positive motivation for this activity, and so on. The outlined conditions, being a part of the technique of forming analytical competency, will reflect its special features.

### Criteria to evaluate the analytical competency

Based on the experience of organizing different kinds of educational, research and scientific activities and its analysis, we can conclude about the kinds of criteria to evaluate the analytical competency: the breadth and depth of the subject knowledge; transformation of the existing knowledge and skills as well as analytical work technologies; the ability to undertake self-assessment and assessment of the situation.

The level of students' analytical competency is measured by a system of criteria: motivation and goal-oriented, cognitive-activity, evaluative and reflexive. The criteria allow to evaluate the student's awareness of the motives and goals of analytical work; the student's technological base for analytical work; the degree of student's technological base for analytical work; maturity of the student's reflective culture (Table 1).

**Table 1.** Criteria of analytical competency formation

Criteria	Motivation and goal-oriented - awareness of the motives and goals of analytical work	Cognitive-activity - knowing technologies of analytical work,	Evaluative-based on the experience of using	Reflexive - maturity of the reflective culture

		namely, knowledge of methods and means of analytical work	methods and means of the analytical work	
<b>Low level</b> (weakly expressed or absent)	Indirect interest in analytical activities, as interest in the training tasks; experiences difficulties in independent definition of the activity goals	Solves typical tasks with outside assistance, experiences difficulties in independent application of existing knowledge in typical situations	Analytical work is carried out only if guidance notes are available	Gives an incomplete and insufficient self-evaluation and mutual assessment
<b>Medium level</b> (mastered)	Direct interest in the analytical work, i.e. the student shows interest in searching, collecting, comparing, compiling information necessary to solve the problem; independently defines the overall activity goals and experiences some difficulties in independent definition of the specific activity goals	Independently applies existing knowledge in typical situations	Analytical work is carried out in only if an enlarged algorithm is available	Fully and arguably gives self-evaluation and mutual assessment on the proposed criteria and can adjust them
<b>High</b> (mastered perfectly)	Sustained interest in the analytical work; independently defines overall and specific goals, aimed at solving the problem	Independently applies existing knowledge in unusual situations	The student generates new ways of analytical work on the basis of the available experience	Fully and arguably gives self-evaluation and mutual assessment on the self-developed criteria

Diagnostic tools are: interview, observation, questionnaires, self-assessment, peer review, an analysis of students' responses in the classroom, testing, analysis of the activities product, analysis of documents (practicals, laboratory, written assignments).

It should be noted that these criteria and indicators act in close unity and cooperation, forming an integrated system and as such help to orientate oneself in research activities, to achieve the desired goals.

## Results

To test the effectiveness of the developed technology, used to implement the model of forming students' analytical competency, an experiment was used.

Questionnaire results revealed the students' attitude to the problem of forming analytical competency, a certain level of understanding of the process and the nature of the competency.

The performed survey showed that 58% of respondents define analytical competency as a set of specific skills necessary for future professional activities



and expressed the need to form the given competency, 30% could not explain its essence, 12% did not express their attitude to the problem.

The main motivation for developing this competency in students is successful learning in a higher educational institution (62%); 18% believe that this competency will help in their future career; 9% think it necessary for their research activities, the remaining 11% did not show any interest in further development of analytical skills and the formation of the respective competency.

The above analysis of the survey results leads to the conclusion that, first, the students poorly realize the importance of the analytical competency for future professional activities; secondly, without a purposeful activity of higher school teachers it is impossible to further develop students' analytical skills and form on their basis the analytical competency.

To determine the level of analytical skills of first-year students we carried out control data slices in the disciplines of natural sciences at the beginning of the first semester, which allowed to determine their starting point. The tasks involved various mental operations.

Requirements to the level of analytical competency are presented in the Federal State Educational Standard of Higher Education. The analysis of this standard in the training areas of "Physics", "Mathematics and Computer Science", "Applied Mathematics and Informatics", "Fundamental Computer Science and Information Technologies" made it possible to identify the elements of analytical competency, which we expressed by the following skills:

1. the ability to improve their professional competence in the field of the educational and professional tasks (new theories, interpretations, methods and technologies);
2. the ability to identify and formulate relevant educational and scientific issues in the field of future professional activity;
3. the ability to develop a plan to solve the educational and professional goals;
4. the ability to use methods and technologies from related fields of knowledge, while solving educational and professional goals;
5. the ability to interpret the obtained results and to identify their practical significance;
6. the ability to generalize the results obtained and presented them in the form of articles, reports, essays;
7. the ability to publicly report the results in a presentation.

78 graduate students of the stated-above training areas took part in the experiment.

Assessment of analytical competency level was conducted under a three-point rating scale:

- mastered perfectly - 3,
- mastered - 2
- weakly expressed - 1
- absent - 0.

The given index correlates with the criteria, reflecting the level of competence:

- 75-100% - optimum,
- 55-74% - valid,
- 25-54% - critical,
- 24% or less - an unacceptable level.

According to the experiment results, we obtained the following data (Table 2).

**Table 2.** Evaluation of students' analytical competency

Analytical competence		Skills						
		1	2	3	4	5	6	7
Level of formation	mastered perfectly	27.4	25.1	17.0	26.7	23.9	46.1	42.6
	mastered	65.2	63.1	60.8	53.2	70.5	53.9	41.4
	weakly expressed	4.4	11.8	16.1	20.1	5.6	-	14.0
	not mastered	3.0	-	6.1	-	-	-	-

After analyzing the given tables let us match them with the criteria of the level of analytical competency.

15.1% of students demonstrated a critical level of analytical competency, 41.5% – valid and 43.4% – optimum. Unacceptable level is not detected. Consequently, 84.9% of the students demonstrated the optimum and valid level of analytical competency. This indicates a relatively high level of formation of analytical competency among the students tested in the classroom while studying professional disciplines and rather a high quality of analytical training of the future professionals.

### Discussions

The issue of analytical competency formation in higher school has been dealt with in the works of many scholars, such as Yu. K. Babanskiy (1987), A. F. Alekseev & Gromova (1993), V. V. Laptev, N. I. Ryzhova & M. V. Shvetskiy (2003), M. Ya. Vilenskiy, P. I. Obraztsov & A. I. Uman (2004), S. M. Okulov (2005), E. S. Gaydamak (2006), A. A. Korostelev & A. N. Yarygin (2009), O. N. Volik (2011), A. N. Yarygin & O. N. Yarygin (2011).

Analysis of the psychological and pedagogical sources revealed the existence of contradictions:

- between the social order on specialists having the analytical competency, and the professional education system, which is not facilitating its formation at the appropriate level;
- between the need for theoretical understanding of the process of the analytical competency development among the students during their vocational education and the lack of appropriate science-based content-related, organizational and process-efficient means;
- between the need for the development of students' analytical competency in the process of professional training and the lack of content-related and methodological support of the development of this competency.

Pedagogical theory and practice accumulated a considerable amount of material on the development of students' analytical competency (Trofimenko, 2014). The works of many scholars discovered effective methods of its development. In our opinion the analytical competency components, discussed in these works, are based on the concept of personal qualities of a successful person, a professional, and do not cover fully the entire formation process. For the vocational training under the implemented competency-based approach in education it is worthwhile to consider the degree of analytical competency formation as a system of knowledge, skills, abilities, personal qualities and

experiences that contribute to fulfilling professional analytical tasks.

### Conclusion

The study aimed at developing a model of the analytical competency formation among future students studying mathematical sciences, while teaching special disciplines using information and communication environment from the standpoint of competency, personality-activity and systemic approaches, based on the integration of mathematical, information and pedagogical knowledge.

The result of the study is a model of analytical competency of higher school students, conditions of its formation and methodology of selecting educational content, on the basis of which the learning process is designed, which aims at the formation of students' analytical competency.

The theoretical and experimental work has confirmed, on the one hand, the importance of the problem of forming analytical competency among higher school students, which is due to society's demand for professionally competent, creatively thinking professionals, who are able to find non-standard solutions and to involve employees in the effective, creative, innovative activities, and on the other hand – the availability in the pedagogical theory and practice of some reserves and the possibility of solving this problem.

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No potential conflict of interest was reported by the authors.

### Notes on contributors

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