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A Question to Eratosthenes

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Abstract

The inclusion of Russia in the world educational area and the signing of the Bologna Agreement, educational priorities of UNESCO, international cross-sections of students' knowledge (PISA, TIMSS), federal state standards at all levels of Russian education actualize the problem of the effectiveness of knowledge. Research, carried out by Russian scientists, was based on the acceptance of competence and cognitive approaches, as the implementation of knowledge, abilities and skills in the work of each student. At the same time, the formation of a complete image of the material world is not possible without the synthesis of two forms of expression: real (the study of real objects) and knowledge (concepts, theories, etc.). Knowledge translation which is not only within one discipline would eliminate the problem of shaping discrete vision of the world.

The competency-based approach involves comprehensive domain knowledge by way of an increase of cross-curriculum components. The ability to "interpret" subject or cross-curricular skills has been developed to prepare undergraduate and practicing teachers. Research results can be used in the process of studying natural sciences and humanities. The current study helps to reduce the gap between academic sciences and general education disciplines, form holistic views on methods and ways of knowing the world, and organize an effective and high-quality educational process.

Keywords: standard, cognitive-activity approach, professional development, subject and meta-subject skills.

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Introduction

Throughout the history of mankind knowledge has always been an important factor of the intellectual and economic development. Cumulative product that all people produced consists of three parts. The first part is sale of natural resources that is 10-15% of it. The second part is the results of goods-production that is 30% and the last part that is 60% is the result of intellectual output.

Merritt & Coombs (1977) describe the circumstances that caused the global crisis of education. They are the rigidity of system of education, a high demand for education, lack of resources, passivity of society and indifference to educational needs and problems. Russia had yet to provide the innovative development of economy with the most powerful replicable resource that is knowledge.

One of the priority areas that are not only for education, but also for the State's social policy should be the human capital formation.

A significant fact of concept of continuing education should be basic scientific support of reform that aims at the establishment of an innovative education system, the development of innovative ability of science: the methodology of work that is an operating mechanism from philosophical paradigm to educational practice. A special role is given to secondary school and therefore the training of future teachers.

However, current trends in updating the content of education suggest an optimal combination between the fundamental and the empirical component.

According to the competence approach the subject knowledge involves the increasing of the cross-curriculum component, the organization of consolidated activity from goal-setting to introspection of the process and outcomes of work.

Purpose and objectives of the study

The purpose of the study would be the ability to «interpret» substantive and meta-substantive skills according to the cognitive and activity approaches in the form of verbal, tabular and graphical representations of undergraduate and practicing teachers.

The aim of the study is to identify the conditions for establishing of meta-substantive learning outcomes according to the cognitive and activity approaches on the example of geography and related disciplines.

Objectives: 1. To justify importance of formation of cross-curricula outcomes that are based on analysis of philosophical, psychological and pedagogical literature; 2. to establish the importance of pursuing cross-curricula educational outcomes during modernization; 3. to substantiate using methods of systemic and situational analysis and semigraphical method that is displaying dissonance of time displacement during the study of duplicated topics in geography; System simulation in developing cross-curricula educational outcomes.

Literature review

There are many ways to determine quality of education. The compliance of individual needs and society to the quality of education is considered by Abylkassymova, Popey-ool, & Shishov (2019), Kubrushko et al. (2018). Bondarevskaya (2000), Redko, Kuleshin, Goncharov, Kolosova, & Ivashova (2020) associate the quality of education with formed level of skills and socially significant qualities of personality. Baidenko (2018), Selezneva (2003) link the quality of education with the requirements of the standard, social and personal norms. Potashnik (2002) connect the quality of education with potential personal development. Bordovsky, Nesterov, & Trapitsyn (2001), Tretyakov (2009), link the quality of education with identified needs. In our research, we agreed with the opinion of the fourth group of researchers, who are connecting the quality of education with the development of personal creative potential.

In the modern educational situation such characteristics like the disposition of knowledge, instrumentality and utility are required. The disposition of knowledge means that «maps» for finding certain knowledge in the world will be created. We understand instrumentality as an adaptation of knowledge for using, and utility means field testing of knowledge (Hafizova, 2016).

Bogoyavlenskaya & Klyueva (2012) think that learning will be successful only when a student shows initiative and intellectual activity. According to Michel Crozier, French sociologist, professor of University of Nanterre in the modern competition, first of all, the fighting is for the ability to innovate (cited in Kozlov, 2015). Manetskaya (2012) and other researchers have noted that the ability to harness knowledge in resolving various kinds of problems depends on level of education.

Organizational, substantive, technological and evaluation procedures of educational process according to the competence approach are identified with following principles:

- Development of ability to cope with one's own life;

- Representation the content of education as didactically adapted social experience for solving various problems;

- Shaping the experience for solving problems on their own;

- Justification of the evaluation of educational outcomes that is based on the analysis of progress that was made by students;

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According to Subetto (1987), a qualitative revolution means qualitative changes of social intelligence.

Zhilin (2011) analyzed Western educational strategies and compared the strategies of instructivism and constructivism. He came to the conclusion that it is possible to operate with cross-curricula skills on the basis of knowledge in a particular area if you ask questions, analyze, synthesize, interpret and build analogies and solve problems. It is not possible to develop a plot of distribution of the concentration of salt in water if you only know and look at information about salt (Zhilin, 2011).

Traditionally Russian education has been based on an instructive approach. The inclusion of Russia in the world educational area has shown that success in education is based on the dialectical synthesis of instructivism and constructivism. And they are staying in dialectical relationship and in search for borders of their applicability (Zhilin, 2011).

It is noteworthy that Germany, as the initiator and participant of the Bologna Process reformed its system of higher education, but at the same time has maintained its own traditions of education (Mawlsharif, 2011).

According to the Concept of Geographical Education the absence of geography in the curricular module on Natural Sciences leads to the loss of subject and cross-curricula links between geography and other natural sciences. During final biology exam many students had great difficulties with tasks that are related to geographical and physical factors: 1. impact of geographical processes on speciation; 2. Special features of evolution; 3. causes of the enhanced greenhouse effect; 4. biogenic migration of atoms.

According to PISA experts (Bybee, McCrae, & Laurie, 2009), the new concept of school science education and basic school science programs focuses on Science Literacy of students using scientific method as a way to achieve this goal.

Educational process should facilitate the development of high-order skills such as explanation of phenomena, making assumptions and hypothesis tests, predicting events, planning the main stages of research, an analysis of the data, justification and discussion of the results of experiments.

It would be feasible to re-establish the experience of science education in Russian schools. It is necessary to develop the use of scientific methods in textbooks and teaching materials for Natural Sciences.

In subjects with the leading component of «scientific knowledge» the role of competence approach is less, but at the same time it does not exclude the development of cognitive and training competence for any other subjects (Ivanova, Osmolovskaya, & Shalygina, 2006).

Shestak (2010) who is engaging in a polemic with Professor Vasily Senashenko agrees that the thesis about outdated information refers to teaching methods and is not appropriate to the content of the fundamental disciplines. He supposes that competence building takes place throughout life in a wide variety of situations and in different educational structures (Shestak & Shestak, 2009).

Mastering the full amount of knowledge is possible when they are used in a new situation. And it is regardless of whether leading component «modalities of operation». The fourth level of complexity of knowledge that is allocated by psychologists as «knowledge-translation» is a translation of gained knowledge to acquire new skills and knowledge by using skills from other disciplines.

The second point is mastering the ability to integrate knowledge and use interdisciplinary communication. The third point is mastering the ability of multidimensional examination of objects and processes. Fourth, it is necessary to understand the algorithms of completing the assignment. Fifth, you need to study the requirements for evaluation of different tasks.

Meta ... (in Greek meta means between, after, through) is part of complex words that is signifying a gap between or that is following or transit into something else, or maybe that is changing its state and transform (for example, metagalaxy, metacentre).

Berezhnova & Krayevsky (2005) pay attention to the fact that the freedom of creative self-realization of students is provided with cross-curricula content. The content of Russian education is presented in two forms that are pre-subject and subject. The idea of a cross-curricula approach has been laid in a pre-subject form as philosophical, methodological and fundamental scientific ideas.

Gromyko & Polovkova (2009) propose a new school model using the idea of Vasily Davydov that schools should first of all teach all children to think.

Some meta-subjects were developed such as sign, knowledge, task and problem. These are a kind of meta-subject courses and during the study students should work with concepts, schemes, etc., that develop basic abilities. But at the same time they are not bound to a specific discipline.

Methodology

According to the competence and cognitive paradigms the author used such theoretical methods such as study of philosophical, psychological and pedagogical literature and reflexive analysis of pedagogical activity. Also author used empirical methods such as detonant graph and a semigraphical method.

Detonant graph is a way of isolating some essential features of the key concept from the text - (Latin denoto - “I designate” and Greek “I write”). Using this method, for example, analyzing population density maps, areas of oil production, a table of the cost of transportation of petroleum products (geographic knowledge) petroleum-based fractions (knowledge of chemistry) a teacher leads students to understand the Rational location of oil refining. The use of a detonant graph makes it possible to rationally use the time of the participants in the educational process. Semigraphical method can visually display dissonance of time displacement during the study of the evolution of life on Earth.

The study involved 11 3rd year students from Kazan Federal University with dual training (geography and English) and 56 teachers of geography and biology. They participated voluntary and could withdraw from the study.

In order to form a holistic image of the material world we need to use tasks that are aimed to engage students’ attention. For participating students we offered the task using the lines from a poem of Lev Gumilev “And this stone roared one day. And this ivy floated in the clouds” and asked them to develop lesson’s theme where they can use these lines. We asked students two questions: 1) What does Lev Gumilev write about? 2) How can you use this passage to catch student’ attention? And what topic are you going to teach? The didactic value of this technique involves: a) formation and development of ecological thinking; b) the motivation of cognitive and communicative activity of students; c) identifying the relationship and complementarity of the rational and the figurative in understanding and forming the world picture.

Diesterweg (1844), an outstanding German teacher-practitioner, came to the conclusion that it is much more important for students to learn the argumentation, emphasizing the developing capabilities of the heuristic method of learning, and discover truth through their own reflection and research. The scientific method is the basis of training according to Razumovsky (2016).

For instance, during the exam of geography a graduate student does not understand why oil production is located in Western Siberia and oil refining is located, for example, in Yaroslavl. Students need to know the abovementioned facts for teaching geography of Russia (grades 8-9), biology (natural sources of hydrocarbons and their processing), physics and chemistry. The answer to this task involves geographical knowledge, but also knowledge in biology, physics, and chemistry as separated subjects. It also involves methods of logical thinking and skills of identifying interdisciplinary key concepts (cost price, fraction, mismatching location of consumers and oil production areas).

During the study of a new topic or extracurricular activities the cross-curricula tasks are not limited to the inclusion of generalized repetition lessons, integrated lessons and methods of capturing attention. The solution to the problem of the development of universal training maneuvers at schools takes effect not only in the classroom during teaching individual academic subjects, but also in the course of extracurricular activities and during the advanced courses and disciplines (electives).

Results

The use of the detonant graph as a way of isolating the essential features of the key concept from the text (in Latin denoto means «I designate» and in Greek it means «I write») will help teacher to make students understand the rational placement of oil refining. And also that task requires knowledge of economic and social geography and chemistry (7 grade, Topic 3. Mixtures of substances, their composition and separation method (10 hours) (distillation of oil, oil products and their use, fractions).

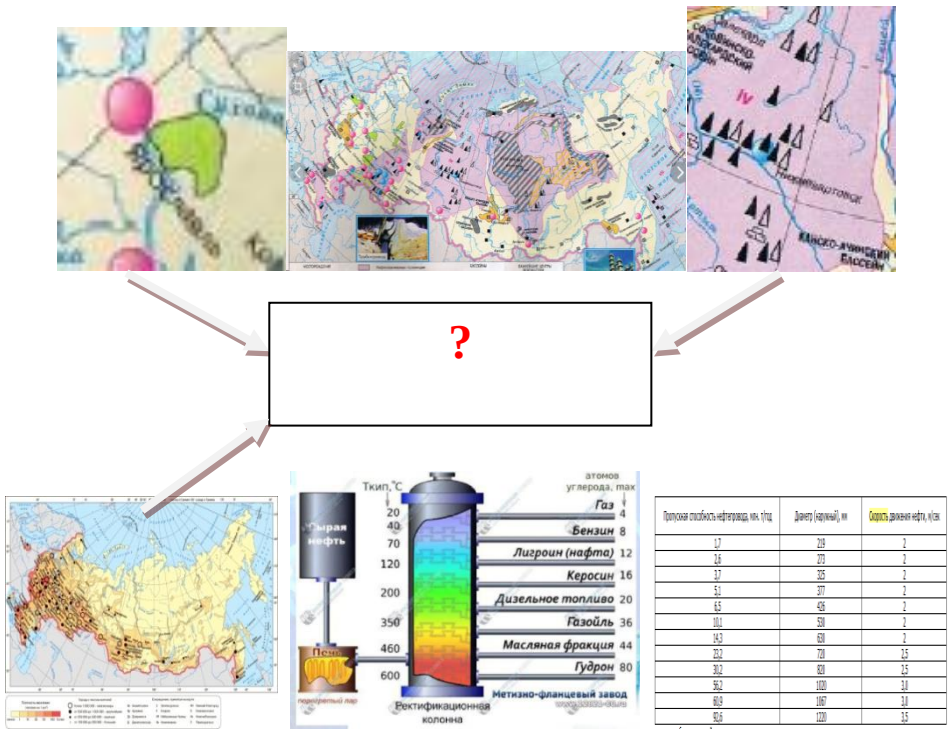

Figure 1. Denotat Graph "Oil Refining Industry Placement"

The semigraphical method visually displays dissonance of time displacement during the study of the evolution of life on Earth that is illustrated by such subjects as geography, biology, physics and chemistry at general education schools.

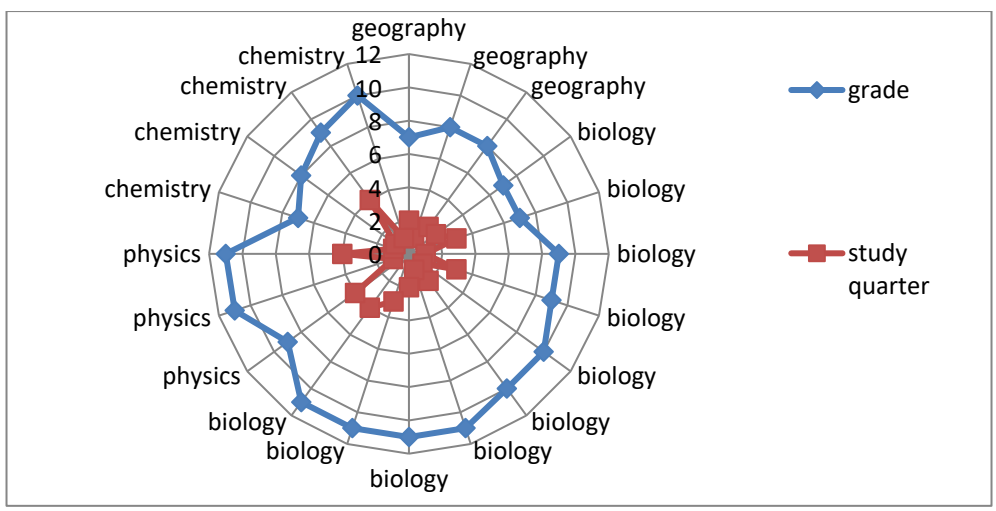

Figure 2. Dissonance of the time mismatch in the study of the geochronological history of the Earth

The example of studying the topic «Atmosphere» clearly shows both the availability and the chronological disagreement between studying related topics (Table 2). It is obvious that there are related topics in geography, biology, physics, and chemistry.

Table 1 shows results of survey of 3rd year students about the lines from a poem of Lev Gumilev. The data also shows dissonance of time displacement during the study of the topic «Atmosphere». Atmospheric pressure, its measurement and its change are studied during 5-6th grades at schools. This interdisciplinary communication is defined as promising direction. Despite the fact that pedagogy has accumulated sufficient experience of using interdisciplinary communications modern educational standards do not pay attention to it. Practically there are not such tasks that are aimed to train methods of study. It is appropriate to remind a famous statement by Leo Tolstoy who said that «It does not matter that the earth is round, but more significantly how people came to this thought».

Table 1. Survey of 3rd year students in Education (with two profiles) Profile: Geography and foreign language (English)

The master student's name	The seminar weeks (using 1,2 and 4 school terms as an example)
M.A.	1 There is no answer. 2 During studying of geological eras.
S.E.	1 There is no answer. 2 «Wind», «Animate and inanimate nature».
S.G.	1 There is no answer. 2 «Wind».
Y.D.	1 Wrong answer. 2 During studying of natural areas.
Z.T.	1 There is no answer. 2 «Animate and inanimate nature », «Volcano».
S.E.	1 About wind and storm that is plucking the plants. 2 «Wind».
M.O.	1 There is no answer. 2 There is no answer.
B.K.	1 There is no answer. 2 There is no answer.
M.R.	1 Battle, defense of homeland. 2 Nature of Russia.
M.P.	1 Roaring as a synonym for destruction, ivy as a synonym for the wind. 2 Cataclysms
K.A.	1The collapse of stones, seed transfer 2 Volcanoes.Wind.

According to the Table 1 there are no answers about the circular flow in the answers of bachelor's students. However this concept is well known and was studied during the 6th grade at schools.

The answers to the second question indicate the fragmentary views of students on the inclusion of such material in educational process. There is no answer about the circular flow.

Table 2. Answers from geography and biology teachers

Question №	February 4, 2016 (24 people) KFC	February 24, 2016 (11 people) CSSO	April 12, 2016 (21 people) CSSO
1.	0 points - 4 people 1 points - 3 people 2 points - 1people 3 points – 3 people 4 points – 4 people 5 points – 9 people	0 points – 6 people 1 points - 2 people 2 points – 1 people 3 points – 1 people 4 points – 1 people 5 points – 0 people	0 points – 18 people 1 points - 2 people 2 points – 1 people 3 points – 0 people 4 points – 0 people 5 points – 0 people

According to the information in Table 2, teachers of Center for Social and Humanitarian Education had difficulties with tasks, where they need to summarize concepts, convert information from one to another and determine reliable information in case of a contradictory or conflicting situation.

Some other students had difficulties with the tasks that deal with transformation of information to other students in Center for Social and Humanitarian Education. Only 9 teachers completely finished all tasks, 7 have done tasks partially and 8 did not do the task 5.

Discussion

Criticism of the knowledge-based, instructive approach and reduction of a constructive approach to the project-based teaching method is inappropriate in the Russian education. The main principle of domestic education needs to be kept because it is a scientific approach based on a constructive theory with cross-curricular learning outcomes.

In the USA the big experiment «Success for All» (Slavin & Madden, 2001) showed high educational outcomes and effectiveness of knowledge among students, where cognitive and activity approaches were used. The effectiveness of knowledge involved shaping the cross-curricula educational outcomes.

The cognitive approach that was used in shaping cross-curricula educational outcomes during teaching such subjects as geography and similar disciplines is based on the foundation for dealing with this issue and the importance of using cross-curricula educational outcomes with such exams as Unified State Exam, TIMSS and PISA. In this paper we also used the method of situational analysis, the semigraphical method that is displaying dissonance of time displacement during the study of duplicated topics in geography and other similar disciplines.

Conclusion

The results can be used in teaching of Natural sciences and Humanitarian Sciences. The research allows us to conclude that it is necessary to solve at least several didactic tasks: 1. holistic knowledge and common understanding of world order; 2. reducing the gap between academic sciences and sciences that are taught at schools; 3. Inclusion of scientific thinking skills in the content of secondary education; 4. organization of a system of training for undergraduate teachers with a focus on cross-curricula activities; 5. using the cognitive approach for developing the student' creative potential; 6. preparation of future teacher (also advanced training of teachers) that are going to use resources of related disciplines for organizing productive activities; 7. Developing such ideas, methods and ways of conceiving the world to achieve effectiveness and quality in educational process. The results of research can be used in different work programs for secondary and higher education.

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