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Theoretical and Empirical Aspects of Project Activity at Modern Russian School

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Abstract

Due to democratization processes in Russia the search for new methods and forms of education has resumed. In recent years the "Project Method" introduced by American teachers and actively used in the 1920s at Soviet schools but then abandoned in the 1930s has gained large expansion. Currently the project method is developed in terms of pedagogics well enough, but still lacks a clear psychological foundation. In the paper, we viewed the process of formation of ideas about comprehensive cognitive operations, in particular, generalization, analysis, synthesis etc., as a psychological ground for using the project method. The theoretic research was complemented by trial and experimental research of generalizing character. For 4 years Yelets State Ivan Bunin University has held project contest in mathematics among schoolchildren of 5-11th grades. In order to hold the contest, the relevant methodological basis has been developed (contest statutes, project requirements, assessment criteria). The contest results have allowed revealing both advantages and disadvantages of using the project activity that should be taken into account while organizing the education process at school of the future.

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1. Introduction

Reforms in education system which took place in the Russian Federation pushed scientists to development of new pedagogical technologies. With regard to this, implementation of project technology to education institutions has become active. According to the new federal state education standards, students have to be engaged into project activity as early as in elementary school.

However, historic experience shows that innovative forms and methods of education cannot replace traditional ones. With regard to this, it seems important to evaluate the prospects of applying project method in

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modern school estimating its advantages and disadvantages. Advantages of the method are obvious, but difficulties are studied much less. The method still lacks a clear psychological basis, there is no generalizing research of positive aspects of using the project method at schools across a large region, with the students' projects contest suitable to be used as one. It is the above mentioned problems that have determined the relevance of the topic of our study.

2. Objectives, methodology and research design

The methodological basis of research includes the theory of project method (Dewey, 1925; Kilpatrick, 1925; Polat, 2000; Chechel, 1998), ideas of combination of traditions and innovations during teacher training (Balyhina, 2002; Kolyagin, 2001; Sergeev & Serikov, 2013), the theory of intercivilizational borrowings in pedagogics and education (Kayumov, 2014).

In order to meet the objectives we have applied a complex of **research methods,** including theoretical analysis of psychological, pedagogical, legal and program-methodological documents on the topic of research, qualitative and quantitative processing of experimental data.

The goal of research is to *determine the prospects of application of project method in modern school and reveal its advantages and disadvantages*. Within this goal, the following objectives were set: 1) studying the history of origin and application of project method; 2) developing psychological foundation of project activity; 3) trial and experimental work (project contest).

The research was carried out in 3 phases. The first phase (2010–2012) included analysis of sources and reconstruction of the problem history. We have developed didactic support for the project contest (contest statutes, objectives, project requirements, assessment criteria).

At the second phase (2011-2014), contests of projects in mathematics were held each year, the didactic support was improved, project assessment criteria were specified, and contest results were drawn up. In order to set foundation for project activity, the theory of formation of comprehensive cognitive processes was suggested. Strong and weak points of students' works presented for the contest were identified.

The third phase (2014-2015) saw the conclusions as for the prospects of using the project method in modern school. Based on psychological theory and contest experience, conclusions about successful application of the method in modern school were made.

3. Discussion of the research outcomes

The origin of project activity as a form of education dates back to the epoch of Enlightenment. In the XVII century, Czech teacher Yan Amos Komenskiy (1592–1670) noted that the main thing in education is for students to explore and study the objects themselves and not to "remember just other peoples' observations and explanations" (Komenskij, 1893, p. 138).

At the end of the XIX century, Western teachers drew attention to emotional attractiveness of educational process within "pragmatic pedagogics".

The American teacher and psychologist John Dewey (1859 – 1952) pointed out disadvantages of the state-of-the-art school system: detachment from life, abstract, scholastic character of education process etc. Instead, he suggested upgrading school education, which attached fundamental importance to practical activity and personal experience of the child (D'jui,1925).

Ideas of John Dewey were further developed in the works of his disciples and followers – American teachers E. Parkhurst (1887–1973), W.H. Kilpatrick (1871– 1965) (Kilpatrick, 1918; Kilpatrick, 1925; Parkhurst, 1922). John Dewey and W.H. Kilpatrick were colleagues and worked in teacher training college of Columbia University. According to Dewey's conception, the leading form of education had to become "project method", the core idea of which is for students to create "projects" by carrying out individual practical tasks. The teacher acts as a consultant. He identifies the problem, guides students' activity to the right direction, helps find information source, etc. During this process children have to plan, carry out, analyze, assess and solve the problem individually, i.e. engage in project activity.

The idea about result-driven direction of educational cognitive activity that could be obtained by solving some sort of practically or theoretically significant problem underlies the method. External outcome can be felt,

comprehended, applied in practical activity. Internal outcome (activity experience) has to become according to authors of "project method" priceless possession of students, uniting knowledge, skills, competencies and values.

In due time W.H. Kilpatrick singled out phases of "project method" which are applied in modern school: objective setting, planning, practical implementation, critical assessment of the achieved results.

In educational practice "project method" started to be applied considerably earlier (in 1911 the American Education Bureau legalized the term "project method") than the essay of W.H. Kilpatrick "Project Method" (1918) where he identified the term as "wholeheartedly purposeful activity" became known to the American pedagogical public.

In 1920s "project method" was borrowed from the American school to the Russian one. Advocates of "project education" in the Soviet work schools were V.N. Shulgin (1894–1965), M.V. Krupenina (1892–1950), B.V. Ignatiev (1883-1958) and others. According to these scholars, the project method prepares students to future life most successfully, helps work out a habit to "collective labor and mutual help" (Na putjah k metodu proektov, p.11). The scholars specified that project method application sets higher requirements to professional training of teacher: it has to be versatile, since all sorts of various projects may come to a child's mind and imagination. Such important qualities as universalism and complexity were associated with project method. The teachers were confident that it is this method that would facilitate transformation of school of study into school of work. Y.M. Kolyagin writes that "project method" supported by the theory of "school growing into manufacturing" was introduced to Soviet school under the name of "complex education method" (Koljagin, 2001, p. 146). In 1923 subject teaching was replaced by complex approach to schooling and education programs. Complex program rejected systematicity in education, instead of school subjects (mathematics, Russian language, etc.) complex topics were suggested for studying related to the human, nature and society. The result was that students did not have an integral idea about the world around them, and they only received knowledge which could find practical application in real life; the level of education at schools was insufficient for continuation of study in higher educational institutions.

In 1930s by a range of legislative acts of the Central Committee of All-Russia Communist Party (b) the application of "project method" in our country was suspended and until the end of the XX century this form of education was not used at schools (Narodnoe obrazovanie v SSSR: Obshheobrazovatel'naja shkola: sb. dokumentov 1917-1973gg., 1974, p.156–157]. The method turned into engineering area and was applied in holding business, emergency situation and engineering games used in training of technical and engineering staff.

In the second half of the 1990s, with democratization processes in education and intensive development of information and communication technologies, conditions formed for resuming of the project activity. The attitude towards this innovative method is still controversial in the pedagogical community. In particular, there is an opinion that the method is not applicable in teaching sciences because it often "turns into profanation and contagious dilettantism" (Kajumov, 2014, p. 11).

In modern school a whole range of innovative teaching methods are applied, in particular the problem-based learning, integrated education, technologies of project and research learning (Chechel, 1998; Sergeev & Serikov, 2013; Balyhina, 2002; Pahomova, 2003). However, as teaching theory and practice has demonstrated, the project method possesses a range of advantages as compared to other forms of education, in particular:

– it allows bringing student's learning activity closest to practice;

– it forms skills of working with the original sources of information and select necessary information to check a hypothesis, to solve a problem;

– it increases the level of independence of students who explore, comprehend and apply the obtained knowledge;

– it promotes development of communicative and team work skills;

– it fosters creative adoption of information.

It should be noted that project method is substantially founded in terms of pedagogics, bust still lacks a clear psychological basis. In our opinion, the process of forming of ideas about complex mental operations that partially or completely are unobservable, in particular, ones of generalization, analysis, synthesis etc. could become the psychological basis for the project method. Two operations are especially important for the project method: generalization and synthesis. For example, generalization is "associative automatic assignment of certain characteristic features to an object that are inherent to other similar phenomena" [14, p. 209]. Out of two variants of generalization: involuntary and purposeful – the second type is widely used in the academic activity. Purposeful generalization is carried out during intentional observation of agents of the surrounding world in order to obtain individual knowledge, including the one obtained not only by direct observation but also from other sources of information. Generalization provides understanding of causal dependence of presence in an object of certain properties on some other properties the object may possess. When working on the project, it

is this cognitive operation that allows putting forward a hypothesis which further serves as a guiding idea of the entire activity.

Performance of the project suggests formation of some psychological image, and here an important role is played by the cognitive operation of synthesis. Synthesis is used when certain relevant characteristic features of the studied object are unreachable for perception at this phase. The process runs as follows: a certain basis is selected, as a rule "it usually becomes a mental image of change relevant for the individual that are initiated by the process. This idea is united by the causative component with not yet identified images of component parts of the process. The relevant change becomes the first known to the researcher details of comprehensive process. … As research goes on the person accumulates ideas about its causative composition. … The mental images of individual agents of the comprehensive process join the basis by individual blocks. In the image of a comprehensive process, formed by the block method, the fact of development of each individual change is fixed twice: first time each change serves as a consequence of development and the second time – as its reason" (Trofimov, 2010, p. 240). This is the essence of synthesis.

It is important to highlight that in the course of obtaining new scientific knowledge, the complex use of above mentioned cognitive operations does not always lead to correctly solving the problems set by the researcher. The same can be observed in the project activity of students for whom the process of implementing the project is simultaneously the process of obtaining subjectively new knowledge.

As a student commences on a project, he holds the basis image formed by the project name and, as a rule, by its purpose briefly described by the teacher – project leader. Other elements of the image are gradually added to the basis. The difficulty of image construction consists in the possibility of new elements during their introduction into the image structure and reservation to prove incompatible with ones already existing in the basis.

With systematic learning of school subjects, such difficulties are partly overcome by science development logics, multi-century experience and existing methods of teaching. In project activity, there is no such structure, and the image elements are joined to its basis spontaneously. The absence of abstract thinking and lack of theoretical knowledge prevent the student from verifying the created image independently, which may lead to project failure. And if such a situation repeats, it will create the background for formation of clip thinking. Overcoming the said difficulties is only possible during work specially organized by the teacher. With regard to this, taking into account the level of formation of cognitive operations depending on the student's age is an essential requirement for the successful use of the project method.

With this method becoming widespread in school practice and its advantages revealed, an idea to hold a project contest in mathematics was put forward.

In 2011-2014, the contest of projects in mathematics among students of 5 – 11th grades of general education institutions was held on the basis of Yelets State Ivan Bunin University.

Students of grades 5 through 11 of general education institutions were invited to participate in the contest.

The purpose of the contest was to popularize knowledge of mathematics among schoolchildren. The objectives of the contest were as follows:

– forming the motivation to open up the students' own creative potential;

– upbringing personal qualities by means of mathematics, creating the ideas of importance of mathematics in general human culture;

– getting acquainted with historic facts and evolution of mathematics theories;

– developing the eye-mindedness, understanding of practical application of mathematics;

– exchanging the skills and knowledge among students;

– demonstrating the potential of modern information and communication technologies in school mathematical education;

– creating an electronic bank of schoolchildren's presentations in mathematics, algebra, geometry.

The student project was designed to demonstrate skills and knowledge of students, their ability to work with original sources of information, design and implement research project work, compare various standpoints, systematize and structure the obtained materials, generalize and word conclusions.

Participation in the contest implied two phases:

1) preparing the application, an electronic copy of the project text, presentations (with further sending all the prepared materials to organizers of the contest);

2) defending the project in classroom (in front of other competitors and their scientific advisors).

The electronic copy of the project text and presentations submitted for the contest had to have the following compulsory features: research character, independent performance, originality, scientific character, grounds provided, validity, esthetic setting and presentation, and a creative approach.

During defense of the projects, each student had to demonstrate his ability to present the main content of the work (culture of oral presentation), use information technologies, answer questions and be able to participate in discussion of the problem.

In 2011 60 students took part in the contest, in 2012 – 55 students, in 2013 – 57 students, and in 2014 – 47 students. All participants were divided into 3 age groups: students of 5-6th grades, 7-9 grades, and 10-11th grades.

The highest interest towards the contest was shown in 2011. Over 60 projects from 20 cities, towns and villages of Lipetsk, Orel, Novosibirsk regions were submitted to the organization committee. All the projects sent in passed the preliminary review.

The projects were assessed using the following criteria: location of educational establishment (the further from regional center, the higher the score), degree of subjective novelty of the selected topic for the student; problem character degree; logical structure of the project; culture of personal presentation, degree of presence of mathematical tools, correct use of references.

It was especially important to familiarize the students with project assessment criteria and assessment system before they commenced work since it promoted creating the motivational environment, improved organization of work, comprehension of its goals and objectives.

Speaking of assessment, the main typical advantages and disadvantages of the study research projects in mathematics should be mentioned. In order to assess validity of the text, experts judged from proximity (or distance) of the selected topic to school curriculum. The general picture looks as follows: students either prepared a project related to school curriculum, trying to find aspects of research problem going beyond it, or they selected a completely unknown subject from the very start. The authors of such projects searched for an opportunity to apply new methods, theories and formulae in solving problems known in the school curriculum in mathematics. Meanwhile, it was senior grade students who succeeded in wording the aims of project most efficiently, in independently collecting, analyzing and systematizing the material. In our opinion, this is a crucial border separating the research work from report one which usually suggests a mere review of scientific and methodological literature on a certain problem. Hence, the greater part of projects submitted had not report but independent research character.

Yet this positive feature also had a downside: many works lacked theoretical knowledge foundation (some serious mathematical tools) without which an adequate research problem cannot be extracted, goals and objectives cannot be determined, and the research method suitable to the set goal cannot be selected.

It was the most experienced teachers of mathematical analysis and elementary mathematics chair (currently the chair of mathematics and mathematics teaching methodology) who were engaged in reviewing the projects. The experts assessed the projects submitted for the contest, selected those complying with contest criteria, and made a joint decision on awarding the most interesting, integral and intelligent works.

Among projects awarded the 1st prize, there were: "The problem of brachistichrone (least-time path)" (10th grade), "The angular sum of n-gon (various methods of proofs)" (10th grade), "Diophantine equations" (10th grade), "The development of program for constructing charts of functions, its derivatives and primitives" (11th grade), "Figural numbers – it is interesting!" (5th grade), etc.

Bellow is an excerpt from introduction to one of the projects, "The problem of brachistichrone" (10th grade): "The suggested paper deals with finding a solution to the famous problem of brachistichrone and related optical problem. The goal of the research is to obtain the equation of brachistichrone and its graphical representation. The hypothesis consists in the following: the problem can be solved by means of differential and integral calculus based on the knowledge of elementary mathematics and general physics. The objectives of research: to study the origin of the problem; to find information from the course of analytical geometry, trigonometry and physics required for solving the problem; to analyze opportunities of application of differential and integral calculus to solving the problem of brachistichrone".

The author of the project succeeded in holding the main line of research fine: starting with the history of the problem, he turned to setting the objective supplementing it with quality illustrations and then demonstrated the connection of the problem with optical processes. In the end he drew solution of the set problem widely using trigonometry (the school material for 10th grade) and by means of integral calculus solved differential first-order equation. Juxtaposition of the project text with the original souse of information showed that a large part of mathematical calculations was carried out independently. During personal presentation of the project the reviewing experts could make sure that the calculations were carried out by the author consciously and independently.

For comparison, we give an abstract from the introduction part of another project "Loan for education" (10th grade). "I have conducted a questionnaire survey among my classmates about our future education:

- After school graduation you wish to continue education – 100% of answers were "yes";
- Where do you plan to enroll – 91% of the surveyed plan to continue education at colleges and higher education institutions;
- If you fail to enroll on the budget-funded basis, do you plan to use the fee-based education – 100% (from the number of students who wish to continue education);
- Does your family budget allow you to get fee-based education – only 10% of the surveyed can count on their family support.

It means that the rest 90% of future students from our grade will have to solve the question: "Where to get the money for further education?".

Next, the author words the objectives of the research: "to study the notion of loan, find out what are subjects of credit relations, to familiarize with the main notions and formulae related to credit calculation; to find out the difference between consumer loan and educational loan; to calculate the amount payable under the credit conditions, with interest payable taken into account; to perform comparison study of the obtained results; to formulate conclusions and recommendations for the prospective students on favorable credit conditions".

When experts reviewed the project, they found out incorrect borrowings of other people's text (plagiarism), and secondly, the mathematical techniques were used at the minimum level. The project only contained the notion of an "interest rate" and several simple formulae for monthly payment calculation. The comparison study declared in the objectives of the research, as well as research conclusions, looked unconvincing.

During the contest of the schoolchildren's defending their projects, the organization committee faced several difficulties:

1) Among the projects submitted, some reflected mathematical notions and statements quite weakly. For example: "Mathematics and smoking", "Lipetsk in problems and figures", "Establishing deal price for a particular apartment for a particular date judging by its price being equal to other apartments of this type";

2) Among the projects, there were some having a high degree of scientific character, yet students could not always master the material, they would fail to answer the questions, which confirmed their choice of a topic exceeding their age-related abilities.

Unfortunately, with the course of time, there was a trend of the interest towards the contest going down, the quantity of participants decreased, project topics began to be repeated, the degree of originality and independence of project implementation declined. And there are objective reasons for that. The range of topics for projects is limited by the students and teachers' knowledge. The question about how to treat the repetitions remains open. For a teacher, the repeated topic does not bring any novelty, but for each student who implements the project for the first time the same topic will be subjectively new. Apparently, this will lead to a lower level of independence of the student carrying out the project.

4. Conclusion

Having reviewed theoretical and methodical aspects of organization of project activity of schoolchildren in general and matters of organization and conducting of a contest of projects in mathematics in particular, we have come to the following conclusions.

1. The analysis of the current state of education process shows that organization of project activity repeats the mistakes of the past. Just like in the 1920s, a great role in the projects is taken by practical activity of students, i.e. working on the project the student only sees a specifically practical direction of the new knowledge which often tends to have pragmatic character. Over the four years of conducting of the contest of mathematics projects, we have faced such works all the time. No doubt, they contain figures and sometimes complicated calculations, but what they lack is new mathematic facts discovered by the student himself.

2. The projects either have weak mathematic techniques, or they are presented sufficiently but the degree of comprehension of their application is critically low, which in its turn does not promote any intellectual development and often gives formal character to knowledge. Therefore, this method is more appropriate for teaching technology and natural sciences rather than mathematics.

3. Implementation of the project suggests mastering such cognitive operations as analysis, synthesis, etc. that could be formed only during systematic study of school subjects (mathematics, natural sciences, etc), therefore the project method shall not replace traditional classroom-lesson and subject systems of education – it can only be used as a supplement.

Proceeding from the above, we believe that using this method of activity for teaching schoolchildren requires a high degree of caution. The use of the project method has to be balanced with traditional methods and forms of education with the past experience borne in mind.

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