

# Use of Project Technologies in Implementation of Activity Approach in Training First-Year Bachelor's Degree Students at Modern Stage of Education Digitalization

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## Abstract

The relevance of the study is connected with the necessity to upgrade project work with the activity approach in training 1st-year Bachelor's Degree students with regard to their psychological characteristics. The conducted studies allowed to identify a weak methodological framework of organizational and pedagogical conditions of project activities with the use of the electronic information educational environment (EIEE). The study aims at developing a model of implementation of project work under the activity approach in the system of training 1st-year BA students under the conditions of digital educational environment. The developed model of project activity organization was implemented with 1st-year students of the BA programmes «Pedagogical Education, Specialization – Physics and Mathematics», «Applied Mathematics and Computer Science» at Astrakhan State University (ASU). The paper gives an example of an integrated project, involving knowledge and skills of future Bachelors students on the subjects «Calculus», «Programming Languages and Methods», «Computer Science» with an active use of the university's information and educational environment. The following methods were applied during the research: theoretical (a study and analysis of pedagogical, psychological, methodological literature on the issue under consideration), empirical (an observation over the educational process and students' activities within the project activity, an analysis of the learning outcomes). Considering students' psychological characteristics allows to find new opportunities for improving learning efficiency. Organization of practice-oriented project

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activity under the conditions of the university's EIEE raises interest to future specialization and motivates to self-study.

Keywords: activity approach, project technologies, 1st-year BA students, information technology, information and educational environment, psychological characteristics, facilitation, computer science, calculus, organizational and pedagogical conditions, project activity model.

## 1 Introduction

Education is one of the most important aspects of the development of modern society. Today, there is an emerging need for modernization of the educational system and raising competitiveness of Russian HEIs. A study on the quality of education of graduates of some educational institutions of Russia and Western developed countries (USA, France, Canada, Israel) showed that students from Western developed countries demonstrated a higher degree of the development of analysis, synthesis and decision-making skills in contrast with Russian students who have a high level of the indicators «knowledge» and «understanding» but very low results by the criteria «knowledge application in practice», «analysis», «synthesis» and «evaluation» [Yala08].

Rapidly developing information technologies require adaptation of the educational process to new conditions and future challenges. Russian and foreign educational practices apply the activity approach to training as an efficient pedagogical technology. Lecturers and professors involved in the education of future teachers need to have priority in these activities, as they have more experiences in innovative didactic approaches and they contribute significantly to the development of skills and knowledge regarding the use of ICT in learning process that future teachers must acquire during their studies [Rug18]. The activity approach allows to activate a student and his/her interaction with real world to the maximum extent. Implementing the activity approach is possible with the use of project technologies. They are aimed at applying gained knowledge in solving vital tasks, developing new practical experience, gaining new knowledge and achieving specific results. It allows to form a fundamental scientific basis of students' knowledge, increase their professional knowledge together with gaining practical experience. In this regard, there is an emerging need to develop projects (content component) for specific BA and MA study programmes.

Together with an active use of the activity approach, another modern tendency in education is its digitalization. Forming skills of work with and application of digital educational technologies is one of the most important components of training highly-skilled specialists. The global experience of education digitalization is aimed at supporting the educational process and pushing its limits. An analysis of successful international experience of education digitalization indicates the necessity of establishing a framework of digital literacy at all levels of education [Kaf18]. Digital technologies allow a person to get a convenient and quick access to a vast volume of knowledge. According to T.G. Vezirov, the digital information and educational environment, as a component of the interactive educational environment, is an efficient tool for developing Bachelor's professional competences, as it is where their work with digital resources and services takes place [Vez18].

## 2 Task

The study is relevant due to the following contradictions:

- project technologies are one of the efficient tools for forming professional experience and developing universal competences; however, organizational and pedagogical conditions of productive development of this approach under the conditions of education digitalization are poorly developed in terms of methodology;

- innovative educational technologies and modern digital materials are introduced into the educational process everywhere, but means and conditions of their efficient use in educational process organization are described poorly;

- implementation of the activity approach at the undergraduate level, when students have enough knowledge and skills, is often described in detail in methodological literature. However, in order to obtain efficient activities at the undergraduate level, it is necessary to form skills of activity-focused studies from the 1st study year, taking into account freshers' psychological characteristics.

The given contradictions determine the problem statement: determination of a set of organizational and pedagogical conditions for implementation of project technologies in training 1st-year BA students within the framework of the activity approach under the conditions of education digitalization.

Studying and analyzing pedagogical and methodological literature, as well as Internet resources on the issue under consideration shows that implementation of the activity approach to training under education digitalization gives an opportunity to ensure a high level of professional competences, necessary to a modern student: self-organization, digital literacy, critical thinking, communication skills and cooperation, flexibility and adaptability.

### 3 Development Of Methodology

Based on the personal experience and conducted analysis of activities of foreign and Russian pedagogical practices [Shvets19, Ger16, Klim16, Mill11], let us determine a set and organizational of pedagogical conditions for raising learning efficiency. In order to keep up to date, it is necessary to organize a cognitive activity of students, aimed at development and use of modern digital educational resources.

- Informatization of education leads to formation of an innovative educational environment. With the advent of Web-based tools and services and increasing consumerisation of personal devices, students encounter seamless computing experiences anywhere and any time, thus taking control over knowledge artefacts and environmental conditions [Val16]. Introduction of digital educational resources into theory and practice of university education and development of a modern learning and teaching module makes it possible to benefit from a whole set of advantages and prospects [Eli10].

- Organization of the activity approach, starting from the 1st study year, with a high degree of facilitation at the initial level and its gradual decrease.

- N.A. Zabelina's research shows that it is important to start active application of the activity approach to training with the use of project technologies from junior years. It allows to increase responsibility of a specialist-to-be for a final product and develops teamwork skills. The gained practical experience will allow undergraduates to complete their tasks with greater responsibility and professionalism [Zab18]. The authors' experience (Agibova I.M., Bedzhanyan M.A., etc.) shows that the organization of research activities using different levels of tasks with different levels of facilitation forms research competencies and promote the solution of one of the most important tasks of higher education - preparing a graduate who is able to plan independently and carry out research activities which corresponds to the modern ideology of education [Agib17]. Consideration of psychological peculiarities of freshers' adaptation process and difficulties that occur during the study process.

Based on the analysis of studies on psychological characteristics of modern freshers and their adaptation to university studies, the following problems are identified:

- low level of cognitive motivation development;
- poor development of psychological self-regulation of behaviour and activities;
- inability to distribute their time and power in the optimal way; a fresher does not put enough effort for meeting necessary requirements and social norms of behaviour;
- lack of skills of independent work with learning and scientific literature;
- freshers need organizational and guiding (controlling) help from an adult in setting tasks, giving step-by-step instructions and external control over their activities;
- prevailing «clip» thinking, aimed at digesting information in small portions: information should be given easily, simply and graphically, students cannot concentrate their attention on anything for a long time;
- undeveloped communication skills, students cannot speak and present clear and well-structured reports [Isa12].

Along with the problems, modern 1st-year students also have some advantages:

- well-pronounced individualism;
- they easily navigate global informational resources and quickly find necessary information [Isa12].

It should be noted that for representatives of socially oriented professions such qualities as benevolent attitude towards people, justice, interpersonal skills, tolerance, self-control, etc., are significant [Sor19]. It is important to create conditions for the development of these qualities. Therefore, the following organizational and pedagogical conditions of project work in implementation of the activity approach to the training of 1st-year BA students were developed (Table 1).

Table 1: Organizational and pedagogical conditions of project work in implementation of the activity approach to the training of 1st-year BA students.

| Organizational and pedagogical conditions   | Characteristics of project work in implementation of the activity approach   |
|---|--|
| - Providing the skills of personal growth, self-organization, time and resources management to freshers   | - Students' extracurricular self-study<br>- Setting of time limits at each stage of the project<br>- Clear determination of requirements to results of each stage of the project   |
| - Organizational and guiding help from an adult   | - Teacher's external control over students' activities<br>- Learning facilitation  |
| - Introduction of competition elements into the study process<br>- Improvement of skills of communication with peers and teachers<br>- Teamwork for solving the task at hand<br>- Development of a skill of presenting a clear and well-structured report | - Organization of a group project, formation of several groups<br>- Students' discussion of a process of solving a mathematical problem or programming task within a group, consultations with the teacher<br>- Students' work on a thorough selection of materials, structuring and presentation of outcomes  |
| - Introduction of the information and educational environment into the study process  | - Active use of capacities of the university's information and educational environment and Moodle<br>- Study of Moodle electronic materials, relevant to the project<br>- Use of Internet resources<br>- Forums, e-mailing<br>- Work with application software, Microsoft Office and Open Office packages, Google services (Google Drive, Google Keep, Google Class, Google Docs, Google Forms, Google Presentations)<br>- Electronic presentation of the project results: a text file, computer program, presentation |
| - Unity of theory and practice<br>- Application of knowledge from different subjects and their transfer to a new situation, provision of the study process unity  | - Practice-oriented projects<br>- Presence of a socially-important task<br>- Interdisciplinary project   |
| - Giving small portions of information in an easy and graphical way   | - Short-term project<br>- Use of different forms of presenting information: presentations, virtual newspapers, mind maps<br>- Modularity in presenting the project material  |

## 4 Results

Astrakhan State University teachers develop projects for training different-major students in different subjects [Kal18, Sich18, Kol17].

Let us consider a model of implementing project work in the activity approach in the system of training 1st-year BA students under the conditions of the modern digital educational environment, Chart 1. This model is implemented with 1st-year BA students of the programme 44.03.05 Pedagogical education (with two programme specializations «Physics and Computer Science») and BA programme 01.03.02 «Applied Mathematics and Computer Science» at Astrakhan State University. The authors developed and tested a set of projects, implemented during the 1st study year, Chart 1.

Interdisciplinary research project «Programmer-Researcher. Solving Practical Problems». Partial coordination. The project is held during the second semester of the 1st study year. It implies completion of 3 mini projects, each to be implemented during a month. The project is aimed at generalization, systematization, deepening, consolidation and control of knowledge gained from the subjects «Calculus», «Programming Languages and Methods», «Computer Science» and «Information Technologies in Education», development of such com-

petences as systems and critical thinking, project implementation, teamwork and leadership, communication, self-organization and personal growth (Federal State Educational Standard of Higher Education 3++, universal competences 1-4, 6), [Abz18].

All the mini projects are of the same type, but the task differs in its topic and difficulty level. The tasks, given in the project, comply with students' age peculiarities, are practical and oriented to the link between theory and practice.

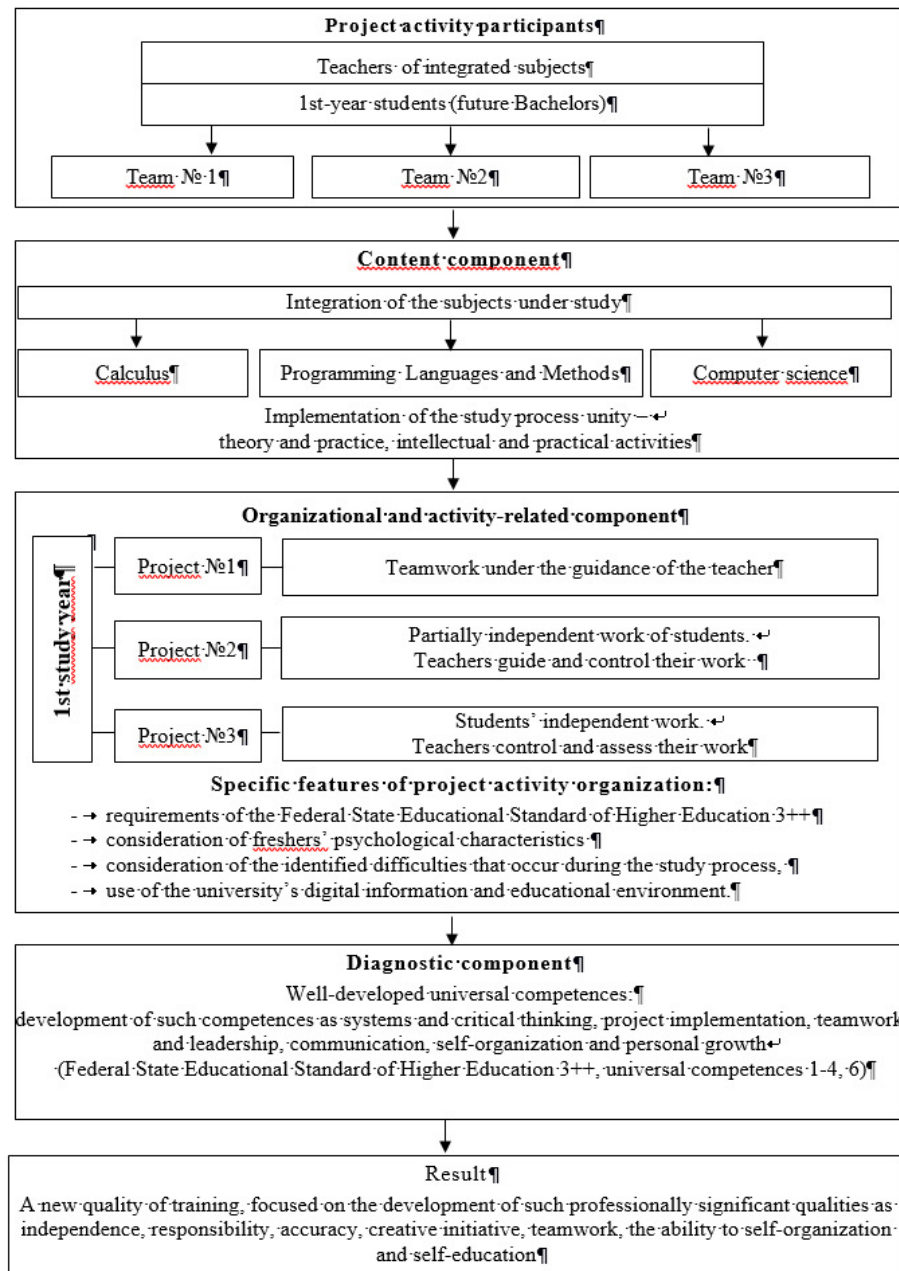


Figure 1: Model of implementation of project work in the activity approach in the system of training 1st-year BA students under the conditions of the modern digital educational environment.

Each project has clearly set tasks, criteria of result achievement and deadline.

Each level initially implies mathematical solution, then its results are used to construct a computer program; the project report is made in a text file, in the form of presentation with the use of a mind map or virtual newspaper.

Calculus implies a mathematical study on practical problems and an analysis of the results. Each next level increases the difficulty and the volume of knowledge, necessary to solve the problem, and the depth of analyzing the results [Abz18].

Project 1, zero level, topic «Function». The students consider a problem of composing a function and analyzing the results.

Example. A window has the form of a rectangle which ends at the top a) with a regular triangle, b) with a semicircle. The window perimeter is  $p$ , the rectangle base is  $a$ . Comprise a formula to calculate the window area [Ber77].

Project 2, first level, topic «Definition of the derivative, geometrical and physical meaning». For the project, it is proposed to solve a problem on composing a function and finding its limit, following the definition of the derivative, and to analyze the results.

Example. The thermal coefficient of linear expansion of a bar is increment of the value of its length under temperature increase by 1 if thermal expansion is supposed to be even. In fact, the process is uneven. Give the definition of the linear expansion coefficient and calculate it [Ber77].

Project 3, second level, topic «Finding the largest and the lowest value of the function on a line». The students consider a problem on composing a function and studying it, using the derivative, in terms of its largest and the lowest value on the line, and analyze the results.

Example. There are two peateries A and B near a floating river. Choose a place for constructing a quay C so that the sum of the distances from the quay C to both peateries A and B is the smallest.

The programming languages and methods imply program implementation of the problem. It is necessary to construct a program to solve the problem at hand in the software environment that is studied within the subject «Programming Languages and Methods». During the process of constructing a program, each new level adds structures of the programming language that must be used. Each level has additional requirements on the program efficiency, incoming (outgoing) control of the data and the code style culture.

Project 1, zero level. Using the results of the mathematical solution, construct a program for calculating the value of the window area depending on its shape. While constructing the program, use the following structures of the programming language: linearity, branching.

Project 2, first level. Construct a program to calculate the coefficient of the linear expansion of a bar at the set period of time in increments of  $h$  in cases when the bar length is a) a linear function of time, b) a quadratic function of time. The following structures must be used in the program: linearity, branching, cycles.

Project 3. At the second level, the students must use linearity, branching, iteration, cycles and sub-programs. The problem is supposed to be generalized [Abz18].

There are  $n$ -pairs of peateries  $(A, B)_1, (A, B)_2, \dots, (A, B)_n$  near a floating river. Choose places for constructing quays  $C_1, C_2, \dots, C_n$  for each pair so that the sum of the distances from the quay  $i$ , to both peateries  $(A, B)_i$  is the smallest. Display graphically the location of the peateries and quays depending on the initial data and obtained results.

Computer science is applied for drafting a project report and its presentation. All the projects include uniform requirements to making a presentation and report. Apart from the material presentation, made in PowerPoint, the students should learn and use other forms of presenting a material – a virtual newspaper and mind maps [Abz18].

#### Organization of 1st-year students' activities

One of the important aspects in organizing freshers' project activities is external control of their activities. This objective is met with project ranging by the degree of their support and learning facilitation.

- The first project contains a detailed step-by-step instruction at each stage with the description of tasks, forms of students' interaction, an exemplary distribution of roles, time limits and requirements for the results. The work is carried out under the guidance of teachers: the teacher explains in detail all the actions at each stage to the students, helps distribute roles and leads to correct results. There is a fixed schedule of consultations with 2 meetings a week. During the project implementation, the students gain teamwork and communication skills, they learn how to work with information, learning and methodological literature, get to know about the university's electronic information educational environment (EIEE), available resources for efficient learning and discover the links between the subjects.

- The second project implies partially independent work of students, like the previous project does. Teachers just guide the activities and control the results, obtained at each stage. There is a schedule of consultations with 1 meeting a week. During the project implementation, the students improve their teamwork and communication skills, skills of working with information, learning and methodological literature, the university's EIEE and

resources; they develop self-organization skills, time and resource management, consolidate and systematize their knowledge in the integrated subjects.

- The third project implies fully independent work of students; teachers advise them, if necessary, and assess the results. These are the students themselves who initiate consultations. During the project implementation, students keep improving their teamwork and communication skills, skills of working with information, learning and methodological literature, the university's EIEE and resources, self-organization skills, time and resource management; they gain self-education skills, develop proactivity and responsibility, systematize and deepen their knowledge in the integrated subjects.

Freshers find it difficult to present clear and well-structured reports, there are signs of fragmented autism. Taking into account these peculiarities, the teacher's task is to teach students how to select the material for presentation properly, to structure and present it at the stage of the project defense. Using multimedia technologies at this stage allows to form the skills of composing and presenting the learning material, to activate students' independent work [Abz18].

The combination of group and individual forms of work contributes to a better learning and understanding of educational material. The organization of teamwork in project activities enables collective assessment of the results and work processes [Tkach17]. The university's EIEE is the closest external environment for the student, a set of conditions within which his/her project activity takes place. To prepare for the project, the student can use electronic educational learning materials, available in EIEE, to get an access to e-catalogues of libraries, to databases and electronic textbooks, thus self-organizing his/her individual educational activities [Azi16].

Work on the project is organized using the Moodle learning management system. It contains the electronic resource "Project work. Programmer-researcher". It consists of sections:

- general information,
- tasks for projects,
- project results,
- forum.

Section "General Information" contains subsections:

- General characteristics of the project. There are the goal, objectives of the project, authors, coordinators and organizers of the project, its participants, forms of interaction of participants, deadlines for implementation.

- Project stages: preparatory, research, stage of mathematical solution of the problem, stage of program implementation of the project, stage of presentation and protection. Each of them describes the tasks, the interaction of participants, an approximate distribution of roles, sources of information.

- Project requirements:
  - requirements for the report, for the content;
  - requirements for the presentation of its design in electronic form, for the content;
  - requirements for the program presented in one of the programming languages: the correctness of the algorithm, the use of the indicated language constructs, the efficiency of the program, the culture of the design of the program code;
  - requirements for the design of a text document.

Criteria for evaluation. The components of the project, the criteria for evaluation, the maximum number of points, assessment are listed.

The section "Tasks for Projects" contains formulations of mathematical problems and programming problems.

Section "Project Results", fig. 1, contains subsections:

- mathematical solution of the problem,
- software implementation,
- project report,
- presentation of the project.

## PROJECT RESULTS



Mathematical solution of the problem (deadline – 25.04.2018)



Form of presentation – a text file with detailed comments.

The document must include:

- problem statement,
- mathematical model of the problem in a graphical form
- to enumerate input and output parameters,
- problem solution,
- analysis of the obtained results,
- formulae, necessary for the program construction.



Program implementation of the problem (deadline – 11.05.18)



1. Form of presentation – a live application for the problem at hand (see "Program requirements") (deadline – 06.05.2018).

2. Form of presentation – a text file (deadline – 11.05.2018):

- problem statement;
- relevance of software implementation;
- program requirements;
- stages of the software implementation of the problem (it is advisable to use a mind map);
- program listing with detailed comments;
- program testing results that prove the mathematical conclusions.



Project report (deadline – 20.05.2018)



Form of presentation – a text file (see "Report requirements")



Project presentation (07.06.2018 at 3:20 p.m.)



Form of presentation:

- a presentation made in Microsoft Office PowerPoint or OpenOffice Impress (see "Presentation requirements"),
- a virtual newspaper or a mind map.

Figure 2: Project results in Moodle.

Each stage has its own deadline, a form for presenting results. There are the materials on the results of the work are loaded by students. Section "Forum" allows you to communicate between project participants.

## 5 Discussion

The study results were discussed at the Department of the Applied Mathematics, Information Science Quality Management of Astrakhan State University, at the 3rd International Scientific Conference «Convergent Cognitive Information Technologies» and the 13th International Research Practice Conference «Modern Information Technologies IT Education» (November 29 – December 2, 2018, Faculty of Computational Mathematics and Cybernetics of Lomonosov Moscow State University, Moscow). The developed electronic resources were placed on the website of Astrakhan State University.



## 6 Conclusion

A survey was conducted among 36 students who participated in the project activities. The freshers noted that they had gained experience in:

- independent project implementation (73%);
- work with information, analysis of problems at hand and their solution (46%);
- organization and planning of their activities, optimal management of time and resources (38%);
- arguing their point of view, correct articulation of their ideas (33%);
- an ability to listen to other people (23%);
- presentation of clear and well-structured reports (28%).

They developed skills of

- communication (53%);
- teamwork (42%);
- coordination of their own and someone else's work (8%);
- team management (18%).

The proposed model of project work organization within the activity approach allows to create necessary conditions for a gradual transition from freshers' independent work, guided by the teacher, to independent planning of their activities, organization of their time during the project implementation, which causes the main difficulties in the 1st study year [Abz18]. Correctly-organized project work of freshers is one of the ways to raise their interest in professional activities. As a result, 1st-year students have become more initiative and responsible and realized their creative potential. They have developed project implementation skills.

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