Model of projects-based internship system for future mathematics teachers

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Abstract. The article presents a model of a project-oriented system for bachelor’s internships in pedagogical education; one of their teaching profiles is mathematics. The model is built on the basis of a systematic, activity-based and competency-based approach. The project activities play the central role in the internships system. It provides substantively and organizationally the other types of students’ professional activities during the internship and contributes to their formation. The article shows how the requirements for the degree of independence of students’ project activities are consistently changing in the project-oriented system of internships due to the increase in the number of project skills formed during the internship period. The authors reveal the relationship between project skills and universal and general professional competencies of bachelors. The substantive succession of internships is presented that help student to improve in the chosen subject and complete the system of projects by completing the final qualifying thesis. The article considers the relationship of the internship system with the educational environment of the university and the territory. It contributes to the development of methodological support for a project-oriented internship system.

1. Introduction
The project activities as a tool for professional training of students in the process of education at a pedagogical university have been studied quite well. However, the role of educational and manufacturing internship in organizing students’ project activities remains not fully studied. The scientific pedagogical literature notes the problems that arise in the process of students’ internship, for example, N. Stevi and D. Candra [1] indicate problems of intern-student in the evaluating the process and the result of the cognitive activity of schoolchildren. We believe that the development of a methodology for organizing project activities in the process of internship would help to overcome these problems.

2. Statement of the problem
The authors of the article consider that it necessary to create an integral system for the project activities implementation in organizing internships for future mathematics teachers from mini-projects developed by students during educational internships, to methodological projects implemented during manufacturing (pedagogical and preparation of final qualifying thesis) internships. So, the purpose of the article is to present a model of a project-oriented internship system for a future mathematics teacher (figure 1). Let’s reveal the methodological basis of the model for a project-oriented internship system.
From the point of view of a systems approach, the creation of a practice system requires identifying the interrelationships of practices and their individual components.

**Figure 1.** Model of the project-oriented internship system.
The activity approach at the forefront of the project-oriented internship system puts the formation of the professional activity of the future mathematics teacher. The project activity as a system-forming core of the project-oriented internship system, groups other types of professional activities that students develop during the internship. The role of the competence-based approach is to subordinate the goals of project-oriented internships to the requirements of the professional standard of a teacher and the Federal State Educational Standard of Higher Education 3 ++ in the Pedagogical Education direction, aimed at the project as one of the types of professional activity of a teacher. The model of a project-oriented internship system is based on a lot of years of experience in organizing students' project activities at the Physics and Mathematics Faculty of the South Ural State Humanitarian Pedagogical University [2; 3].

3. Result and discussion
The sequence of four educational and three manufacturing internships included in the system ensures the continuity of the students' project skills formation and the content of projects through the development of their subjects of research with different requirements in terms of content and complexity. Consider internships in sequence, indicating their goals, content and evaluation criteria. The first educational internship is aimed at mastering mathematical knowledge, skills, methods and project skills. During this period of the internship, students do not carry out projects, but project assignments; the internship program includes the information retrieval on applied problems, electronic educational resources retrieval and their application in investigation of functions. The choice of the content of the second educational internship on mathematics is associated with the idea that students should know the possibilities of digital technologies in order to build strategies for teaching and learning in the future [4]. A form of the task is a mini-project. I. G. Lipatnikova considers mini-projects to be universal mechanisms for the development of creative initiative and the ability to develop solutions [5]. The products that students must prepare are computer models and descriptions of computer experiments for solving mathematical problems, supplemented by a hypothesis about the mathematical properties of the objects under study and its proof. An example of a mini-project is the study in geometric environments of geometric locations of points on the plane and in space. The third educational internship on mathematics is devoted to improving students' knowledge in elementary mathematics. As an example, consider the project "Study of elementary methods for solving optimization problems". For the problem "There is a picture on the wall. Its lower end is 75 cm, and the upper end is 3 m higher than the observer's eyes. "At what distance from the wall should an observer stand to view the picture at the greatest angle?" Students find different ways of solving and come up with a continuation in the form of a system of tasks. Here we see how the content of the two previous internships is synthesized in a new project of students. At this stage, students are offered with group projects for the first time, requiring them to set a goal, draw up a plan, and assign responsibilities. The fourth educational internship (project- research) is of the transitional nature. This practice is carried out in an educational organization to study methods of teaching mathematics. Students perform a group project, i.e., development of extracurricular activities course. Students rely on mathematical knowledge gained in previous internships, the ability to use computer tools and experience in project activities. An example of the application of the projects content taking into account previous internships is conducting an extracurricular activity lesson "In the world of geometric places of points" using a geometric environment or presentation.

In educational internships, students develop universal competencies. In accordance with the tradition adopted in Russian higher education, the levels of competence formation are characterized by the descriptors "know", "is able to", "possess" and in our model are formulated in terms of project activities (table 1).
Table 1. Specification of competence "Is able to determine the range of tasks within the set goal and choose the best ways to solve them, based on the current legal norms, available resources and limitations."

| Indicator | Description |
|-----------|-------------|
| Knows     | requirements for project activities, its stages and methods of results presentation; set a goal of the activities based on a specific problem and existing opportunities (only 3 and 4 internships); organize and coordinate the work of project participants, build positive relationships in the process of project implementation (only 3 and 4 internships); justify and implement the choice of the most effective ways to solve the project's problems |
| Is able to | analyze various sources of information (electronic resources, study guides, scientific articles, etc.), form a sample from search sources; develop computer models or a description of a computer experiment (2 internships), task systems (3 internships), technological maps of extracurricular activities (4 internships); present the results of the project in the form of reports, speeches, enter into a discussion of the progress and results of the project, defend their point of view correctly and reasonably, observe the norms of public speech; |
| Possesses | make evaluative conclusions about the achievement of the project goal based on criteria and indicators, scorecards, during a group discussion of the experience of implementing educational project activities |

We have developed criteria for the formation of project skills in educational internships; for one of the skills, a description of the levels of its formation is presented in Table 2.

Table 2. Criteria for the levels of formation of the ability to analyze various sources of information, to form a sample from search sources.

| Level | Description of the level |
|-------|--------------------------|
| Low   | analyzes only those sources that are offered in the methodological instructions, the analysis performed is incomplete, the ideas of the content of the source material are not sufficiently disclosed |
| Average | compiles an additional list of references for solving the task, conducts a critical analysis of materials, but cannot transfer this knowledge to a new situation |
| High  | conducts a comprehensive analysis of selected references, can prepare an overview on the topic under study, can reveal the ideas of an article on other material |

The fifth internship in the proposed system is the manufacturing (pedagogical) internship in the fourth year. The project assumes the choice of creating electronic educational resources for one of the branches of the school mathematics course or extracurricular activities programs. The topics of the projects are interconnected with those previously presented, for example, students could choose to develop an electronic educational resource for mathematical modeling or an extracurricular activity program for solving practice-oriented problems. The form of the project is a group project. It corresponds to the idea of the need for cooperation among groups of students during pedagogical internship [6]. The sixth internship in the proposed system is the manufacturing (pedagogical) internship in the fifth year. An individual long-term project is meant for the whole period of the internship. The application of the results of project activities in previous internships can stimulate the student to choose the preparation of a cycle of lessons for solving practice-oriented problems. The last, seventh manufacturing internship (preparation of the final qualifying thesis) completes the process of studying at the university. Students carry out individual short-term projects for the preparation of final qualifying
work, for example, on the topic "Formation of functional literacy based on solving practice-oriented problems."

During manufacturing internships, students develop general professional competencies, including those aimed at developing educational programs and their individual components. The development of programs for extracurricular activities can be considered as a project; therefore, the competence is concretized as follows (table 3).

**Table 3.** Specification of competence "Is able to participate in the development of basic and additional educational programs, develop their individual components (including using information and communication technologies)."

| Indicator   | Description                                                                                                                                                                                                 |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Knows**   | requirements for the results of the educational programs and their individual components development (including the use of information and communication technologies)                                               |
| **Is able to** | set a goal and objectives for educational programs and their individual components development; form a schedule for the educational programs and their individual components development; organize and coordinate the work of intern-students working on educational programs and their individual components, build positive relationships in the process of work; analyse various sources of information (electronic resources, study guides, scientific articles, etc.), form a sample from retrieval sources; develop methodological and substantive support for the educational programs and their individual components implementation; implement fragments of educational programs; present the results of the educational programs and their individual components development, defend their point of view correctly and reasonably, follow the norms of public speech; evaluate the content and organizational aspects of the educational programs and their individual components development |
| **Possesses** | experience in the educational programs and their individual components development (including using information and communication technologies) |

We have developed criteria, for one of the skills they are presented in table 4 to evaluate the level of formation of design skills in production practices. The subject of students' project activities determines the criteria for the formation of design skills during internships.

**Table 4.** Criteria for the levels of the ability formation to develop methodological and substantive support for the educational programs and their individual components implementation.

| Level  | Description of the level                                                                                                                                                                                                 |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Low    | finds it difficult to choose methodological material, to determine the methodological goal of the assignment, cannot carry out a comparative analysis of exercises from different textbooks, has difficulties in drawing up a flow chart of a lesson, in drawing up a lesson outline; limited in the choice of presentation forms |
| Average| knows methodically how to select methodological material based on different sources, often uses templates when choosing forms of presentation, is inert to gaining new skills                                                                                   |
| High   | determines correctly the methodological goal of the assignment, understands the possibilities of supplementing the system of assignments, taking into account the individual abilities of students, is able to compose his own assignment, uses various forms of presentation of the material, focusing on maintaining the interest of students, draws up a flow chart of the lesson based on regulatory documents |
During all internships, students are immersed in the educational environment of the university. One of their main purposes is to organize the information and educational environment that provides students with access to the educational programs of the internships, to publications of electronic library systems and electronic educational resources. The educational environment of the university makes the methodological support of the project-oriented system of internships effective and accessible, facilitates their organization, leadership and control. D.A. Trishchenko emphasizes a teacher consults and evaluates the products of students' activities, approves or disapproves of the results of assignments that at each of the stages of project activities [7]. However, we hold the view that during any internship, a degree of independence of students in the implementation of projects gradually increases, so a teacher plays the role of a facilitator and moderator. This means that a role of methodological support increases from internship to internship. The structure is the same for all internships (figure 1), and the content changes in accordance with the goals and a subject of the internship. During the industrial practice, students are included in the educational environment of the territory, i.e., they are assigned to different educational organizations of the city (4th year) and the region (5th course). In accordance with the requirements of the educational environment of the territory, the topics of students' methodological projects are updated annually, and representatives of educational organizations of the territory take part in the evaluation of students’ projects.

The authors attach great importance to monitoring the formation of students' project skills while evaluating students' abilities. L.M. Kaino, considering the use of a portfolio in the pedagogical internship of future mathematics teachers, recommends a cumulative evaluating method [8]. The authors created electronic journal that helps them to track the formation of students' project skills and form the final evaluation of a student for the internship. Keeping such a journal during the implementation of the constructed model of the project-oriented system of internships will allow evaluating its effectiveness.

4. Conclusion
The developed model of the project-oriented system of practices is a theoretical construction. However, the first experience of implementing the built model in the 2019-2020 academic year showed its usefulness. The methodological support of the internship system passed empirical testing during the internship and entered the educational environment of the university. It was found that work on a project orients students towards the result, motivates them and positively affects the formation of professional skills of future mathematics teachers.

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