

# Methodical practice model of future teachers of mathematics

Tatyana Gavaza\*, Svetlana Lebedeva, and Lidiya Pavlova

Federal State Budgetary Educational Institution of Higher Education Pskov State University, Russian Federation

**Abstract.** The professional training of subject teachers should be aimed at developing professional competencies that will allow them to be successful in their field, to be professionals, ready for change, and be able to adapt to various situations. A significant element of professional training at a university is pedagogical practice, during which the student performs the subject teacher functions. However, students in practice often face such difficulties as organizing their activities and the activities of students in the lesson, allocating time to the lesson stages and observing the time schedule, selecting didactic materials, evaluating outcomes of students' activities, solving unexpected pedagogical situations, and others. Particular attention should be paid to the psychological readiness of the future mathematics teacher to work at school. Therefore, it is essential to prepare students methodically and psychologically for the implementation of primary professional activities in teaching practice. This can make it feasible to carry out methodological practice, which is a transitional stage between educational and industrial practice. The issue of organizing methodological practice is currently new. Based on the literature analysis and the experience of organizing and managing practices, the paper proposes a model of methodological practice, which is aimed at applying active teaching methods to prepare future mathematics teachers for the main activity in teaching practice, namely, preparing and conducting lessons. The model includes seven stages with tasks, describing active learning methods and student activities.

**Keywords:** professional training at the university, future teacher of mathematics, methodical practice, educational practice, pedagogical practice, model of methodical practice, active teaching methods

## 1 Introduction

Professional training of a teacher at a university includes subject, methodological and psychological-pedagogical components. Each of the components cannot be formed separately, and it is required to establish interrelations between them so that their formation is subject to one general idea – the preparation of a modern professional in the field of school education. A significant element of the professional training of a future teacher at a university is pedagogical practice, which allows the student to “try on” the role of a teacher, to work out theoretical knowledge gained in the subject, methodology, pedagogy, psychology, and other disciplines. However, the student needs to be prepared for teaching practice at school. Educational and methodological practices that allow working out the indispensable professional skills at a basic level before going to school for active teaching practice are aimed at achieving the given aims. It is essential to comprehend how to organize students' activities within the framework of methodological practice in order for them to acquire the necessary skills to work as a teacher of mathematics in the course of pedagogical practice.

## 2 Problem statement

The professional training of a future mathematics teacher begins at the university. A graduate must have such qualities, skills and competencies that will permit him to be successful from the first working days. One of the components of the professional training at the university are practices that, together with the study of disciplines, help to form competencies required for pedagogical activity.

According to the new standards in the teacher education, methodological practice precedes active pedagogical (industrial) practice with access to school; it is passive in form. The main method of immersion in the professional pedagogical sphere is observation. Besides, it does not involve active actions on the part of the student. Moreover, methodological practice should prepare the student for active pedagogical activity, which seems to be impracticable without being included in this activity. There is some contradiction in the organization of the professional training process of students – future teachers of mathematics in the course of methodological practice, which consists in the discrepancy between the organization form of methodological practice and its aims.

To solve the identified problem, it is essential to develop a model for the methodological practice implementation with the inclusion of active teaching methods, which will contribute to the activation of

\* Corresponding author: tag148@mail.ru

mental and practical activities of students through immersion in professional activity.

### 3 Materials and Methods

The organization of the professional training process in a pedagogical university can be conditionally represented as follows: subject (discipline) study – educational practice – methodological practice – pedagogical (production) practice.

Currently, the issue of organizing pedagogical practice is of concern to many researchers [1, 2, 3]. The studies examine the development of professional competencies, the implementation specifics of the university educational environment in the practice organization, professional education in the course of practice. However, the study of the methodological practice organization, which is a transitional stage between educational practice, where students are trained to be a teacher, and pedagogical practice, where students act as a teacher, is not sufficiently represented.

Consider the concepts of educational, methodological, pedagogical practice and their characteristics.

We present educational practice as an activity that is carried out as part of classroom work at a university (but may also involve access to employer institutions, for example, to a school) and is aimed at developing professional skills that are associated with the application of knowledge acquired within the framework of academic disciplines.

If we talk about the preparation of a future teacher of mathematics, then students consolidate theoretical knowledge gained in the course of studying the discipline "Methods of teaching mathematics" within educational practice. Besides, they work out the following skills: to conduct a logical and didactic analysis of educational material; select educational material on a specific topic; analyze the finished lesson plan; and design peculiar lesson notes of various types for students of different age categories. The given stage of professional training does not require immersion in real pedagogical activity, but is a compulsory basis for other practices. Passive teaching methods may prevail in the educational practice course.

Methodical practice assumes that students get acquainted with the basics and professional activity features of a mathematics teacher by observing the work of a teacher in an educational institution and analyzing this activity. There is an "immersion" in the teacher's work in real conditions. Attending mathematics lesson of a particular teacher and analyzing this lesson, the student needs to comprehend not only the lesson structure and its organization, but also to see how to work with the class, how to explain problem solving, how to behave in diverse situations. The ability to catch the listed moments must be formed. Therefore, it is substantial to discuss the knowledge and impressions gained in the course of observing the teacher activities in the classroom work, together with the head of practice and other students: to learn to analyze their work outcomes

and the activities of "colleagues"; correct the identified shortcomings, errors; respond to comments. In this case, active learning methods should prevail.

Pedagogical (production) practice involves the theoretical knowledge application and practical skills obtained and consolidated during previous practices for complete immersion in the professional activities of a mathematics teacher. During the practice, students take on the role of a mathematics teacher in the school and spend several weeks teaching in a particular class.

For successful completion of methodological and pedagogical practices, students should have the following groups of knowledge:

1. Subject (mastery of the subject they will teach).

The concern of subject training is noted in many scientific papers [4, 5], which present models of subject training for students in pedagogical areas, as well as the experience of identifying and overcoming subject deficiencies. We also believe that a future mathematics teacher should have a high level of subject knowledge.

The disciplines studied at the university have a great impact on practice efficiency at school, both in terms of their content and well-thought-out sequence in a curriculum, but the given issue requires particular research.

In the course of creating a model of methodological practice, the curricula analysis for the bachelors' preparation 44.03.05 Pedagogical education (with two training profiles), profiles of "Computer Science and Mathematics", "Mathematics and Physics" has been carried out. Methodological practice is implemented in the mentioned areas in the 6<sup>th</sup> and 7<sup>th</sup> semesters. By the 6<sup>th</sup> semester, students complete the study of psychological and pedagogical disciplines that are included in the general professional module, as well as the disciplines of the project module. By the first passive practice, students have already studied the general methodology of teaching mathematics and, in parallel with the internship, study private methods. University mathematical disciplines are partially studied, such as mathematical analysis, algebra and number theory, and geometry. From the 5<sup>th</sup> semester, the study of elementary mathematics begins, which is included in the subject module. Besides, such disciplines of the special module as the history of mathematics, introduction to game practice and gamification have already been studied. Therefore, we can conclude that students have the required theoretical background for the first acquaintance with professional activities of a teacher.

2. Psychological and pedagogical (involve the ability to organize educational process, manage it, resolve various situations, knowledge of age characteristics, and others).

It is crucial for future teachers to be psychologically prepared to perform pedagogical activities and possess the knowledge and skills that will allow them to manage and correct the learning process of schoolchildren. The paper [6] reveals the issue of psychological readiness of students to go to school and teach their subject. There are also studies [7], which consider the psychological and pedagogical aspect in the practice organization of future teachers.

3. Methodical (ability to teach a subject).

If a student knows the subject perfectly, but cannot explain it to schoolchildren, then this is not the teacher that a school expects today. A students' survey of 10-11 grades of one of the schools in Pskov revealed that in the first place (80%), potential consumers of educational services put knowledge of the subject and the ability to explain it in an accessible way, and teach it in the classroom. The given result confirms the significance of high-quality methodological training of a contemporary mathematics teacher, the need for early immersion in the teaching profession

The existing experience of organizing passive methodological practice for future mathematics teachers at Pskov State University indicates that if students simply attend mathematics classes at school and complete assignments (lesson analysis, construction of lesson notes, etc.) without being actively involved in the process, without discussing completed assignments, then it does not bring the desired effect. Therefore, it is indispensable to organize passive practice applying active teaching methods, create a system of such tasks being aimed at methodological, subject, psychological and pedagogical training of students with the leading role of a mathematics teacher. One of the reasons for the passive practice ineffectiveness is not only its organization by the university, but also the fact that teachers are generally not interested in providing students with methodological skills, and simply offer an opportunity to observe the learning process of schoolchildren. In this regard, it is necessary to include a teacher of mathematics in the professional training process of a student in the course of methodological practice.

One of the main components of the teacher's professional activity is to conduct a lesson. According to the survey, students experience the greatest difficulty at this stage, when entering the pedagogical (production) practice and working as novice teachers. Meanwhile, one is able to prepare for this activity type, it can be "rehearsed" in advance in the course of methodological practice, if one of its main goals is to prepare students for conducting lessons on the subject.

The formulated purpose determines the objectives of methodological practice, their content and the implementation model.

Objectives: in the course of practice, it is required to work out the skills to arrange a lesson, plan a lesson on a subject, choose means and methods for conducting lessons of various types, select and design methodological and educational materials, conduct a lesson, and analyze it.

The methodological practice outcomes should be workable, in order for students to apply them in teaching practice, for instance, high-quality notes (scenarios) of lessons, a bank of tasks on a particular topic, a set of teaching materials, a portfolio, a project, and others, depending on offered assignments by the head of practice.

The methodological practice model in the subject (mathematics), includes several stages:

1 stage. **Learning the teacher's experience**

Assignment: attend a mathematics lesson, observe the work of a teacher, analyze a lesson.

Active learning method: analysis of a particular situation (professional activity), through specially designed forms. Forms differ in structure and content, depending on the lesson type (a lesson in studying new material: studying concepts, theorems, properties, etc.; a lesson in consolidating knowledge; a lesson in testing knowledge; a lesson in repetition and systematization of knowledge, etc.).

Student activity: observes; having determined the lesson type, selects the appropriate form; fill it in during the lesson; supplements with the necessary information after the lesson; conducts an analysis of the teacher's activities on the basis of the gained information; draws conclusions about the possibility of applying teacher's experience in their activities.

An exemplary structure and the form content for monitoring and analyzing the teacher's activities in the lesson are below:

1) **Lesson protocol**

School \_\_\_\_\_,  
 Classroom \_\_\_\_\_,  
 Teacher \_\_\_\_\_,  
 Date \_\_\_\_\_,  
 Lesson topic \_\_\_\_\_,  
 Lesson type \_\_\_\_\_.

Lesson stages, time	Content of the teacher's activity	Content of students' activities	Notes, comments
Warming-up, 2 minutes			
...			

2) **Sample scheme of lesson analysis**

1. Lesson place in the system of lessons on the topic based on thematic planning.
2. Purpose of the lesson \_\_\_\_\_.
3. Forms and methods of bringing the goal to students: \_\_\_\_\_.
4. Achievement degree of the set goal (fully achieved, partially achieved, not achieved).
4. Lesson structure:
  - lesson structure rationality as a whole;
  - rationality of each of the structural elements (stages) of the lesson;
  - rationality of lesson time distribution.
5. Mathematical content of the lesson:
  - concepts, theorems, algorithms introduced in the lesson;
  - methods for solving examples, problems, equations, conducting proofs, practiced in the lesson;
  - content relevance to the abilities of students;
  - logical, scientific, accessible presentation;
  - content connection with life.
6. Methodical side of the lesson:
  - concept formation method;
  - methodology for working with a theorem;
  - problem solving method;
  - methodology for the formation of skills.
7. Organization of the lesson:

- methods, techniques, teaching means;
  - compliance with their features of the topic, class;
  - application of teaching means;
  - organization of independent work of students;
  - methods, forms and means of assessment.
8. Students in the lesson:
- demonstrating interest in the lesson;
  - classwork, activity;
  - response to teacher assessment.
9. Teacher in the lesson:
- level of pedagogical requirements for the students' work, and development of their speech and thinking;
  - teacher's speech;
  - style of behavior;
  - style of interaction with students.
10. General conclusions on the lesson, reflection.
11. My questions about the lesson.
12. Valuable experience (knowledge gained in the lesson for my future pedagogical activity).

The presented lesson analysis scheme is general and is specified for a particular type of the lesson.

#### 2 stage. **Designing a lesson script**

Assignment: develop a detailed lesson plan (script) of the type that the student has attended and analyzed.

Active learning method: modelling of probable professional activity in the process of self-creation of the lesson script. Meanwhile, a detailed script is written according to the proposed model applying gained experience when visiting the teacher's lesson, the required materials are worked out for the given lesson. The lesson topic is chosen due to the theme that has been presented before.

Student activity: conducts a logical and didactic analysis of the lesson topic; selects, develops materials for the lesson; creates a detailed plan of the lesson.

#### 3 stage. **Discussion of outcomes**

Assignment: be divided into groups according to the evolved lesson type, briefly present the plan in the group, talk about the features, planned methods and technologies of work, answer questions from group members, note the shortcomings and advantages of the presented plan (script) of the lesson, offer options for resolving the announced comments, conduct an examination of the lesson plan, highlighting the shortcomings.

Active learning method: group form of work, in which the practice head organizes a discussion, can participate in it, ask questions, suggest possible options for correcting the identified shortcomings.

Student activity: participates in the discussion of the presented lesson notes, asks questions, defends the point of view, draws conclusions.

#### 4 stage. **Improving the lesson script**

Assignment: complete (improves) the plan (script) of the lesson after discussing it in the group.

Active learning method: re-modeling of feasible professional activities in the process of independent revision (reworking) of the lesson plan.

Student activity: independently finalizes the lesson, considering comments and suggestions after discussing the plan. It may be required to select or create

supplementary materials for the lesson and rewrite (make changes) the script.

#### 5 stage. **Expert review**

The developed lesson plan with all methodological materials is given to the teacher of mathematics or the methodologist of the school in which the student is undergoing practice to evaluate it. Peer review is carried out according to the model proposed by the head of practice.

Assignment: after the examination, completes (improves) the lesson plan (script), considering the comments and suggestions which are made by the teacher (or methodologist) for its further enhancement.

Active learning method: re-modeling of probable professional activities in the process of improving the lesson plan.

Student activity: independently completes the lesson script, considering the comments and suggestions after the evaluation of a professional.

#### 6 stage. **Gaining practical experience**

Assignment: if possible, conduct a lesson on the school developed topic.

Active learning method: practical activity (implementation of the developed lesson plan).

Student activity: conducts a lesson according to the developed script in the presence of a teacher or a methodologist, head of practice; participate in class discussion.

#### 7 stage. **Public performance**

Consistent and repeated work on the lesson plan provides high-quality methodological developments that can be presented by students at events of scientific and research and project nature.

Assignment: arrange practice materials in the form of methodological elaboration, present them in the form of a report, theses, and articles at conferences, competitive events, for instance, "Open Lesson", "Festival of Future Teachers of Mathematics", and others.

Active learning method: work on the publication text; public speaking; participation in the discussion.

Student activity: outcomes' approbation of primary professional (pedagogical) activity.

The model for the implementation of methodological practice proposed and described in the paper differs from those previously used with the inclusion of active teaching methods in it, which are aimed at preparing future mathematics teachers for the performance of professional activities of a subject teacher in pedagogical practice. It can be supplemented with other tasks that are associated not only with the methodology of teaching mathematics, but also with other university subjects, for instance, the task of developing a mini-project in the field of education; the task of creating methodological recommendations for the study of specific topics; research assignment in the history of mathematics. Pedagogy and psychology assignments are also beneficial.

## 4 Discussion

The proposed model of methodical practice is cyclical and involves seven stages. At each stage, active learning methods are applied, such as: conscious work according to the template; lesson plan development; presentation of the developed lesson; group work; discussion; conducting a lesson; participation in competitive events, which is a feature of the suggested model. Consistent implementation of all stages of the model can contribute to the formation of a primary positive experience in the professional activity of future teachers of mathematics. Besides, the practice model can be transferred to any subject area.

The implementation of the developed model is planned on the basis of Pskov State University in the 2022–2023 academic year.

## 5 Conclusion

The methodical practice model allows students to develop and improve lesson plans for various types of lessons, conduct some lessons and gain sufficient practical experience in preparing for the lesson. The application of active teaching methods contributes to the formation of a more responsible attitude to the design of lesson plans of various types, the analysis of shortcomings of the developed lessons, the creation of educational and methodological materials for the lesson, the use of interactive forms of learning. In the course of the model implementation of methodological practice, the future mathematics teacher interprets the primary professional experience gained, develops the ability to see basic elements of the teacher's activity in preparation for the lesson, analyze own outcomes and exterior professional activities, and correct and improve the results of activities. The mentioned skills will allow feeling more convenient and confident in teaching practice.

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