# Interactive Methods as the Way of Forming the Research Competence of Future Math Teachers

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**Abstract**: The article presents the use of interactive methods as the way of forming the research competence of math students. Contemporary school is needed for a creative educator and researcher who have innovative teaching methods. The training situation analysis of the future math teachers shows that their teaching methods give undue attention to the formation of research competence among the students that does not correspond with society's demands for a competent specialist. The aim of the study is to develop methods of using the interactive methods for forming research competence for the math students in the "Math Teaching Methods " training course. The following research techniques were used in the study: theoretical analysis of a problem, literature review, observation, questioning and testing. As a result, the students showed independence performing their project works on the topic of "Developing mathematical literacy of 5-9 grade pupils", "The project method as the way of forming research abilities among the pupils" and actively participated in the scientific conferences. The technique of using interactive methods such as the case-method, the analyses of practical situations and their application in the practicum of the "Math Teaching Methods " (MTM) course had been developed during the study.

**Keywords:** research competence, professional activity, interactive methods, university education.

## Introduction

Today there is a new challenge for the higher schools - to educate a new generation of pedagogues and researchers which will be focused on the needs of innovative knowledge economy. Therefore it is vitally important to teach students the techniques of obtaining and processing the scientific information by their independent research practices within the competence approach. N.A. Nazarbayev (Назарбаев, 2012) stresses that institutions of higher education should not be limited to their educational functions. It is critical for them to develop their research activities actively.

In that context, forming of research competence in the field of future teachers' work is one of the most important goals of all modern teacher education programmes.

The current transition to the common European Education System places a responsibility on pedagogical science on forming a competent teacher and researcher who will have the technique for development the students' cognitive ability and their creative use of the knowledge acquired in any education and real-life situations. The future teachers with creative thinking skills are likely to be educated through the involvement of their students in the academic research work. However, the level of research skill formation in the conditions of pedagogical university has not fully met the current requirements and the tasks for modernization of higher pedagogical education. The targeted formation of research competence among the students requires implementation of modern teaching methods and modes of study in the educational process of higher educational institutions.

However, the common educational practice does not facilitate a full motivation of the research orientated training of the future teachers which will result in the need for searching the ways for implementation and development of the new methods of forming their research competence.

That way, there is a contradiction between the necessity to use innovative math teaching methods and a lack of the appropriate studies of development and implementation the new techniques for forming the research competence of the future teachers in pedagogical university conditions. The contradiction revealed creates the problem of developing and implementing interactive teaching methods for the formation of research competence among the future math teachers. The interactive teaching techniques are presented in the different fields of the scientific knowledge and studied by a great many of pedagogues and psychologists. However, the methods for formation the research competence of the students is understudied which explains *the timeliness* of the topic.

*The subject of the study* is the usage of interactive methods for forming research competence of the math students. *The objective of the study* is to substantiate how to develop a methodology for the use of interactive methods for formation the research competence among the math students during the "Math Teaching Methods " (MTM) course.

## Methodology

To achieve this, the following hypothesis was put forward: if the training in the MTM will be conducted in accordance with the established methodology based on the use of interactive methods, then research competence of students will increase and provoke the development of mental activity of students.

The experimental work was organized with the aim of forming of research competence of students (third year). The educative process was carried out with the help of Educational-Methodical Complex (EMC) which provided the abstracts of lectures, questions for testing and conducting examinations and the tasks for each student's practical and independent work. There were 18 students in the experimental group and 21 students in the control group. In both groups the classes were taught by traditional and innovative methods in the computer classroom with an interactive whiteboard. The educational conditions were created in the experimental group for forming the research abilities of the students. The results of the students' independent works (SIW) and testing were assessed each odd week of the semester, the rating control was held on the 7th and 14th week and an exam was conducted on the 15th week. Further the students took their first teaching practice at schools. The educational work of the students during their practice was evaluated every week.

At the end of the teaching practice the practice teachers were interviewed and questioned on their educational work and their formation of research abilities among the pupils and after that there was a final conference. To show the effectiveness of using interactive teaching methods after three semesters the students' works were examined during their teaching practice. The students together with their pupils solved non-routine tasks and showed their ability to arrange the learning activities of the students. The students from the experimental group showed the higher results in their test review works and their skilful ability to prepare essays, reports and presentations and to write non-routine tasks. The students performed their project works on the topic of "Developing the math literacy among the 5-9 grade pupils" (Group 1) and "The project method as the way of forming the research abilities among the pupils" (Group 2) which gave the specific results and are ready for their implementation into the teaching practice. The result of the first project was the applied problem systems prepared by the students and of the second one was making reports by the students at the conferences. The students actively participated in the scientific conferences. Yergeshova Aidana, the 4-year student, took the 1st place at the International Conference - 2016.

## Results and discussion

The research works of G.T. Aleksanova and S.A. Aleksanova (Алексанова, Алексанова, 2016), V.S. Yelagina (Елагина, 2012), A.M. Derkach (Деркач, 2012), G.N. Lobov (Лобова, 2000) are devoted to the study of research competence. Theoretical understanding of the competence approach is reflected in the works of V.N. Vvedensky (Введенский, 2003), E.F. Zeyera (Зеер, 2003) and A.V. Hutorskoy (Хуторской, 2003). The works of M.A. Choshanov (Чошанов, 1996) are devoted to the problem of modular education. G.L. Ilyin (Ильин, 2009) investigates the project-based education technology and S.N. Lukashenko (Лукашенко, 2011) the topic of multilevel preparation of the economics experts. The analysis of scientific and methodological literature has shown that the techniques used for math teaching give inadequate attention to the problem of forming the research competence, and there is not a methodology developed for its formation yet.

The research activity of the students must be oriented to the formation of their research abilities and skills as a universal way for the reality awareness, development cognitive motivation, acquisition of knowledge about the methods and techniques for understanding the reality and getting new knowledge which will be significant for the students (Алексанова, Алексанова, 2016).

The research competence is defined by us as a complete, integral characteristic of a future math teacher's personality which is shown through his/her readiness to take an active creative research position towards the teaching math activity and which also allows obtaining the best research results (Kaskatayeva,

Tastanova, 2015). Also the pedagogical conditions for forming the research competence among the future math teachers of pedagogical university were previously revealed (Kaskatayeva, 2014).

This paper presents the interactive teaching techniques as the way of forming the research competence for the future math teachers.

The research methods of the students in a higher teacher education system can be considered as a system of interaction between teachers and students with account of their abilities and inclinations which is aimed at forming and developing the research competence.

Over the past ten-year period the interactive forms and methods of teaching math in MTM course have been widely used at the Department of Mathematics of Kazakh State Women's Pedagogical University. From the variety of interactive teaching forms and methods developed in the field of didactics there can be selected those that best take into account a specific character of the subject and can be successfully applied in formation the research competence among the students.

The interactive teaching techniques include interactive lecturing, the case-method (analysis of the specific practical situations), the method of projects, didactical and role-playing games, discussion and the method of "brainstorming."

Interactive forms of education are the dialogic teaching method; group work; joint activities of the students aimed at solving the tasks of non-deterministic nature; and laboratory work (Выготский, 1982).

Interactive (where «inter» - mutual and «act» - to act) teaching model is carried out in conditions of constant, active interaction between the students themselves and their teacher and environment and provides for some joint activities of the students. In this case a student and a teacher are the equal members of an educational process. Note that in the recent research interactivity is also thought of as an interaction with a computer and via a computer (Давыдов, 1996). An interactive teaching model creates a significant change of a teacher's role in the learning process, from the source of knowledge and information the teacher turns to an assistant and advisor, organizer and a training coordinator.

The content-related part of a subject learnt as well as a form of giving an assignment is also undergoing a change. The focuses in formulation the purposes to fulfill the tasks and solve the problems are moved from consolidating the knowledge and skills obtained towards setting the new goals and consideration the new problems (Деркач, 2012).

Depending on the content studied there can be used the round table method, the competitions of practical works with their further discussion, trainings, process and situation simulation, discussion of special videos, including a record of own actions, methods with the use of computer technology and a skillful combination of traditional and innovative tools, forms and methods of education.

The choice of forms and methods of education used in the learning process depends, first of all, on the level of personal qualities and abilities of a group's members, activity of the group, the specifics of a particular course and a content of an educational material.

G.N. Lobova identifies two levels of the research competence: the Educational Research Competence (ERC) and the Scientific Research Competence (SRC). G.N. Lobova believes that the educational research competence of the students should involve a student's ability to set up the problem, analyzing the information existing in advance, and conditions, methods and planning the pedagogical experiment (Лобова, 2000).

The scientific research competence also includes the students' active efforts which enable them to acquire necessary creative research skills and is completed with a student independently solving the tasks and problems already developed in science.

A.K. Markova defines three main component parts in the structure of educational work, including 1 - motivational oriented component (orientation in the environment, setting goals and objectives and the emergence of motives); 2 - performing component (implementation) and 3 - control and the estimated component (result) (Маркова, 1994). In the first stage a teacher formulates the educational goals and objectives (in any type of activity), in the second stage he/she chooses the relevant pedagogical tools for their implementation and in the third stage he/she analyzes and makes assessment of his/her own actions.

In formation of students' research competence an activity approach to learning becomes of particular relevance and involves the formation of students' research thinking abilities in providing of motivational incentive and orienting research activities.

*The activity approach* is focused on the mastery of approaches to a professional activity. The personal activity approach is based on the psychological works of L.S. Vygotsky (Выготский, 1982); A.N. Leontiev (Леонтьев, 1983); S.L. Rubinstein (Рубинштейн, 2002) and V.V. Davydov (Давыдов, 1996). A person in these works is considered as the subject of the activity which determines his/her personal development through his/her own activity and communication.

An activity is characterized by the common essential properties and a single scheme where the presence of the required components such as purpose, motive, content, methods and the results provides the result sought by a student.

According to the personal activity approach the purpose of education is formed in terms of the activities where the problem is a situation in which you need to achieve a certain goal; an activity itself is the process of achieving the goal, and an action is the way of carrying out the activities (Мамыкина, 2009).

A personal activity approach on the practical and laboratory sessions of the "Math Teaching Methods" (MTM) course is implemented when the action is one of the case-study interactive methods. A case study (in English - Case-study, in German – Fallstudie) is analysis of specific practical situations. This method means transition from knowledge accumulation method to an activity or practice-oriented method with regard to the real activity of a manager to the approach. The purpose of this method is teaching students to analyze information, identify key issues, choose alternative solutions, evaluate them, find the best option and formulate the action programs.

In the analysis of specific situations it is particularly important to combine individual work of students with the problem situation and a group discussion of the proposals prepared by each member of the group. This allows the students to develop their group or teamwork skills, which expands the opportunities for solving common problems within the educational subjects studied. As a result of the analysis and discussion the students are able to develop analytical and planning skills. Development of practical situations may be in two ways, including 1- based on the description of real events or actions or 2- on the basis of artificially constructed situations.

While studying a particular situation and analyzing a case study a student must understand the situation, assess it and determine if there is a problem in it and what is its core, and determine his/her role in solving the problem and develop his/her own rational strategy.

A case study method can be divided into the following stages: preparatory, introductory, analytical and final.

In the first stage a teacher specifies goals and develops an appropriate "particular situation" and scenario of a lecture.

While developing it is important to consider a number of strong requirements:

- an example of situation must be a logical extension of the theoretical course content and meet future professional needs of today's students;
- the complexity of situation must include the level of students' opportunities and create the desire to cope with it and experience the feeling of success;
- the content must reflect the real professional situations not fictional events or facts;
- students must be provided with clear instructions on a particular situation.

In the second stage students are involved in a lively discussion of a real professional situation. Since the analysis of a particular situation is teamwork then it is preferable to solve the problem the in the form of open discussions. The important point is the development of cognitive activity and adoption of other students' solutions without any prejudice. This allows the students to develop their ability to analyze work-related situation and make their own decisions.

The use of a case study method in a practical of the Math Teaching Methods (MTM) course is shown in the following example.

*Topic: "Teaching maths through the problems*"
I. *Preparatory stage*. Review the topic of "Polygon area".
II. *Introductory stage*. Introduction to particular situations.

Check a SIW task: a student must independently create and solve the applied problems taken from his/her life experience and choose the most relevant among them. The problem of constructing a separate house for the student called Lunara has been chosen.
The research thinking process is drawn according to the following flowchart: a situation ⇒a problem ⇒modelling solutions ⇒getting a solution.

Description of the problem No.1. A workman was offered a task to cover the roof of the house which was under the construction (Figure 1). Taking the measurements, the workman calculated that the roof's height (h) is 4 m, the length of the house (a) is 12 m, the width of the house (b) is 6 m and the length of the ridge (c) is 6 m. Please, calculate the amount of tiles (Figure 2) required for the task accomplishment (in sq.m.).

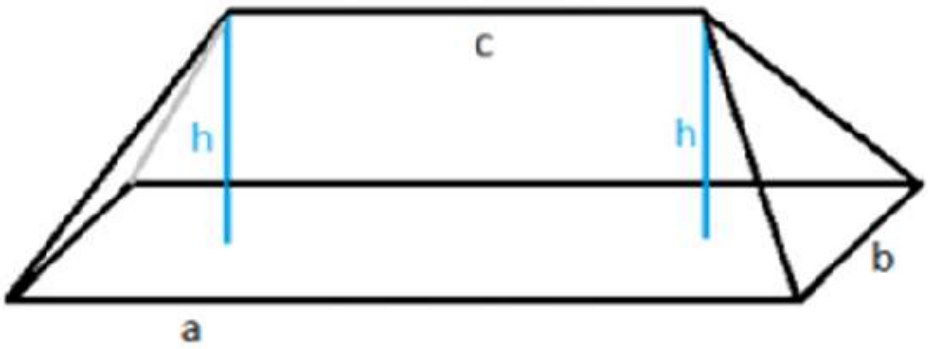


Figure 1. A house roof's model.

Figure 2. House roof under the construction.

Motivational incentive activities and orienting research activities are arranged for students. The problem introduces the formation of the students' ability to research thinking. Thus will result in the following:

- involvement of students in a live discussion of a real life situation;
- identification of problem signs (the problem must be stated clearly, precisely and in a concise way);
- group discussion of the terms and scenario of solving the problem.

How can the discrepancy between the calculating area of an unusual shape and the amount of the tile be adjusted? Are there any missing elements in the problem's statement? It was revealed that the tile size was absent. Supposed that the tile size is 0.8 m; 0,4m.

III. Analytical stage:

- to consider different tactics for solving the problem;
- alternatives and their justification.

*Problem solution*. As can be seen from (Figure 2), the roof of the house consists of two isosceles trapezoids and two isosceles triangles that is needed to know the formula for determining the area of trapezoid and a triangle. To calculate the areas is needed to insert additional symbols (Figure 3).

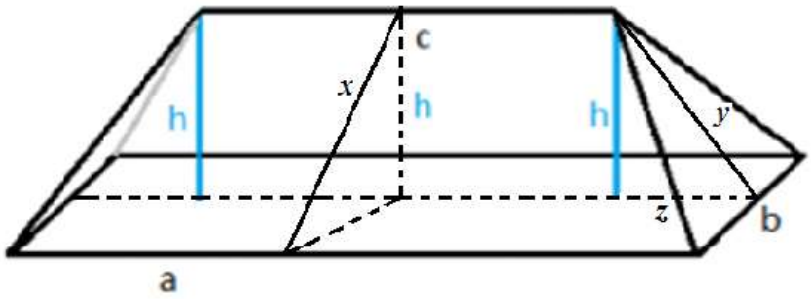


Figure 3. The solution of the house roof under the construction after the measurements.

The trapezoid's area:

$$S_m = \frac{a+c}{2} \cdot x \qquad (1)$$

The triangle's area:

$$S_\Delta = \frac{b \cdot y}{2} \qquad (2)$$

First, find *x* by virtue of Pythagoras' theorem:

$$x = \sqrt{h^2 + \left(\frac{b}{2}\right)^2} \qquad (3)$$

By Pythagoras' theorem also find *y*,

where $y = \sqrt{h^2 + z^2}$, $z = \frac{a-c}{2} \Rightarrow y = \sqrt{h^2 + \left(\frac{a-c}{2}\right)^2}$ (4)

With the formulas (1) and (2) calculate the areas of trapezoid and the triangle by inserting numerical values from the problem's statement:

$$S_{mp} = \frac{12+6}{2} \cdot \sqrt{4^2 + \left(\frac{6}{2}\right)^2} = \frac{18}{2} \cdot \sqrt{16+9} = 9 \cdot 5 = 45 \text{ (m}^2\text{)};$$

$$S_\Delta = \frac{6}{2} \cdot \sqrt{4^2 + \left(\frac{12-6}{2}\right)^2} = 3 \cdot \sqrt{16+9} = 3 \cdot 5 = 15 \text{ (m}^2\text{)}.$$

Calculate the required volume of the tile in sq.m, it is necessary to calculate total area of the roof:

$$S_{\text{общ.}} = 2S_\text{т} + 2S_\Delta \ (5) \text{ (m}^2\text{)}$$

$$S_{общ.} = 2 \cdot 45 + 2 \cdot 15 = 90 + 30 = 120 \text{ (m}^2\text{)}$$

If the tile size is 0,8m; 0,4m., then the amount of the tiles required is 120: (0,8 0,4) =375.

The answer is 120 m2 or 375 roof tiles.

IV. Final Stage:

- analysis of the solution;
- initial objectives and feasibility of their implementation.

This problem is of topical and applied nature. Preparation and solution of this problem requires research actions, mathematical modeling and creative activities as a result of which the students will learn how to creatively use the knowledge acquired in any educational and life situations.

In the same manner, we have developed and implemented the other interactive methods of teaching math. So, from our observations and the lessons learnt we have concluded that the joint activity of the students in the process of their learning and acquisition of learning materials means that each individual

brings their own special contribution, and there is an exchange of knowledge, ideas and work methods between them. Moreover, it happens in an atmosphere of goodwill and mutual support which allows them not only to acquire new knowledge, but also develops their research skills. This is the way of developing the research abilities among the students and high school pupils through them as well.

Development of educational research competence is a necessary basis for the development of scientific research competencies. The indicators showing development of the research competence among the students of pedagogical university are their generated research knowledge and skills.

The positive results of the research conducted require carrying out *further* research activities in this direction, development, introduction of innovative methods and techniques into the other university math disciplines in order to jointly solve the problems and complete the experimental work.

## Conclusions

This article contains the technique of using interactive methods such as the case study method (analysis of the specific practical situations). For the first time the paper suggests using interactive methods in learning the MTM course to solve the problem of development the students' research competence. As a result of application the developed technique the students showed the independence when carrying out their project works named "Development of maths literacy among the 5-9 grades pupils " and the "Project method as the way of forming the research abilities among the students" which implementation gave a specific result that is ready for introduction into the teaching practicum. The first project resulted in the applied problem book prepared by the students for the development of scientific kind of thinking. The second project resulted in the reports and presentations delivered by the students at conferences and submitting the final results in the form of methodological recommendations. The students from the experimental group showed their independence, search skills and exploratory behavior while performing their individual tasks. They also took an active part in scientific conferences. Now it can be seen that the research activity was arranged for students in the practicum of the MTM course by using interactive teaching method. The students have not only acquired new and significant knowledge and the research skills but also the knowledge of the methods and techniques of understanding the reality. We came to the conclusion that the targeted use of interactive forms and training methods facilitate the development of research competence among the students as one of the leading competence in the structure of teacher's readiness to his/her professional work.

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