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Exploratory learning in the mathematical classroom (open-ended approach)

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This paper explores the possibilities of the organisation of research projects by pupils in the Secondary school when the open-ended approach is utilized.

Keywords: Exploratory learning, open-ended approach.

RATIONALE AND BACKGROUND

Exploratory learning has been often used in the mathematics teaching practice in Russia, typically, using the form of project (Shatskiy, 1989). As a result of the preliminary research, our interest focused on the open-ended approach to mathematics teaching that appeared in Japan in the 1970-s and was developed in the next decades (see, e.g., Becker & Shimada, 1997; Nohda, 1991). Essentially, this method was based on the use of problems with multiple solutions. After studying the philosophy of this approach, as well as its didactic opportunities and similar Russian practices, we developed a methodical system of using open-ended problem approach for lessons of mathematics in the secondary school. The goal of this study is to check the effectiveness of the exploratory learning based on the open-ended approach in the mathematical classroom.

SETTING AND METHODOLOGY

We created a toolkit consisting of two blocks: a methodical manual for teachers and a booklet for pupils. The methodical manual contains practical guidelines for using open-ended tasks in classes, a set of tasks for pupils of different age, examples of assessment systems, and instructions for composing open-ended tasks. The booklet for pupils is intended to assist in developing their metacognitive awareness.

Some of the important stages in the lesson preparation coming from the experience of schools using ex-

ploratory learning approach in their practice should be mentioned: 1) solving open-ended tasks cannot be used more often than once a week, 2) at the same time such an activity will not be of any use if research assignments are not used at least once a month.

Also, it is necessary to decide if the exploration is to be done by the entire class acting as one group or the class is to be divided into groups.

The experiment has been carried out during three years. The first phase of research included the design of the format of classroom work, and the identification of the indicators to be controlled, as well as the development of teaching materials. The second (main) phase of the experiment began in the fall of 2012 in a secondary school in Moscow, in three grade 5 (12 years old pupils) classes, and was continued in those classes up to grade 7. One class (N=28) formed an experimental group, and two others (N=45) a control group. The objectives of the research project were:

- 1) to clarify possibilities and ways for using open-ended approach;
- 2) to examine how pupils' problem solving ability develops in response to the changes of teaching methods;
- 3) to reduce pupils' mathematical anxiety.

Before the beginning and at the end of the experiment, teachers' and pupils' opinions about methods of teaching mathematics have been collected using questionnaires and interviews (that are presented on the poster). At the second stage of the experiment, about 20% of lessons in the experimental group (a lesson once a week) were devoted to open-ended tasks.

FINDINGS AND DISCUSSION.

Summarizing the results of the study, we observed the following changes indicated by the responses to the questionnaires before and after the main stage of the study:

- increase of students' engagement in the classroom;
- progress in acquiring the experience of applying mathematics to real life;
- stable positive dynamics of improvement of research competences;
- improvement of the psychological climate in a classroom;
- changes in the role of a teacher as a participant of the educational process in a classroom;
- acquisition of skills of team work.

Some important questions still require further research. In particular, our further research will focus on the development of detailed recommendations for teachers for using open-ended tasks in their practice, and for preparing worksheets with opened-ended tasks for pupils of different ages. Changes in teachers' beliefs and practices seem to be crucial.

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