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Teaching prospective mathematics teachers to solve non-routine problems

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This paper explores different ways of teaching pedagogical universities' students to solve various types of non-routine mathematical problems.

Keywords: Problem solving, teacher education.

RATIONALE AND BACKGROUND

The rationale of this paper is to describe a new experimental course in solving non-routine mathematical problems developed for prospective mathematics teachers. The course was based on the genetic approach combined with G. Polya's principle of consecutive phases and also with principles and rules developed by Soviet tradition of fostering problem-solving abilities. The creation of the course as well as the study of its results was guided by the following questions:

- 1) How new course will improve problem-solving skills of students?
- 2) How students' views of mathematical problem solving will change?

George Polya (1981, I, p. xii) emphasized that prospective mathematics teachers should be specially taught to solve mathematical problems. "...The solution of a non-routine mathematical problem is genuine creative work". Moreover, he indicated the importance of the discussing methods of solving problems in the classroom. However, as Abramovich & Brown (1996, p. 323) rightly mentioned, "traditional teacher training courses have offered little if any engagement in exploratory mathematics". Furthermore, non-routine mathematical problems now constitute the essential part of the Uniform State Examination in Mathematics for secondary school graduates (tasks C1-C6). The aim of this paper is to describe the experience of teaching prospective secondary mathematics teachers to

solve non-routine mathematical problems including Olympiad problems and problems C1-C6 of the Unified State Examination in Mathematics. The new experimental course in solving non-routine mathematical problems for prospective mathematics teachers conducted with a group of 4-th year mathematics major students at the Moscow City Pedagogical University will be discussed.

SETTING AND METHODOLOGY

In our course, we used genetic approach (Safuanov, 2004). In particular, having solved a problem, we gradually establish its connection to some fundamental mathematical theories. For example, considering naturally arising problem of Konigsberg bridges, we arrive to the important mathematical theory of Eulerian graphs. G. Polya (1981, II, p. 133) wrote that "the genetic principle may suggest the principle of consecutive phases".

The principle of concentrated teaching (Safuanov, 1999) manifests itself in our course in several directions. Knowledge of some mathematical topics was deepened. Some simple problems serve for the anticipation of more complex problems and mathematical theories. Many problems serve not only for the raising of the interest to studies (due to their entertaining character) but also promote the acquisition of new theoretical knowledge because they are connected to modern mathematical theories – one can say that the combination of pedagogical functions was achieved. Finally, the "linkage" and "connections" were systematically used: one interesting problem led to other, in some way connected with the former; thus the chains of problems were considered. For example, we offer chains of problems on weighing coins, chains of problems on quad paper etc. It is important to tell student teachers about more general approaches, using the psychological characteristic of the process of problem

solving. The new course was implemented within an undergraduate curriculum for a group (N=18) of 4-th year mathematics major students. Before the beginning and at the end of the course, students' skills of solving non-routine problems have been tested and their views of problem solving have been identified using questionnaires and interviews. The classroom work has been organized as a collective solving of some key problems and mostly as a work in small groups solving problems.

FINDINGS AND DISCUSSION

First outcomes of the implementation of our course demonstrated the positive changes in prospective mathematics teachers' skills in solving non-routine problems as well as in their beliefs about the problem solving.

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