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MATHEMATICS COMPETENCES OF PEDAGOGY STUDENTS AT THE BEGINNING OF THEIR UNIVERSITY STUDIES

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Abstract. In the contribution the results of the same set of mathematics tasks given to two different pedagogy students groups are compared. It deals with comparison of these two examinations' results. The first group of students was represented by applicants for mathematics pedagogy studies, and the test was applied as an entrance exam in 1985 and 2001. The second group was represented by students of the same field of study at the beginning of their studies in 2010. These students did not sit for an entrance exam because of low number of applicants at that time. The comparison shows a significant decline of current students' competences which are necessary for solving mathematical tasks.

1. Introduction

Mathematics – in the sense of field of study – has a basis character at the universities preparing future secondary school teachers. This basic knowledge is usually considered essential when speaking about effective teaching. To teach mathematics well and with pleasure it is necessary to acquire a specific way of working in mathematics. Next to mastering amount of basic knowledge it requires creating ones own math world in which crystallize your experience with mathematics concepts, algorithms and mathematics tasks solutions in various contexts. "Mathematics cannot be mastered just by memorizing definitions, concepts and theorems, but we have to work with them at the same time" (see Brincková [1, p. 6]).

University teaching of mathematics subjects has gone through a lot of organizational and contextual changes due to an altered philosophy of preparing future teachers. Intuitive experience hand in hand with some researches (e.g. PISA OECD) indicate decreasing level of secondary school graduates' mathematics competences, their knowledge is superficial, episodic and formal. Universities need some inventory showing the level of their preliminary knowledge in the most objective way.

Convenient instrument for measuring the level of their mathematical knowledge is considered to be the analysis of solving tasks. This analysis could become a tool for getting an image of future students.

2. Aims, methods and investigation tools – didactic test and its analysis

The faculties on education in the Czech Republic have no entrance exams at the moment. Their results would show applicants' level of mathematics knowledge. Departments of mathematics obtain only the information about the final marks in mathematics, which is a very distorted information due to different ways of teaching at different types of secondary schools, the amount of mathematics lessons and other factors. Those students, who start to study teaching mathematics at the faculty of education, come from various types of secondary schools – from training institutions and grammar schools at the same time. It was necessary to start solving this situation and to find out how deep is this lack of knowledge, what could be the way to solve this negative phenomenon.

Within the project obtained in Students' grant competition in 2010 the research was done. It took place at four universities: Faculties of Education at Palacky University in Olomouc, Masaryk University in Brno, University of Ostrava and University of Constantin Philosopher in Nitra in Slovakia. The aim of this research was to compare the current state of first grade students' mathematics competences at the beginning of their university studies to wider research done in 1985.

The aims were

- to compare the results of entrance exams by applicants for studies in 1985 with results of the same test written by first year students in 2010,
- to analyze the collection of tasks,
- to find out whether these results might have been influenced by some external or internal factors.

In June 2010 we did the pre-research at the Department of Mathematics at the Palacky University in Olomouc. We wanted to compare the results in the similar test given to applicants in 1985 and first year students. This test consisted of 6 various tasks, the same for both groups of students. These tasks are based on the evaluation standards for grammar schools.

Thematically it corresponds to main area of secondary school mathematics:

- Linear and quadratic equations and their systems
- Rational functions, powers and roots
- Analytics geometry

Changes in curriculum led to content modification of comparative test, for this reason some topics such as trigonometry, combinatorics, sequences and others were removed from the test. Table 1 shows the results of chosen groups of students (S_1 = applicants for studies in 1985, S_2 = chosen group of the first year students at Faculty of Education in Olomouc). Solutions are divided into A, B and C groups with A = correct solution, B = partial solution, C = incorrect solution.

Task number	Relative frequency of results in S_1 and S_2 (%)					
	A (Group S_1)	A (Group S_2)	B (Group S_1)	B (Group S_2)	C (Group S_1)	C (Group S_2)
1	68.7	45	12.5	10	18.7	45
2	37.5	7.5	25	35	37.5	57.5
3	37.5	0	6.2	30	56.3	70
4	25	2.5	25	2.5	50	95
5	21.4	2.5	42.9	27.5	35.7	70
6	33.3	17.5	46.7	60	20	22.5

Table 1: Proportional results in both tests

The test results showed such a huge descent of mathematics knowledge that we decided to create a brand new test with tasks corresponding to collection of exercises from PISA research. It requires the most of all elementary school knowledge, three-dimensional imagination, ability to use mathematics in everyday life and other tasks showing the level of students' mathematics knowledge.

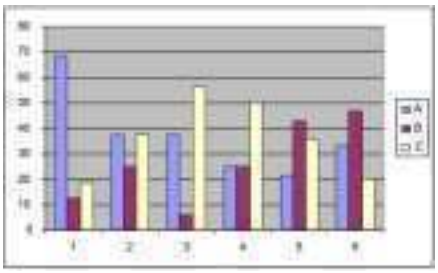

Figure 1: Results of group S_1

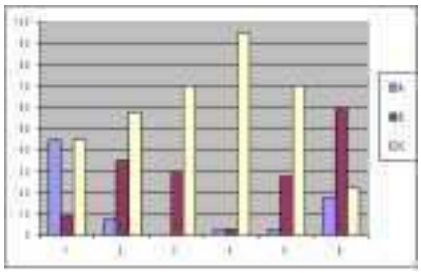

Figure 2: Results of group S_2

It consisted of 10 tasks (some of them had two parts corresponding with educational framework), 8 of which were open tasks and 1 task closed due to demanding interpretation of results. Tasks were put together this way:

Task 1 – student modifies mixed number and solves addition and multiplication of fractions

Task 2 – student uses a rule of three

Task 3 – student forms and solves situations in divisibility of natural numbers

Task 4 – student solves percentage task, uses other mathematics relations

Task 5 – student solves the situations interpreted by proportion

Task 6 – student solves real situations, uses mathematics tools

Task 7 – open task – student sketches and constructs orthocenter and the inscribed circle of a triangle

Task 8 – student uses three–dimensional imagination

Task 9 – student solves goniometrical functions, sketches graphs of sine and cosine

Task 10 – student solves a quadratic equation

Tasks are corresponding with individual wholes of Educational Framework for Elementary and Secondary Schools and are based on Fuchs' evaluation standards from 1994.

Altogether 203 students participated on the research done at the universities in the Czech and Slovak Republics. Graph 3 represents a histogram of test results frequency.

Graph shows better results in comparison to the first testing lap. But realizing the level of tasks (elementary school exercises) it is surprising that a lot of students reached less than average marks. At the same time the international research PISA OECD monitored the biggest deterioration of our students' knowledge since 2003.

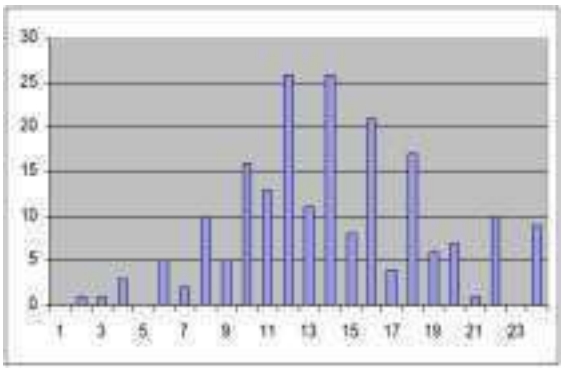

Figure 3: Histogram of test results frequency

In our research we were discussing possible reasons for this knowledge decline. Besides possible social and psychological factors, we were looking for some other we could support by numbers.

The aim of a short questionnaire was to find out the relation between the result in the test and the type of secondary school of particular student. Another factor may be a gender of probed students.

Two hypotheses were created:

H01 – There is no relation between the test result and a gender of probed students

H11 – There is a relation between the test reset and a gender of probed students

H02 – There is no relation between the test result and the type of secondary school

H12 – There is a relation between the test results and the type of secondary school

Statistics confirmed the dependence on the type of school, on the other hand, it showed that a gender of a student does not influence mathematics knowledge.

3. Conclusion

Research enquiry provides us with rich data which will allow not only description, but also causal analysis, relating to the third research aim. Using these results, we have confirmed our expectations about the decreasing

level of mathematics knowledge of students at the beginning of their university studies. The results support us in a long-term trend that signalizes low permanence of mathematics knowledge and points out the difficulties connected with secondary school mathematics teaching when considering final state exams. Standard, traditional mathematics curriculum has not become a steady "equipment" of future mathematics teachers.

Problems with insufficient mathematics tools, when considering students at the beginning of their studies, are being discussed and are still current. The level of knowledge reached in the test is being compared with educational curriculum. But it has a prognostic aspect at the same time – it allows us to judge the preconditions for good studies in a proper field of study, preconditions for success later at work, and it can become an inspiration for subjects' innovation at the faculties preparing future mathematics teachers.

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