Verification of Quality of Some Tasks in Tests of KEGA Grant Projects

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Abstract

The four problems with eight tasks of KEGA grant project (Increasing the key mathematical competencies I, II) tests are specified by Bloom´s taxonomy and their quality is verified in this paper.

Keywords: Test task, Bloom´s taxonomy, reliability.

Classification: 97*C40, 97D10, 97U20, 97U30*

Introduction

Not very impressing results of Slovak pupils´ assessment in international PISA measurements and new state educational program encourage mathematical education from elementary school to be more oriented on development of knowledge and skills in solving of real-life situation problems, which need to be imposed and formulated. Therefore it is necessary to create collections of good and interesting practical problems, proven and taught in elementary school conditions. The Slovak Ministry of Education grant projects No. 3/7001/09 and 015 UKF-4/2012 (*Increasing the key mathematical competencies-alternative teaching programs in mathematics for elementary schools in terms of objectives of new state educational program and in terms of elevating of mathematical competences accordance impact PISA I, II*) was oriented on working out such methodical materials which will advance elevating of mathematical competencies of pupils of elementary schools. The methodical materials consisted of tasks with real-life context and methodical instructions for teachers (Fulier [4], 2014). The effectivity of the didactic materials was consequently verified in the mathematical education process. The level of mathematical competencies of pupils was investigated by posttests at the conclusion of the pedagogical experiment. We verify the quality of eight tasks from the posttests and we specify them by Bloom´s taxonomy (Bloom [2], 1956; Anderson [1], 2001). We observe reliability mainly. These tasks belong to topical sphere *Relations*, *functions, tables and diagrams.* This topical sphere complements and naturally intersects with the topical sphere *Numbers, variable and number operations* which merges into solving equations and inequations by means of propaedeutics of variable quantity.

Eight tasks from posttests

The level of mathematical competencies of pupils was investigated by a posttest in every grade 5 -8. The posttest for every grade contained 6 problems. One problem from them was from topical sphere Relations, functions, tables and diagrams. Each problem consisted of two tasks. The tasks of this sphere are more or less concentrated on ability understanding reading in the work with various tables and diagrams and also on formation of skills to use natural numbers and decimal numbers in the description of real situations in grades 5 and 6. The introduction of fractions in grade 7 ends in applicative branch: percent, calculus of interest, representation of a component element and a percent count by appropriate diagrams. Finally a pupil shall acquire abilities and knowledge to create mathematical models of simple real situations by utilization of literae as variables. These mathematical models are simplest linear equations or linear functions.

We used the following tasks from topical sphere Relations … :

Grade 5

How many cars did manufacture automobile factories?

Three automobile factories act in Slovakia. Information about number of manufactured cars is in the following table and graph:

Automobile factory	Year		
	2007	**2008**	**2009**
KIA	160 301	201 507	151 032
PEUGEOT CITROËN	204 060	186 397	205 030
VOLKSWAGEN	206 710	187 872	107 078
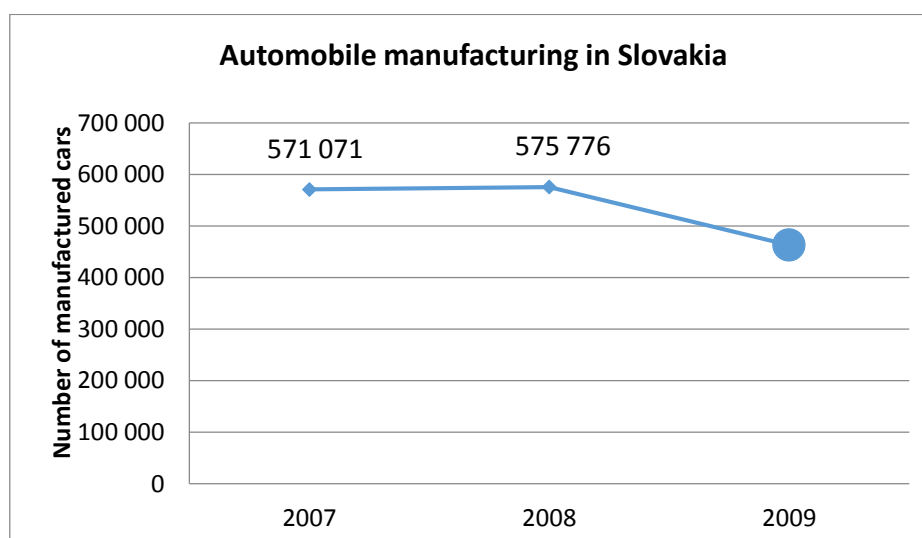
Task 1. Find out which automobile factory manufactured the most cars in year 2008. Round their number to thousands.

Task 2. Fill the missing number for the year 2009 into the graph.

Grade 6

Telephone lines

The price list of telephone lines T-com for the programmes **Indoors Comfort** and **Indoors Mini** is described in the following table. Free minutes are used minutes for which a customer does not pay.

Programmes of telephone lines	Indoors Comfort	Indoors Mini
Classification fee	1 €	1 €
Monthly fee	11.90 €	6.73 €
Free minutes	0	30

Prices of domestic calls for one minute		Indoors Comfort	Indoors Mini
Residential calls	Peak period	0.0757 €	0.1513 €
	Off-peak period	0	0.0956 €
	Weekend	0	0.0797 €
Intercity calls	Peak period	0.1554 €	0.3266 €
	Off-peak period	0	0.1513 €
	Weekend	0	0.1195 €

Task 1. Fill up the following table for the programme **Indoors Mini.**

INDOORS MINI	RESIDENTIAL CALLS Off-peak period: 30 min. Used free min..: 20	INTERCITY CALLS Peak period: 30 min. Used free min.: 10
Charged sum	10 · 0.0956 = 0.956 (€)	

Task 2. The monthly payment for a telephone line is calculated for each programme by applying the following formula: *monthly fee + fee for used minutes.*

Fill in the following table and calculate the monthly payment of programme **Indoors Comfort.**

INDOORS COMFORT	RESIDENTIAL CALLS Peak period:40 min.	INTERCITY CALLS Off-peak period: 30 min.	Monthly fee	Total
Price charged				

Grade 7
Term deposit

The family of Thrifty´s open 1 year term deposit in Slovak Savings Bank at 1st July 2011 to the amount of 26 000 € with interest rate 4%. They planned to use the saved money to buy a new car KIA. Automobile store provided discount of 800 € from the beginning of year 2012 until May 2012.

Task 1. Of how many percent decreased the car price after the discount if it originally cost 16 000 €?

 Task 2. Interest is taxed by 20 %. Interest is not paid in case of premature withdrawal of the money from the term deposit. Would it be for family Thrifty better to buy the car in May or in July?

Grade 8
Consumption of car

Cars have different average fuel consumption in city and outside city. For example Skoda Fabia has declared average fuel consumption 5.6 litres on 100 km outside city and 9.6 litres on 100 km in city.

Task 1. Fill in the following table with approximated fuel consumption in litres if we drive with Fabia only in city.

km	50	100	150	215	x
consumption		9.6			

Task 2. Mr. Rosina rides 1000 km a month with Fabia where from the 1000 km he rides outside the city x km. Denote by S whole fuel consumption in litres for a month. How much litres fuel S is drained depending on x? Write S as an expression with variable x.

Pupil results of the investigated tasks

The descriptive statistics of scores of the introduced tasks are in the Table 1 and the percent distributions of pupil fruitfulness of the investigated tasks are in Figure 1.

Table 1: Descriptive statistics

	Number of pupils	Mean	Standard Deviation	Minimum	Maximum	Mode	Median
5 T1	887	1.37	0.778	0	2	2	2
5 T2	887	1.63	1.425	0	3	3	2
6 T1	737	0.746	0.891	0	2	0	0
6 T2	737	0.614	0.822	0	2	0	0
7 T1	593	0.58	0.495	0	1	1	1
7 T2	593	1.12	1.516	0	4	0	0
8 T1	544	1.158	0.706	0	2	1	1
8 T2	544	0.478	0.977	0	3	0	0

It is evident that the tasks 6 T1 and 6 T2 were too difficult for the pupils of grade 6 (mode and median equal 0).
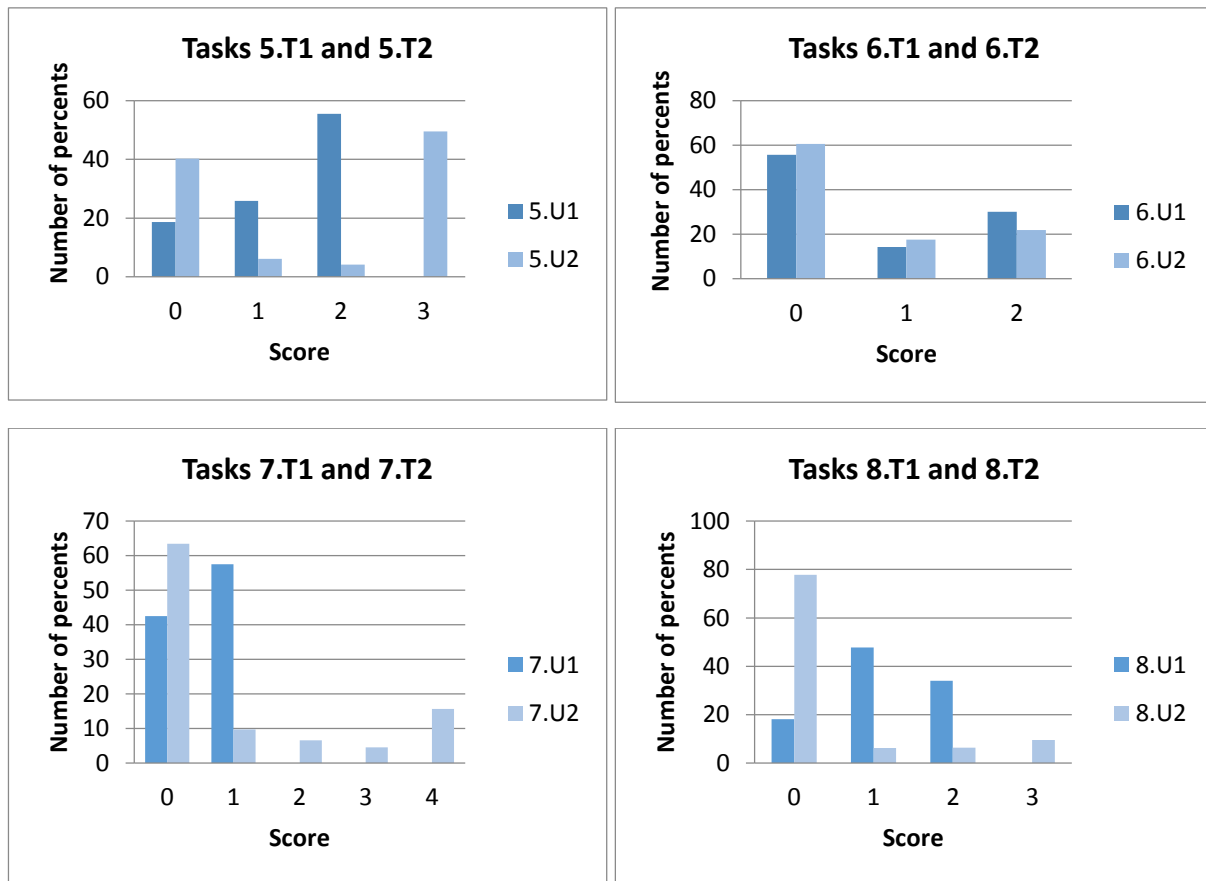
Figure 1: *Number percent of pupils which achieved score 0 – 4 for tasks 5 T1 – 8 T2*

Verification of quality of eight tasks

The posttest for every grade aimed at advanced level abilities how´s the memory acquisition of curriculum. Pupil abilities to solve tasks with real-life context were tested.

All tasks investigated in this paper are open-ended. We classify the tasks with regard to two dimensional Bloom´s revised taxonomy (Table 2).

Table 2: *Bloom´s revised taxonomy of tasks*

	The knowledge dimension	The cognitive dimension
5 T1	conceptual knowledge	understand
5 T2	procedural knowledge	analyse
6 T1	conceptual knowledge	apply
6 T2	procedural knowledge	analyse
7 T1	conceptual knowledge	apply
7 T2	procedural knowledge	evaluate
8 T1	conceptual knowledge	analyse
8 T2	procedural knowledge	evaluate

The tasks 5 T1, 6 T1, 7 T1, 8 T1 are classified to the dimension of conceptual knowledge; the task T1 is classified to the cognitive dimension understand; the tasks 6 T1 and 7 T1 are classified to the dimension apply; the task 8 T1 is classified to the dimension analyse. The tasks 5 T2, 6 T2, 7 T2, 8 T2 are classified to the dimension of procedural knowledge; the tasks 5 T2 and 6 T2 are classified to the cognitive dimension analyse; the tasks 7 T2 and 8 T2 are classified to the dimension evaluate.

The reliabilities of posttests measured by Cronbach`s alpha and test reliabilities if one of investigated tasks is deleted are in Table 3.

Table 3: Cronbach´s alpha and Cronbach´s alpha if item deleted

Year	Scale Mean	Cronbach's Alpha	Scale Mean if Item Deleted		Cronbach's Alpha if Item Deleted	
			T1	T2	T1	T2
5.	17.49	0.823	16.12	15.86	0.807	0.807
6.	12.120	0.851	11.372	11.504	0.839	0.840
7.	10.39	0.862	9.82	9.40	0.858	0.843
8.	13.230	0.873	12.069	12.748	0.863	0.870

All posttests are reliable (all Cronbach`s alpha are greater than 0.82) and no one from investigated tasks does not decrease the test reliability.

Finally we introduce the pupil results of the investigated tasks in the experimental group and the control group (Fulier [3], 2014).

Table 4: Number of students

Grade	Group E	Group C	Total
5.	429	458	887
6.	385	352	737
7.	294	299	593
8.	221	323	544

Table 5: Means and Chi-square Test of independence of score variable and group variable results

	5.T1	5.T2	6.T1	6.T2	7.T1	7.T2	8.T1	8.T2
Mean E	1.417	1.837	0.938	0.813	0.687	1.415	1.452	0.905
Mean C	1.325	1.435	0.534	0.395	0.465	0.579	0.957	0.186
Mean total	1.370	1.837	0.745	0.613	0.575	0.993	1.158	0.478
Chi-square value	3.601	18.480	38.808	47.971	29.948	49.425	73.868	105.383
Degrees of freedom	2	3	2	2	1	4	2	3
p-value	0.165	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rejection of independence	Not	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The score means are greater in the experimental group of students for all tasks and p-values in the Table 5 confirm that the pupil's scores are group dependent for all tasks excepting task 5 T1. That means the task 5 T1 was not significantly difficult for the control group of students than for the experimental group of pupils. All others tasks significantly discriminated in between groups.

Conclusion

The investigated tasks confirmed the didactic efficiency of new learning materials which were created within the framework of the KEGA 3/7001/09 project and the KEGA 015 UKF-4/2012 project.

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