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THE FOUNDATION OF THE ROMANY STUDENTS' ALGEBRA KNOWLEDGE THROUGH TEXT-BASED PROBLEMS

Ileana Máté

Abstract: The purpose of my research is to find a method by which the acquisition of the abstract algebraical thinking can be made efficient in the case of Romany students coming from a socially underprivileged background, through text-based problems. I teach in School no. 1 of Diosig, in Romania, where the rate of Romany minority is of 23%, while more than a half of the children studying in Hungarian at school come from Romany families. The research was conducted in this school. The essence of this method is that I do not teach the algebraic operations, the algebraic method of solving text-based problems, which is to be acquired in the seventh grade, the way the Romanian educational system requires, that is to start from theoretical bases, but I build every item to be learnt around text-based problems. We revised the basic operations by text-based problems, then we introduced the notion of variable through games similarly formulated by texts and calculated the substitute values. They deduced and learnt the reduction of the variables through text-based problems, as well, by an inductive sequence.

Key words: text-based problems, algebra, mathematics didactics.

MSC2010: 97H20, 97D40, 97D70

1. Introduction

Seeing the learning difficulties of the 7th-grade Romany students from Diosig, I tried to utilise a method that I partly used in mixed Hungarian-Romany classes in the previous school years, and it proved to be efficient. Because the Romany students lack any methods of solving text-based problems, they also acquired some arithmetical solving methods in the course of the experimental teaching. When they were able to solve text-based problems in an arithmetical way, and they were able to work correctly with variable, too, only then followed the solving of equations algebraically through text-based problems. However this was not enforced on the students, but we used such problems whose solving produce in them the need for a shorter writing mode, an easier deduction, which cause the algebraic solving method.

Till the very last, I had in mind the teachings of Lázár Péter, a teacher of Romany birth, according to which we need to get to know each Romany child individually, and to build the school around them, because their education can be an efficient process only in this way. (Bordács-Lázár, 2002)

2. Theoretical background

I found the definition of the text-based problems the most getting to the point in Csíkos Csaba's formulation, according to which," we can consider a mathematical text-based problem every such problem that is formulated in words and for whose solving the use of some area of Mathematics is indispensable." (Csíkos, 2003)

With the help of text-based problems, we can enhance the students' text comprehension, we can train them for a problem-solving thinking, and we can also develop their capacities of judgement, retention, finding the main points, and self-verifying.

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In order that the teaching of text-based problems should be diversified, that is to say for the teaching process to work efficiently, we must know the possibilities of formulating the problems. A systematization on several viewpoints is helpful in this case, (Herendiné, 2013), according to which the problems can be arranged by their formation, their topic, their texting, the number of the unknowns, the number of the solutions, or the relevance of the data.

According to Pólya (1985), the solving of text-based problems is done in four steps, where we can step there and back between the steps for the sake of a successful problem solving. The steps of the problem solving are: the comprehension of the problem, the making of a plan, the carrying out of the plan, verifying-feedback.

The text-based problems can be solved with arithmetical and algebraic methods, as well. According to Faragó (1960), in the course of the arithmetical method one must reason and think to the end, because the unknown has to be explicitly expressed. In the course of the algebraic method, the unknown is written implicitly, in the form of an equation. First, we have to write the equation, then we have to solve it with the help of the algebraic technique, that is the procedure of solving equations.

I also presented the psychological background essential to a successful teaching.

According to Bruner (1966), learning is a characteristic property of men. Man's learning is based on curiosity, so it is the teacher's task to sustain the students' curiosity. The acquisition of knowledge is attained on three different levels: material level, iconic level, and symbolic level.

In Ambrus's interpretation (1995), the teaching of Mathematics is the most efficient when all the three levels are activated in the course of the learning process.

According to Skemp (1962), the basis of the teaching of Mathematics is the formation of the systems of notions or schemata. The schemata have two main roles: they integrate the existing knowledge, and they serve as intellectual instruments in the acquisition of the new knowledge. The learning of Mathematics is efficient if it is based on a systematical theory.

Due to the construction of the human brain, we can store relatively few pieces of informations at a given moment, and also for a short time. The storehouse of our knowledge is long-term memory (Ambrus & Ambrus, 2013). When solving problems, the working memory has an important role, the capacity of which can be enlarged by the parallel use of the phonological and the visual stores (Sternberg, 1996).

According to Kieran (2004), one of the most significant problems when passing over from the arithmetical thinking to the algebraic thinking is that the students do not focus on the relation between the operations, but on calculating. A few viewpoints of the development of the algebraic thinking are:

- The emphasis should be on the relations, not on the calculation.
- The emphasis should be on the operations and these should be inversive.
- The emphasis should be on the representation and the solution of the problem, not only on the solution.
- The emphasis should be on the letter and the number, not only on the number.
- Attention must be paid to the meaning of the equality sign. (Kieran, 2004)

Among the utilised forms of work, the group work contains very rich possibilities both from an educational and a teaching point of view. (Buzás, 1980) We can use differentiated teaching in the case of different knowledge levels. The purpose of differentiating is to adjust the content and structure of the syllabus to be acquired, as well as the teaching methods, to the individual needs of certain students. (Tomlinson, 2014)

According to an international survey, the Romany students' average school performance is quite low as compared to those of their schoolmates of the same age. (Wilkin, 2010)

Before beginning the experience, I made up two questionnaires. The first one was filled in by the teachers of the school of Bihardiószeg. By this, I was looking for an answer to the question whether the Romany students they teach got on harder than their classmates, and what the cause of this could be. The answer to the first question was unanimously yes, while in the second, the main factors specified were: the parents' low level of schooling, the family, or even the absence of a family, or the instability of the family.

The second questionnaire was filled in by the children and their parents. By this, I tried to survey my students' conditions at home. The result was that my students had a well-organised family background. The disadvantage consisted in the fact that the majority of the parents had not studied further, and those who had attended more than eight classes, had only attended a three-month professional qualifying. A quarter of the students participating in the experiment lived in an environment where the parents could neither write, nor read.

3. The research

The research was done at the School of Diosig in Romania, in the 7th-grade student group. There are 19 students in the classroom, all 12-14 years old Roma.

The questions of my research are:

- *Can the abstraction skill of the Romany students be developed with the help of solving text-based problems?*
- *What solving method – arithmetical or algebraic – do the 7th-grade Romany students prefer in solving text-based problems?*
- *How do group-work, pair-work and individual work contribute to the 7th-grade Romany students' development of the abilities of solving text-based problems?*

At the beginning of the research, I assessed my students' reading skills, and then I got a picture about their mathematical knowledge through a pre-test and, finally, a post-test. In the course of the experiment, I took photos, made tape recordings about the students' work, and I also constantly checked their work in the notebooks. Two months after the end of the experiment, they solved the post-test again in a delayed test, from the results of which I established what they had acquired on a skill level.

The plan of the experiment of 30 lessons is the following:

Written test of reading comprehension – 1 lesson

Testing of the students' reading aloud – 2 lessons

Pre-test – 1 lesson

Revision of the knowledge about the primary operations – 2 lessons

Revision of the knowledge about the secondary operations – 2 lessons

Acquisition of the algebraic knowledge needed for solving equations – 6 lessons

Solving text-based problems by the arithmetical method – 7 lessons

Is it easier with equations? – problems we tried to solve by both equations and the arithmetical method – 1 lesson

The use of the arithmetical and the algebraic methods – 6 lessons

Assessing the results – 2 lessons.

The pre-test

The first task was to assess the students' reading and reading comprehension skills, which I did through reading aloud and a written test of reading comprehension. I established that my students knew the alphabet, they could read short texts fluently, but, because they did not pay attention to the punctuation marks, their reading was not articulate, so hardly understandable. In order to get rid of this, on a dilu level, we had some reading exercises for 15 minutes before classes, and the students also had to conduct a reading diary.
At the beginning of the experiment, the students did a pre-test, which helped me assess my students' momentary knowledge through 8 items.

For example, below are illustrated some of the problems:

1. *Complete the following with the missing number:*

2	*7*	*15*		***n***
5	*10*	*18*	*24*	

1	*3*	*8*	*100*	
2	*6*	*16*		*2·m*

2. *Csilla has 12 money. Brigi has got with 3 money more than Csilla. How much money has Brigi got?*
3. *In Jafet's family, there are 5 children. His motherbuys each child 3 pairs of socks. How many pairs of socks does mother buy?*
4. *If k = 7, then k + 2 =?*
5. *If c = 2, then 6·c =?*
6. *Complete the expression: 5+8=□ +10*
7. *Together, Panni and her mother are 48 years old. The mother is three times older than her daughter. How old is each one of them?*
8. *Our clock is broken. Write the missing data in figure!*

The accurate time	*What the clock shows*
11:10	*11:13*
12:7	*12:10*
13:45	
	14:30

See the results of the test in Table 1:

Table 1. *The pre-test results*

Problem	The right solution	Partial solution	Wrong solution	She/he did not even deal it
1.	1 pupil – **5%**	**9**	**7**	**2**
2.	14 pupils – **73%**	**0**	**4**	**1**
3.	15 pupils –**78%**	**1**	**3**	**0**
4.	4 pupils – **21%**	**0**	**10**	**5**
5.	7 pupils – **36%**	**0**	**7**	**5**
6.	**0%**	**0**	**19**	**0**
7.	**0%**	**2**	**16**	**1**
8.	4 pupils – **21%**	**2**	**13**	**0**

From the results of the test, I concluded that: the students solved correctly the problems formulated as simple texts, which-solving requires, only one operation. When the problem was more complex, or its text was longer, understanding the problem was already difficult. One could see from the solutions that these students lacked the foundations of abstract thinking. The students were not able to use the arithmetical method of solving text-based problems. They could not use their existing knowledge in new contexts, or hardly did so. The successful solutions showed that it was of great help for the students if the context was familiar to them.

The experiment

During the experimental teaching, I tried to formulate each problem in a text. In order that the students' reading comprehension could develop, they had to express the text of the problem in their own words, as well.

In order to form their abstract thinking, we introduced the notion of unknown, then, in an inductive way, through practical examples, they could understand the notion of variable, the substitution, and the operations with algebraic expressions.
The solving of text-based problems was carried out through object representations, together with drawing the graphics, and we even formulated what we did in words.

The pupils are changing their toys. The price of two little balls is the same as the price of four glass balls. The price of a little car is the same as the price of the 3 little balls and 3 little glass balls.How many glass balls gives Peter, when he gets a little car from Otto?

The solving of the problem, whit the object representation can be seen in Figure 1:

Figure 1. *The object representation*

The graphics representation can be seen in Figure 2:

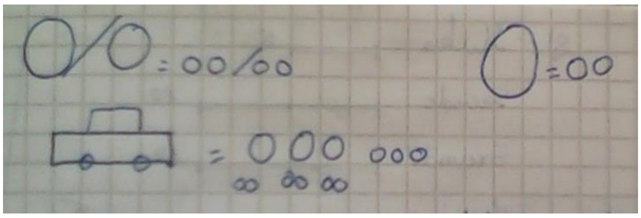

Figure 2. *The graphics representation*

For understanding the meaning of the equality sign from equations we used the two-beamed balance from school. When the scales were balanced, the equality was established.

We passed soon from the arithmetical solving method to the algebraic one in the case of two problems that were easy to solve but needed a lengthy writing manner (see Figure 4), when we use a shorter solving method (see Figure 5), containing variables at the students' request.

First problem:

Sarah and her parents are together 78 years old. Her mother is 12 times older and her father is 13 times older than Sarah. How old is each of them?

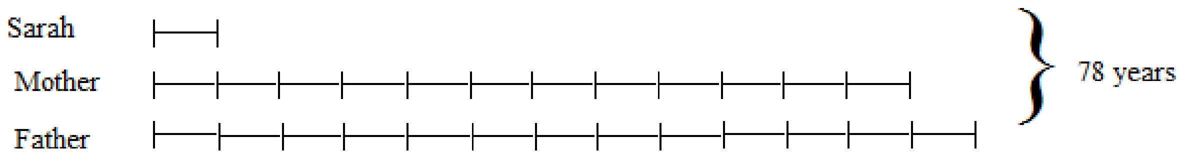

Figure 3. *The longer method*

When we make the representation, the pupils are saying: "It is so much to draw…"
They are asking: "Can we do it easier?"
Erik is drawing using shorter method.

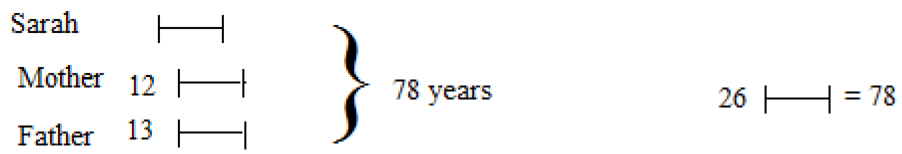

Figure 4. *The shorter method*

From the shorter method it is only one step to resolve using equation.

We also used the balance when writing the equations. Starting from concrete measurings, the students learnt how to write, then solve the equations.

In the course of the experiment, the students first worked in small groups, thus I achieved that everyone join the work, even if they did not had enough self-confidence. Later, we split the groups into pairs, then, after the pair work, we passed on to individual work. By this gradualness, I obtained everyone to become an active part of the learning process.

During the activities, when the students had acquired a certain topic, we often used the method of individual making up of problems. When the students formulated their own problems, their thinking developed, and I was able to see on what level they had got in the learning process.

The post-test

At the end of the experiment, the students had a final test with 8 items, which they repeated two month later.

For example, below are illustrated some of the problems:

1. *Complete the following with the missing numbers:*

3	*8*	*15*		***n***
5	*10*	*17*	*26*	

1	*2*	*5*	*100*	
3	*6*	*15*		*3·m*

2. *Tomi says:" I have k=5 little cars!" Peter has k+3 little cars. How many cars has Peter got?*
3. *Grandmother bakes donuts. Grandmother calculated: each child gets six donuts. How many donuts did grandmother if she has got five grandchildren?*
4. *The pupils calculated their own glass balls. Kati says:" if I had got 14 glass balls more then I would have the same number of glass balls as Tamara. Tamara has got 96 glass balls. How many glass balls has Kati got?*
5. *Anna has f=3 books. Dora has 4·f books. How many books has Dora got?*
6. *The pupils have made measurements with the two-beamed balance from school. There are 4 balls on one tray of the balance and 2balls + 12 grams' weight on the other tray. How many grams does a ball weight?*
7. *Together, Peter and his father are 48 years old. The father is three times older than his son. How old is each one of them?*
8. *Dani and Peter are playing together. Peter is writing a number on a sheet of paper. Dani is writing the pair of the number. Complete the following with the missing numbers:*

Peter's numbers	*Dani's numbers*
5	*8*
12	*15*
20	*23*
35	
	40

See the results of the post-test in Table 2:

Table 2. *The post-test results*

Problem	The right solution	Partial solution	Wrong solution	She/he did not even deal it
1.	10 pupil – **52%**	**0**	**7**	**2**
2.	19 pupils – **100%**	**0**	**0**	**0**
3.	16 pupils – **84%**	**0**	**1**	**2**
4.	12 pupils – **63%**	**1**	**4**	**2**
5.	11 pupils– **57%**	**1**	**4**	**3**
6.	11 pupils – **57%**	**0**	**6**	**2**
7.	**7** pupils – **36%**	**6**	**2**	**4**
8.	9 pupils – **47%**	**5**	**4**	**1**

4. Conclusion

Comparing the percent of the number of students, who gave right solutions in pre-test and post-test and the wrong solutions percent in pre-test and post-test, we can answer to the research questions.

See the percent of the right solutions in Table 3.

Table 3. *The right solutions*

Problem	Pre-test	Post-test
1.	**5%**	**52%**
2.	**73%**	**100%**
3.	**78%**	**84%**
4.	**21%**	**63%**
5.	**36%**	**57%**
6.	**0%**	**57%**
7.	**0%**	**36%**
8.	**21%**	**47%**

See the percent of the wrong solutions in Table 4.

Table 4. *The wrong solutions*

Problem	Pre-test	Post-test
1.	**36%**	**36%**
2.	**21%**	**0%**
3.	**15%**	**5%**
4.	**52%**	**21%**
5.	**36%**	**21%**
6.	**100%**	**31%**
7.	**84%**	**10%**
8.	**15%**	**21%**

The answers to the questions of my research are:

- *The Romany students' abstractisation skills can be developed very well with the help of text-based problems.*
- *On the base of the experimental teaching, we can establish that the students use the arithmetical solving method more willingly and more successfully during solving problems.*
- *The alternation of working in small groups, then in pairs, and finally individually contribute to the Romany students' development considerably.*

The activities in the research demonstrated that, in the course of teaching, it is possible to use such methods that are successful even in the case of underprivileged students. It is very important that the teachers' attitude should be patient, accepting and stimulating. These students need more time to understand and to strengthen the syllabus than do those who have good mathematical fundamentals and good logical capacities.

The Romany students do not possess the knowledge about arithmetical methods of solving text-based problems. In spite of this, they acquired it very well, moreover, according to the end-test, they possessed them on a skill level. They also did well in the algebraic calculations, though few of them used the algebraic method of solving text-based problems, which means that they have not succeeded to acquire this on a skill level yet.

For them, it is much easier to solve only a single-operation algebraic equation drawing a graphic well. Thus, they actually use the two methods complementarily, and, by doing this, the solving process of text-based problems was made easier for them.

In the case of **underprivileged Romany children, teaching mathematics** can be **successful** if:

- we pay individual attention
- we alternate small-group, pair, and individual work
- we give them to handle, we draw, and represent everything we can
- we practise together a lot at school
- we act with a positive, stimulating, and accepting attitude.

A very important research task is to strengthen the algebraic method of solving text-based problems in the same class in the following school year, when we can build on the already existing skill of arithmetical problem solving.

Further research possibilities

- The use of this method with the next Romany class, which are in the 5th grade now, in the 2018-2019 school year.
- The intesification of solving text-based problems with algebraic methods in this same class, during the next school year, when we can already build on existing skills of arithmetical solving methods.
- The use of this method in the case of mixed Hungarian-Romany classes, in small groups during afternoon activities, for underpriviliged students to catch up.

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Author

Ilaeana Máté, Lower-Secondary School of Diosig, Diosig, Romania, e-mail: mateilona@yahoo.com