MATHEMATICA

V

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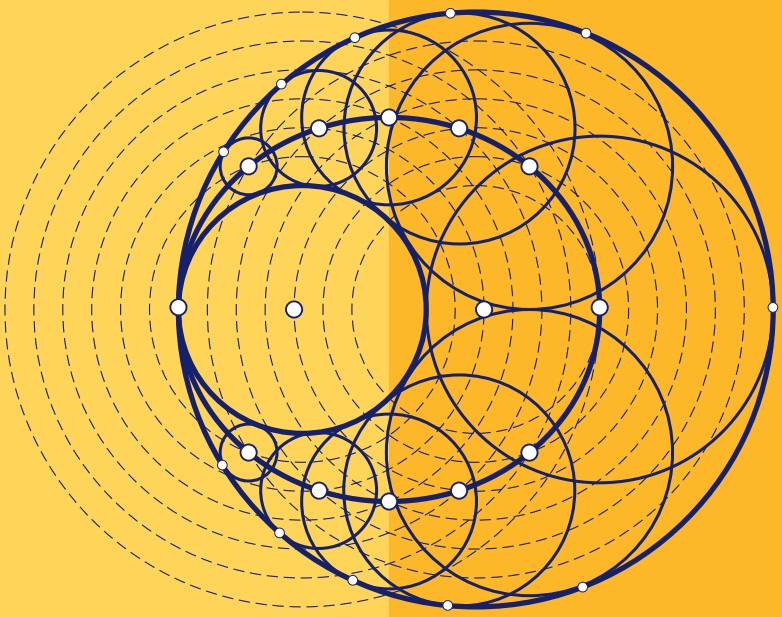

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Martin Billich

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Development of pupils' attitudes towards mathematics

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Abstract. Our paper is dealing with the results of research on pupils' attitudes towards mathematics. We study changes in the attitudes between pupils in different grades of lower secondary education. Analysis of these changes is the source of information beneficial for potential improvement of these attitudes.

Keywords: Mathematics education, attitudes towards mathematics, beliefs.

Classification: C20; C70.

1 Introduction

The attitudes toward mathematics are important factors those are influencing the results of mathematics education (Zimmerman & Bandura, 1994; Pajares, 1996; Marsh & Yeung, 1997; Skaalvik & Skaalvik, 2004; Skaalvik & Skaalvik, 2006). The research in the area of these attitudes is therefore relevant and needed. One of the interesting topics in this area of research is development of the pupils' attitudes towards mathematics during the school education. The goal of the research presented in this paper was to study this development in the lower secondary education (pupils' age 10–15). The results of this research are beneficial for mathematics teachers and also researchers in the theory of mathematics education.

2 Attitudes towards mathematics

Before we continue with the description of our research we will specify the definition of the attitudes that we use in our paper. We will use so called multidimensional definition. By this definition individual's attitudes towards mathematics are defined in a complex way by the emotions that he/she associates with mathematics, by individual's beliefs towards mathematics, and by how he/she behaves (Hart, 1989; Zan & Di Martino, 2007). This definition shows that attitudes are complex and rich notion. In our paper we deal mostly with the more stable part of pupils' attitudes, with individual's mathematics-related beliefs. They form the system of beliefs, that can be define as the implicitly or explicitly held subjective conceptions students hold to be true about mathematics education, about themselves as mathematics learners, and about the mathematics class context (Op 't Eynde & De Corte, 2003). Students' beliefs about mathematics education contain beliefs about mathematics, mathematics learning and teaching. Beliefs about themselves as mathematics learners consist of goal orientation beliefs and self-efficacy and self-concept beliefs. Beliefs related to the mathematics class context are beliefs about the role of the teacher, the role of the students and about socio-mathematical norms and practices in the mathematics class. (De Corte & Op 't Eynde, 2002)

3 Research description

In this part of the paper we will describe the research. As was mentioned before, the goal of our research was to study development of pupils' attitudes towards mathematics during lower secondary education. The research tool to study the attitudes was

the questionnaire. We developed it on the basis of the questionnaires used in previous researches on the attitudes, in some of those we participated too (De Corte & Op 't Eynde, 2002; Andrews at all, 2007, 2008, 2011; Vankúš & Kubicová, 2010). The questionnaire used in the research had 16 items. They were 6 scales Likert type. The scales were: Strong agree; Agree; Partially agree; Partially disagree; Strong disagree. Items were examining 4 areas of mathematics-related beliefs; each area consisted of 4 items. The areas were: The liking of the mathematics; Beliefs on the usefulness of mathematics; Pupils' mathematics self-beliefs; and Self-evaluation of pupils' effort in the mathematics. Considering definition of the mathematics-related beliefs mentioned before, the first two areas of our questionnaire are part of students' beliefs about mathematics education and last two areas are part of beliefs about themselves as mathematics learners. Complete text of the questionnaire can be found in our publication (Vankúš, 2014, pp. 134–135), available for free download on the web address: www.comae.sk/efektivnost.pdf. The items for each area are listed in the fig. 1.

Area	Items
The liking of the mathematics	I am fond of mathematics. I am glad about mathematics. Studying mathematics is pleasure for me. I like mathematics.
Beliefs on the usefulness of mathematics	I need mathematics in various situations of my life. Mathematics will help me to find the job. Mathematics is useful for me in the real life. Mathematics increases my possibilities to get the job.
Pupils' mathematics self-beliefs	Mathematics is very easy for me. I am very good in mathematics. I am sure that I can understand everything we study on mathematics. I am sure I can grasp everything we learn on mathematics classes.
Self-evaluation of pupils' effort in the mathematics	I put lot of effort to mathematics. I work very hard on mathematics. I strive really hard in mathematics. I try to work the best I know in mathematics.

Figure 1: Items of the questionnaire used in the research

The research sample was 154 pupils from the state lower secondary school in Bratislava. Pupils were attending 5th–9th grade of school education; their age was 10–15 years. Questionnaire was administrated on the mathematics lesson. Afterwards we evaluated the answers, marking them with natural number of points between 6 points and 1 point. 6 points was the value for the most positive response

(strong agree) and 1 point was the most negative response (strong disagree). Positive responses indicated positive beliefs towards mathematics. For further statistical analysis we then computed for each pupil final score from the each area of questionnaire, adding the scores from the 4 items, belonging to that area. Then we did test for normality of our data using Shapiro-Wilk test. All the results for each grade of pupils are in the fig. 2.

Grade / Area	5th $n = 43$	6th $n = 25$	7th $n = 26$	8th $n = 37$	9th $n = 23$
The liking of the mathematics					
Mean	17.35	15.32	12.04	13.00	11.87
Standard deviation	4.64	3.50	5.81	5.02	4.18
Normality test, W; p less than 0.10	0.95 not normal	0.94 normal	0.90 not normal	0.97 normal	0.97 normal
Beliefs on the usefulness of mathematics					
Mean	20.86	19.36	14.54	17.51	15.43
Standard deviation	2.66	3.84	5.09	4.05	3.85
Normality test, W; p less than 0.10	0.89 not normal	0.86 not normal	0.96 normal	0.96 normal	0.92 normal
Pupils' mathematics self-beliefs					
Mean	17.65	15.00	13.04	14.54	12.56
Standard deviation	3.80	4.36	4.23	4.60	4.69
Normality test, W; p less than 0.10	0.97 normal	0.96 normal	0.97 normal	0.96 normal	0.93 normal
Self-evaluation of pupils' effort in the mathematics					
Mean	19.77	18.04	15.58	15.03	13.61
Standard deviation	3.25	2.98	4.71	4.53	4.42
Normality test, W; p less than 0.10	0.92 not normal	0.95 normal	0.96 normal	0.95 normal	0.96 normal

Figure 2: Results of the used questionnaire

To study more closely the changes in our results between the grades of lower secondary education we computed differences between the means of each two subsequent grades. To find out if the changes are statistically significant we used nonparametric Mann-Whitney U-test, because our data have mostly not normal distribution, as we could see in fig. 2. The computed changes and results of the U-test are in the fig. 3.

Changes between grades	5th-6th	6th-7th	7th-8th	8th-9th
The liking of the mathematics				
Difference of means	**-2.03**	**-3.28**	0.96	-1.13
p (Mann-Whitney U-test)	0.06	0.09	0.58	0.47
Beliefs on the usefulness of mathematics				
Difference of means	-1.50	**-4.82**	**2.98**	**-2.08**
p (Mann-Whitney U-test)	0.20	0.00	0.02	0.04
Pupils' mathematics self-beliefs				
Difference of means	**-2.65**	**-1.96**	1.50	**-1.98**
p (Mann-Whitney U-test)	0.02	0.09	0.21	0.08
Self-evaluation of pupils' effort in the mathematics				
Difference of means	**-1.73**	**-2.46**	-0.55	-1.42
p (Mann-Whitney U-test)	0.04	0.05	0.61	0.25

Figure 3: Changes between grades; numbers in bold are statistically significant with p less than 0.10

4 Discussion

From the results in the fig. 3 we can see, that there are statistically significant (with p less than 0.10) changes in all our areas of attitudes towards mathematics during the lower secondary education. Namely, there are decreases: in the area The liking of the mathematics between 5th and 6th grade, and between 6th and 7th grade; in the area Beliefs on the usefulness of mathematics between 6th and 7th grade, and 8th and 9th grade; in the area Pupils' mathematics self-beliefs between 5th and 6th grade, and 8th and 9th grade; and in the area Self-evaluation of pupils' effort in the mathematics between 5th and 6th grade, and 6th and 7th grade. The increase was just in the area Beliefs on the usefulness of mathematics between 7th and 8th grade. The above mentioned results are in accordance with the results of some other researchers on the attitudes towards mathematics. They have found out that there is decrease in the pupils' positive attitudes towards mathematics during

the process of the school education (Ma & Kishor, 1997). Possible explanation of this could be difficulty of mathematics problems, too high pace of the education, language not adequate for pupils, negative attitudes of teachers etc. (Philippou & Christou, 1998). Our research showed that the decreases are in all areas of our questionnaire. The reasons for the decreases can be for all areas similar or there can be more factors, those can act separately or in coherence. To find this is the task for future researches that we want to realize using both quantitative and qualitative ways to find out more about this interesting and important matter.

5 Conclusion

In our paper we presented the research on pupils' attitudes towards mathematics. We studied changes in the pupils' attitudes in different grades of lower secondary education. We have found out, in accordance with previous researches, the decline in the positive attitudes towards mathematics. In the future research we plan to study more closely the changes in the attitudes towards mathematics during early years of primary education, to find out in what age the decline in positive attitudes begins to be significant. Then we plan to do some qualitative analyses to find the possible reasons for this and also we plan to implement some active methods of mathematics teaching to find out if we can overcome these negative tendencies. We hope that this will be helpful in the effort to improve pupils' attitudes towards mathematics and so improve in some ways the quality of mathematics education as such.

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