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GEOMETRIC TERMINOLOGY AND IMAGINATION

ROMAN GREBEŇ, JOSEF MOLNÁR

Abstract

How do pupils and students understand geometric terminology, symbols and phraseology? Using the same designation for a particular object, feature or link, allows the use of the same "language" to communicate about topics related to these concepts. The fact that everyone will equally understand the same term depends on how well the definitions are introduced. The objective of this article is one of the surveys, which is a part of the research, aimed to contribute to updating the geometric terminology in the Czech education system.

1. Introduction

Is it important to define and comprehend geometric terminology, symbolism and phraseology? Definitely YES!
The reason is obvious: Using the same designation for a particular object, feature or relation, allows the use of the same "language" to communicate about topics related to these concepts. Provided the definitions are well introduced everyone with equally understand the same term.

Historical frame. 25 years ago the crucial publications which were dealing with the Czech terminology of school mathematics were issued:

(1) Názvy a značky školské matematiky (*The terms and symbols of school mathematics*)

(2) Slovník školské matematiky (*The dictionary of school mathematics*)

The Terminology Commission for School Mathematics was established as a part of The Union of Czech Mathematicians and Physicists. The aim of this Commission is to update both publications and to carry on the efforts on the unification of school mathematics terminology. The focus of

• *Roman Grebeň* — e-mail: rg.univ@email.cz
Palacký University, Olomouc.
• *Josef Molnár* — e-mail: josef.molnar@upol.cz
Palacký University, Olomouc.

the research is closely related to this aim. The important part of it is the questionnaire survey examining geometrical imagination and knowledge of geometrical terms among primary school pupils, secondary school students and university students and mathematics teachers.

In February 2013 we initiated the research, which aims to find out what visions of basic geometric concepts primary students (of 6th – 9th grade), secondary school students (comprehensive schools as well as technical) and the school teachers of math have.

Research tools. Due to the character or the research, the most commonly used method will be questionnaire survey among those groups of respondents. They will give comments on various issues examining their images of geometric objects and relations between them, on the knowledge of definitions and understanding of the symbolic marking in geometry. The questionnaires focused on specific topic are used in the research. Respondents answer questions by indicating their preferred option and explaining or justifying their opinion. The survey is the third in the series.

2. Main results

2.1. **Administration.**

Questionnaire survey was performed in March and April 2014.

- Total respondents: 466
- Female/Male ratio: 1.3 (56% female, 44% male)
- Range of Age: 12 – 18 years

2.1.1. *Number of respondents: Role of respondent in the educational sphere.*

- **Elementary school, second stage** (6th – 9th grade; age from 12 to 15 years): 166 respondents
- **Grammar school, primary stage** (Eight-year grammar school; corresponds to elementary school, sec. Stage; age from 12 to 15 years): 128 respondents
- **Grammar school, second stage** (age from 15 to 18 years): 80 respondents
- **Specialized High school** (age from 15 to 18 years): 92 respondents

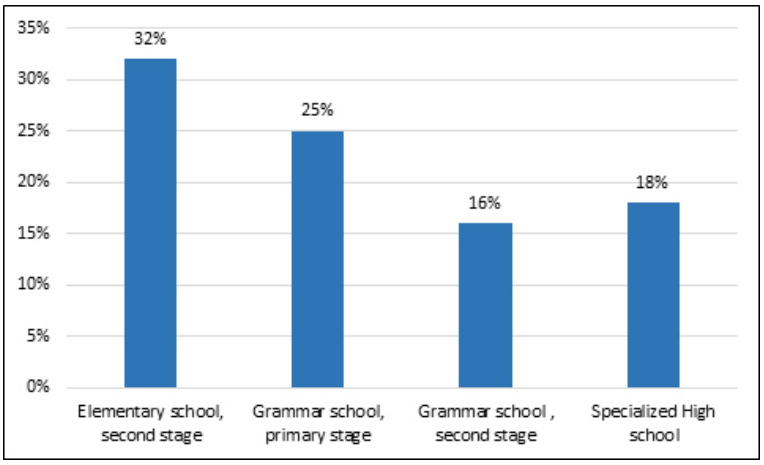

Figure 1. Number of respondents according to types of schools

2.1.2. *Number of respondents: Comparison of Elementary school, second stage and Grammar school, primary stage (see Figure 2).*

Eight-year grammar school:

- prima = 6th grade elementary
- sekunda = 7th grade elementary
- tercie = 8th grade elementary
- kvarta = 9th grade elementary

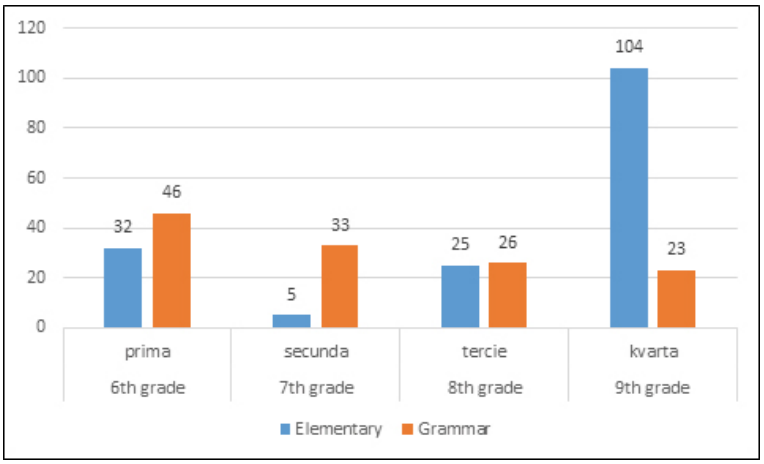

Figure 2. Number of respondents – Comparison of corresponding grades of Elementary and Grammar schools

2.1.3. *Number of respondents: Comparison of Grammar school, second stage and Specialized High school (see Figure 3).*

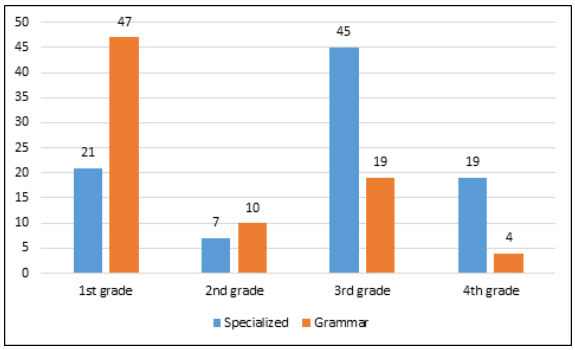

Figure 3. Number of respondents – Comparison of corresponding grades of Grammar school and Specialized High schools.

2.2. **The presentation of the tasks.**
The whole survey consists of 9 tasks. Task processing took place for sample of 466 respondents.

2.2.1. *Write the names of letters of the Greek alphabet.*
The task was to write the correct name of Greek letter according to the Figure 4. in questionnaire

$E,\ \varepsilon,\ \epsilon$		$\Theta,\ \theta,\ \vartheta$		$\Xi,\ \xi$	
$Z,\ \zeta$		$K,\ \kappa,\ \varkappa$		$\Sigma,\ \sigma,\ \varsigma$	
$H,\ \eta$		$N,\ \nu$		$\Psi,\ \psi$	

Figure 4.

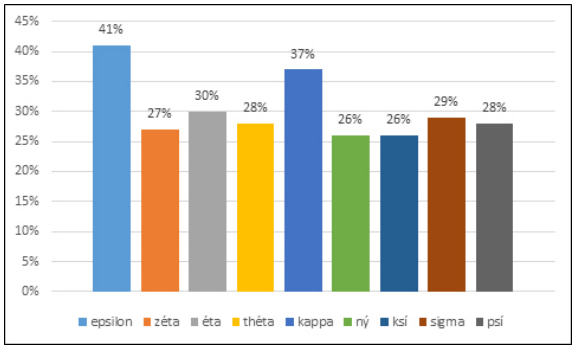

Figure 5. Graphical presentation of the success rate for the names of selected letters

2.2.2. *How to write letters of the Greek alphabet.*
The task was to write the correct symbol of Greek letter according to the Figure 6. in questionnaire

alfa		lambda		tau	
beta		mý		fí	
gama		pí		psí	
delta		ró		omega	

Figure 6.

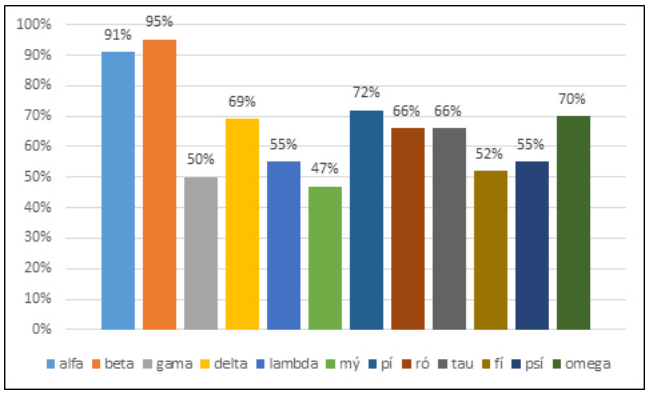

Figure 7. Graphical presentation of the success rate for selected letter symbols

2.2.3. *Names of angels.*
The task was to write the correct name of angels according to Figure 8. (a.–f.) in the questionnaire.

Figure 8.

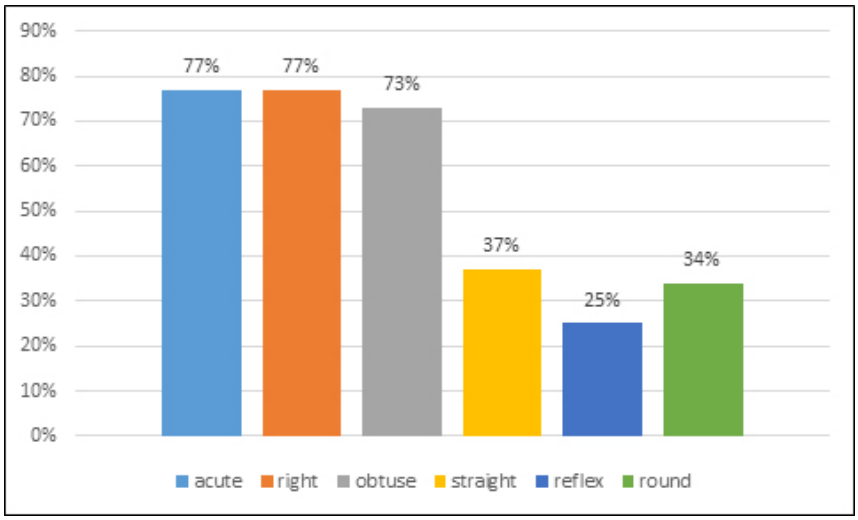

Figure 9. Graphical presentation of the success rate of angle's designation

2.2.4. *Which angle is convex / positively oriented / interior?*
The task was to correctly determine convex angle according to Figure 10. (choice A./B.), positively oriented angle according to Figure 11. (a choice of a/b) and interior angle according to Figure 12. (a choice of a/b) in the questionnaire.

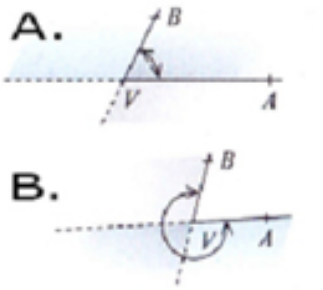

Figure 10.

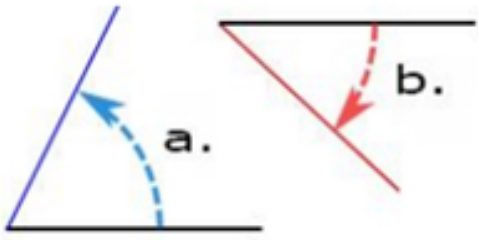

Figure 11.

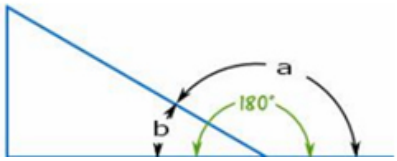

Figure 12.

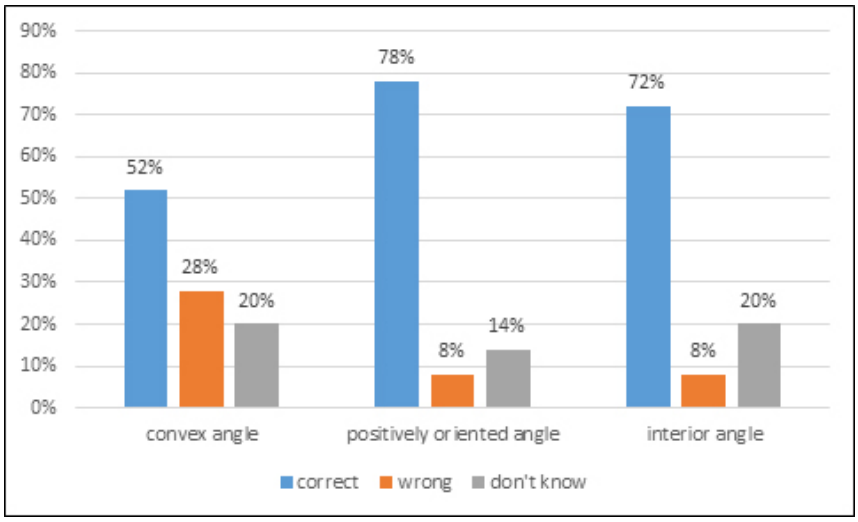

Figure 13. Graphical presentation of the success rate of the correct determination of convex angle, positive oriented angle and interior angle

2.2.5. *Names of Polygons.*
The task was to correctly designate six selected polygons according to Figure 14. in the questionnaire.

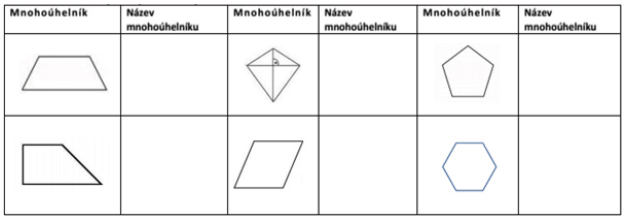

Figure 14.

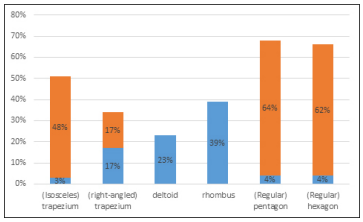

Figure 15. Graphical presentation of the success rate polygon's designation (brackets refer to the blue part of the column)

2.2.6. *Names of 3D objects.*
The task was to correctly designate ten 3D objects according to Figure 16. in the questionnaire.

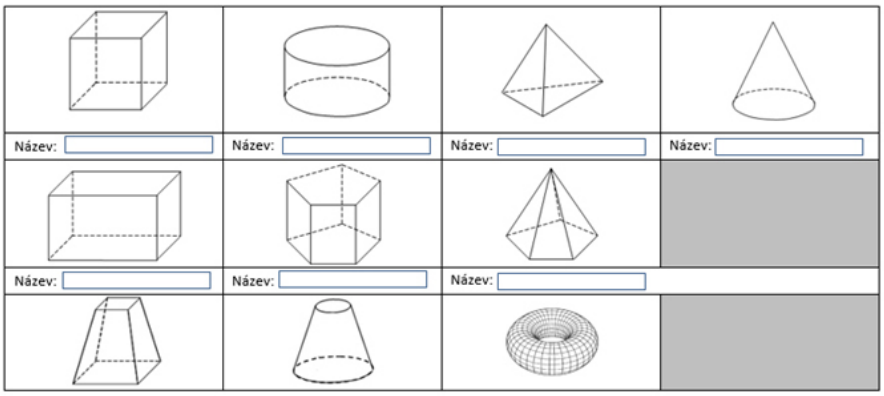

Figure 16.

2.2.7. *Circle and line.*
The task was to correctly designate red signed lines according to Figure 18. in the questionnaire.

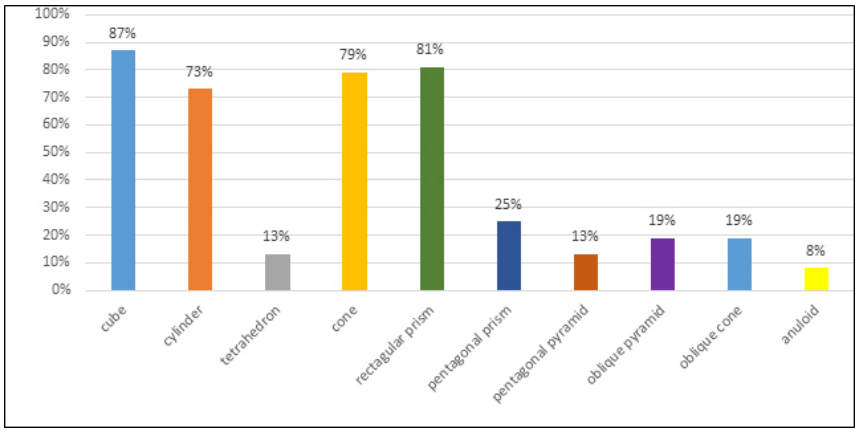

Figure 17. Graphical presentation of the success rate 3D objects designation

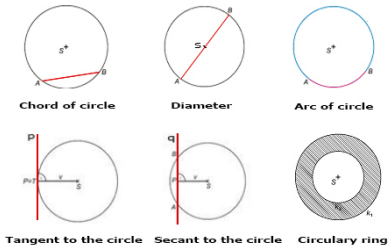

Figure 18.

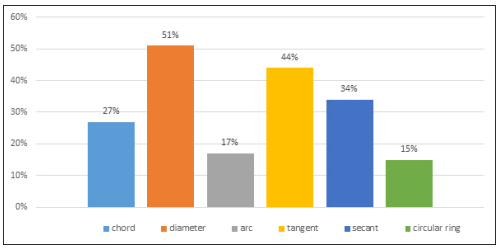

Figure 19. Graphical presentations of the success rate red lines and cross-hatched part of the ring designation

2.2.8. *Visibility of the sides of a cube.*
The task was to correctly determine visibility of the cube's sides in 4 different positions according to Figure 20. – 23. in the questionnaire.

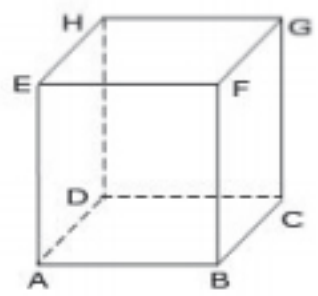

Figure 20. Cube A

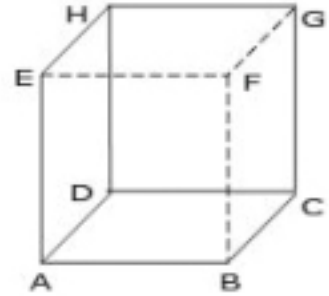

Figure 21. Cube B

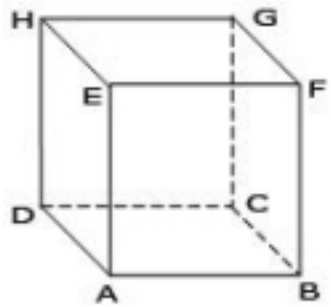

Figure 22. Cube C

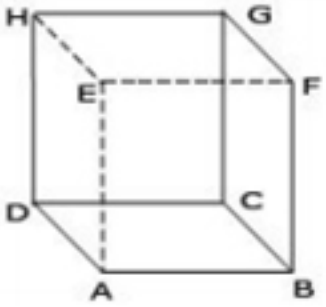

Figure 23. Cube D

Visibility of cube's sides from previous figures is shown as follows:

- Cube A: visibility of sides: ABEF, EFGH, BCFG
- Cube B: visibility of sides: CDGH, ABCD, ADEH
- Cube C: visibility of sides: ABEF, EFGH, ADEH
- Cube D: visibility of sides: CDGH, ABCD, BCFG

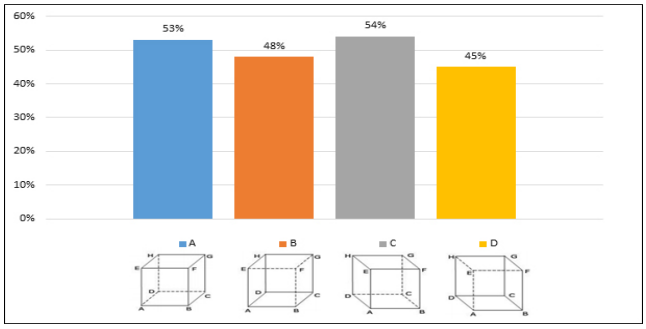

Figure 24. Graphical presentation of the success rate of the correct visibility determination of the cube's sides for its different positions

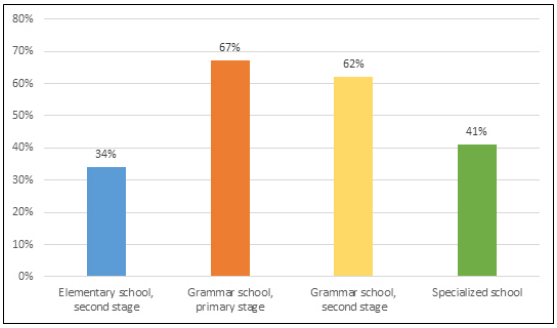

Figure 25. Graphical presentation of the success rate of the correct visibility determination (see Fig. 24) according to types of school

Note: Numerical values in percent mean average values over all space positions of a cube (A – D).

Overview of the presentation of the success rate according to various criteria:

Percent values according to gender (without distinction school types):
Female 50%
Male 45%

Percent values according to gender at Grammar school, 2nd degree:
Female 59%
Male 65%

Percent values according to gender at Specialized High School:
Female 43%

Male 40%

Percent values at Specialized High School for technical school and non-technical school:
Technical school 41%
Non-technical school 42%

2.2.9. *Recognition of parallelism.* Task was to decide, whether it would be possible to consider curves in Fig. 26 (A. – C.) as parallel.

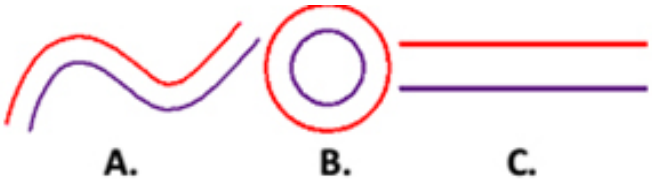

Figure 26.

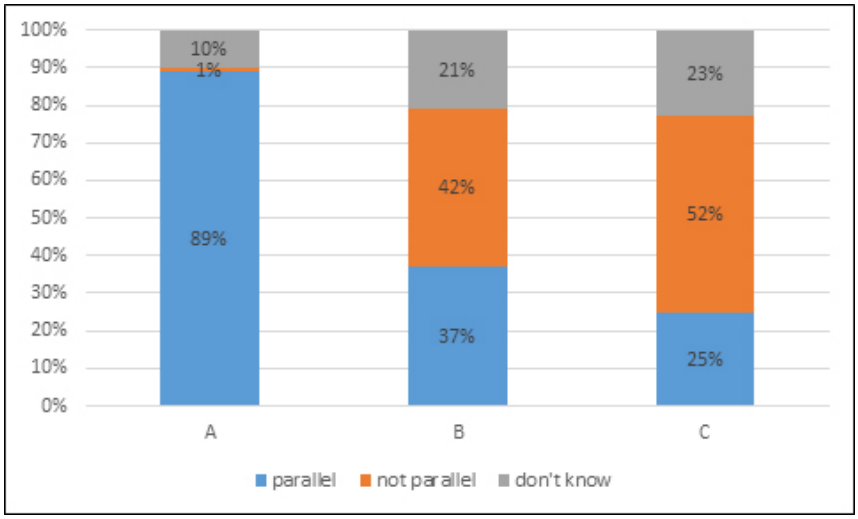

Figure 27. Graphical presentation of the responses to the question about curve's parallelism

3. Final remarks

From the survey results shown in this article the general conclusion can be drawn: the geometrical terminology knowledge of respondents is rather on average rate. Due to importance of accurate and clear introducing of terms, this result is not satisfactory. The construction of geometry demands strong knowledge basis.

The success rate differs not only in particular tasks, but also in particular groups of respondents. It depends on many factors: current grade of education, individual ability of spatial perception, and the period/length of studied subject matters.

Reference

[1] Grebeň R., Molnár J., *Geometrická představivost a terminologie, In: Molnár, J. a kol.: Geometrická představivost*, Vyd. UP, Olomouc, 2014.

[2] Grebeň R., Molnár J., *Geometrické představy žáků střední odborné školy, In: Profesní příprava učitelů přírodovědných oborů*, Vyd. UP, Olomouc, 2013.

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Roman Grebeň
Palacký University, Faculty of Science,
Teaching Methodology in Mathematics and Elementary Mathematics,
Křížkovského 8, 771 47 Olomouc, Czech Republic
E-mail address: rg.univ@email.cz

Josef Molnár
Palacký University, Faculty of Science,
Teaching Methodology in Mathematics and Elementary Mathematics,
Křížkovského 8, 771 47 Olomouc, Czech Republic
E-mail address: josef.molnar@upol.cz