

## GEOMETRY AT PRIMARY SCHOOL

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**Abstract.** Geometry is an essential part of primary stage mathematics curriculum. Its syllabus and performance standards exactly define what a pupil should master after completing each year of primary stage of education. In our survey we mapped real outcomes of mastering key terms from geometry by pupils after their completion of primary stage. The survey also includes a comparison of views held by both primary education teachers and secondary junior stage teachers of mathematics on some issues of concern when teaching geometry in primary & junior school age.

### 1. Starting points for survey

Teaching mathematics in primary school builds up on the pupils' experience of mathematical character gained during pre-school age. Analogically, knowledge and skills gained by pupils in the course of the primary stage of education form essential fundamentals on which further mathematical instruction is built. Mathematics in primary stage is divided into the three basic strands of learning: arithmetic, algebra and geometry. Primary school aged pupils are given early access to some key terms from geometry. Yet, these notions are not defined by the exact terminology of scientific mathematics but rather by language more adequate of their age, most often circumlocutory. Pupils should have formed their own conception of some geometrical terms (Prídavková, 2007). Math curriculum in the respective years provides for the following hours (number of lessons) of geometry: year 1 – 9 lessons out of 132, year 2 – 20 lessons out of 165, year 3 – 25 out of 165 and year 4 – 25 out of 165. Both content and performance standards in primary Mathematics articulate core elements of contents for the particular year. Requirements for knowledge and skills operationalise objectives of the given area that should be appropriated by each pupil at the end of each year.

**Year One**

*Contents:* Geometric shape: triangle, circle, square, rectangle, cube, sphere, cylinder. Curve, straight line, open line, closed lines.

*Requirements for knowledge and skills:* Distinguish geometric shapes: triangle, circle, square, rectangle, sphere, cube and cylinder. Trace straight lines. Draw and distinguish between open and closed line.

**Year Two**

*Contents:* Point, line segment, straight line. Drawing lines and its segments with ruler. Units of length centimetre (cm), metre (m), length of distance.

*Requirements for knowledge and skills:* Identify points and denote them with capital letters. Draw and denote straight line and line segment. Denote segments which lie (do not lie) on the given geometric shape (straight line or line segment). Measure the length in centimetres. Draw a line segment of corresponding length.

**Year Three**

*Contents:* Measuring length of line segment. Drawing line segment of corresponding length. Conversion of length units. Comparison of line segments lengths. Drawing circle. Drawing triangle and rectangle on grid paper, denoting their vertices.

*Requirements for knowledge and skills:* Measure the length of line segment in millimetres and centimetres, the distance in metres, draw the line segment of corresponding length. Acquaint with the length unit kilometre. Convert units of length. Draw circle with given centre and radius. Compare line segments according to their length and notate the result of comparison by means of  $<$ ,  $>$ ,  $=$ . Draw triangle and denote its vertices and sides. Draw rectangle and denote its vertices and sides. Draw rectangle and square in grid paper and denote its vertices and sides.

**Year Four**

*Contents:* Drawing perpendicular lines. Performing addition and subtraction of the length of segments. Multiple of segment's length. Perimeter of triangle, rectangle and square. Conversion of length units.

*Requirements for knowledge and skills:* Draw a line perpendicular to another line (by means of right angle triangle ruler). Determine addition and subtraction of segment's lengths. Determine multiple of segment's length. Calculate perimeter of triangle, square and rectangle. Convert units of length. (Bálint, 1998).

## 2. Methodology of survey

Non-standardised test containing geometry tasks was administered to 230 pupils from the 5 basic schools at the time of completing year four. The pupils sample was proportionately representative of village and urban schools including both fully organised as well as small size integrated mixed age schools. Pupils were taking test during one lesson - 40 minutes to answer, which provided an adequate amount of time. The tests were then assessed on the basis of phenomenal analysis.

Another part of the survey was a distribution of questionnaire on teaching geometry in primary school among teachers in primary stage (93 respondents), and questionnaire on pupils' preparedness for geometry syllabus taught in the secondary junior stage among teachers of Mathematics in the corresponding stage of education (68 respondents).

Through comparative analysis the pupils' real achievement in the test was compared with the respective views held by teachers in both groups (stages).

## 3. Results of survey

The administered test was designed in order to determine the following range of knowledge of pupils aged 10: name and denote geometric figures, name and discriminate plane and space geometry, identify elements of circle and disc, draw perpendicular lines, draw plane geometric figures (square, rectangle), determine perimeter and area of polygons (polygons presented in grid structure).

The answers were assessed on the basis of phenomenal analysis. The most frequent errors were identified.

The questionnaires administered among the teachers of both groups were assessed in terms of agreement/disagreement between a) the views of the teachers and b) the real outcomes attained by pupils in solving geometry tasks (Table 1). A comparative analysis brings out the following findings:

1. Teachers of elementary stage expected solving the tasks by pupils on point, segment and line without any problem. However, the correct denoting of these figures has proved to be the least mastered item.

2. Teachers of both stages presumed that pupils would sufficiently master the contents of plane geometry figures and would be able to name them and identify their elements. The test results have proved that pupils appropriately mastered the identification of planar figures with the exception of circle/disc identification. The above two geometric figures were a bit more problematic to pupils, as they could not identify whether points belong to circle or disc, and interchanged the terms diameter and radius.

**Table 1. Most Frequent Errors in Pupils Answers**

| Type of Error  | Number of occurrences |
|--|-----------------------|
| 1.1 incorrect identification of plane geometry figures (point, line, line segment, circle, disc) | 53                    |
| 1.2 incorrect denoting of geometric figures  | 194                   |
| Incorrect identification of plane geometry figures   |                       |
| 2.1 all figures  | 23                    |
| 2.2 only circle/disc   | 82                    |
| 2.3 only quadrilateral   | 34                    |
| 2.4 only polygon   | 29                    |
| 3.1 incorrect determining whether point resides on circle (disc)                                 | 111                   |
| 3.2 incorrect marking of radius  | 90                    |
| 3.3 incorrect marking of diameter  | 95                    |
| 4.1 inaccurate drawing of lines (perpendicular)  | 57                    |
| 4.2 incorrect (absent) denoting of line  | 137                   |
| 4.3 incorrect answer on the given question (right angle)   | 156                   |
| 5.1 inaccurate drawing of square or rectangle  | 12                    |
| 5.2 incorrect - denoting of vertices   | 19                    |
| - marking of adjacent sides  | 84                    |
| opposite sides   | 65                    |
| - drawing of diagonals   | 44                    |
| Incorrect identification of 3D geometric figures   | 99                    |
| 7.1 incorrect identification of geometric figure (polygon)                                       | 127                   |
| 7.2 incorrect calculation of perimeter or area   | 108                   |
| 7.3 missing unit or incorrect determining of it  | 115                   |

3. Teachers' assumption that the contents of perpendicular lines and right angle would be appropriated on the desired level has not quite proved true. Pupils could draw a line perpendicular to another line passing through a given point but would forget to denote lines. The term right angle has not been appropriated on the satisfactory level; they would not mark the right angle on the picture.

4. The views of the teachers of elementary stage (slightly more positive) and the views of their colleagues teaching in the secondary stage (slightly more negative) on mastering key terms connected with square and rectangle varied.

Pupils' answers have revealed that they are not able to correctly identify adjacent and opposite sides.

5. Teachers of both stages expected the task with 3D geometric figures to be the most difficult. Although, this assumption has not proved true, pupils made mistakes, though, compared with the other tasks, this one was managed on the average level.

6. In many instances pupils interchanged the terms perimeter and area the planar figure. Due to the fact that this task is a part of the year four syllabus, the attained results were not satisfying.

Comparing the answers of the teachers from elementary stage and secondary junior stage of education we have recorded many consistent views on teaching geometry in primary school, yet some discrepancies in their views emerged:

I. In their answers on the question of the amount of time which curriculum allocates to teaching geometry in the first stage of basic school, most teachers indicated that it is sufficient. Yet more teachers of the secondary junior stage inclined towards an idea of extending the amount of time allocated for geometry lessons.

II. In the question on relevance or irrelevance of listing certain parts of geometry into the Math syllabus of the first stage of basic school, both groups of teachers unambiguously expressed that the proportion of geometry in Math curriculum is adequate. However, first stage teachers held some views differing from those of their colleagues: content items as area of square and area of rectangle (currently a part of the non-core, extending-the-breadth-of-study syllabus) should be taught in higher stages, more space should be reserved for practising polygons, and the item of angles should be returned back to the first stage. Math specialists from the secondary stage would conversely shift parallels back to the first stage syllabus.

III. On pupils' preparedness to progress from the first to the secondary junior stage of education in the context of mastering basic geometric terms the teachers held the following views:

**Table 2. Pupils' Progress from the Primary to the Secondary Junior Stage of Education - Assessing Pupils by Teachers**

| Assessment Scale               | Elementary Stage Teachers | Secondary Junior Stage Teachers (Math Specialists) |
|--------------------------------|---------------------------|--|
| Without problems-excellent     | 14                        | 0  |
| Without major problems-well    | 51                        | 40   |
| With minor problems-adequately | 28                        | 28   |
| With major problems-weak       | 8                         | 0  |

#### 4. Conclusion

The results of 10 year old pupils attained when solving geometry tasks have revealed that not all of them have mastered geometry syllabus on the desired level. The analysis of pupils' solutions has primarily brought out the details about the errors that pupils made when solving geometry. Comparing pupils' achievement in test with the views of teachers from the primary and secondary junior stages of education on the pupils' mastery level of geometry syllabus, some interesting findings have emerged. Real results attained by pupils did not always meet teachers' expectation. All relevant information gained from the survey intended for teachers - practitioners is made accessible on the web page [www.matematickapointa.sk](http://www.matematickapointa.sk). Such form of feedback can in our view contribute to enhancing the quality of teaching geometry in primary school, so as the pupils after progressing to the higher stage can smoothly proceed with appropriating a more exacting geometry syllabus.

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