SPECIFIC ASPECTS OF THE DIFFERENTIATED ASSESSMENT IN MATHEMATICS LESSONS IN SECONDARY SCHOOL

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Abstract: *The purpose of the present paper is to highlight some specific aspects of the differentiated assessment in Mathematics lessons in secondary school where have been chosen different education strategies. It is analyzed and exemplified differentiated assessment through didactical game, using the interactive methods: "Gallery tour", "R.A.I." "Brainstorming", "Cube", "Jigsaw" and practical tests. At the end of the paper they drawn conclusions from the survey.*

Keywords: *assessment, differentiation, didactical game, interactive methods, practical tests*

1. INTRODUCTION

"The roles of teachers today are more and more complex. Some roles are being extended (for example the classic role of teaching is today very rich: to teach means more than transmitting information. To teach means to create an adequate learning context, to use ICT, to monitor students' learning, to help students become active participants in learning etc.)". [9]

„Differentiation and individualization of training is an old, but current pedagogical problem, since people have been different from each other not only regarding their way of thinking and being, but by the ability and pace of learning, by the attitude toward it. " [4] Differentiated work is the main way to improve school performance in mathematics. A differentiated work with students in mathematics classes involves choosing the scientific content, the teaching strategies appropriate teaching - learning-assess them according to the possibilities and particularities of students. "Individualized work is different from individual work, it involves adaptation of the volume of information and teaching methods to fit the skills of each student. "[7]

Individualized work lies not in individual performing of the same work by all, but choose the specific work adapted to each individual. " [3] Differentiation and individualisation of the strategies is closely related to differentiation of assessment strategies.

"The behavior of the teacher assessment plays a key role in giving students feedback on Their Performance Enhancing learning and motivation". [2]

"In recent decades assessment has become one of the major problems in education and teaching. The changes of social, political, economic, etc. conceptions determine transformations also in assessment ". [8]

"By diversifying and differentiated application of assessment forms, the school progress may be significantly affected." [5] This can be done in various ways, knowing that "there are no patterns , recipes to be compulsory but will be needed instead of talent and desire to discover the call-vocation for being a math teacher." [7]

2.PROCEDURES OF DIFFERENTIATED ASSESSMENT IN MATHEMATICS

The success of mathematics lessons is in direct dependence with the assessment made by the teacher. It is natural that when surrender of mathematical notions is made using differentiated scientific contents and differentiated teaching strategies the assessment to be also done differentiated. It is not appropriate that the grades obtained by differentiated assessment to be always written in the catalog.

Sharing pupils into groups of level can be done in several ways.Thus, in the case of acquisition of new classes, as happens especially in the fifth grade it is good at the beginning of the school year to give 2-3 tests to establish the level of knowledge of the pupils in relation to the level of their demands. A differentiation of tests on different indicators, such as: knowledge, calculation, of perspicacity helps to a first classification which will be confirmed or invalidated subsequently in current activities. [1]

"Slipping" pupils of a group level to another depending on the marks obtained in each assessment may be considered a criterion for sharing that stimulate pupils in learning, in getting better grades.

Applying the assessment methods differentiated in the lessons of mathematics in which were chosen differentiated instruction strategies, can be done in several ways, all with the idea to get feedback more closely, allowing the teacher to intervene promptly in helping to progress both the pupils which have a high level of knowledge in mathematics, and those with lower levels. We present in the following some of them, specifying that the differentiated assessment in mathematics lessons can be designed in many other ways, than those analyzed below, which are dictated by the existing needs in the classroom.

a) In order to achieve a differentiated assessments the teacher can apply a didactical game.

b) In order to achieve a differentiated assessments the teacher can apply an interactive method.

c) In order to achieve a differentiated assessments the teacher can apply practical tests.

d) Most common differentiated assessments is performed using written tests given to groups level.

As a result of the differentiated assessment the teacher will apply ameliorative measures. Thus, he can take recap and systematization of knowledges lessons in which, through a differentiated work to solve recovery exercises for pupils with poor results, and difficult exercises for those with very good results.

It is analyze and exemplify forwards some of the ways of differentiated assessment listed above.

3. DIFFERENTIATED ASSESSMENT THROUGH DIDACTICAL GAME

If in the mathematics lessons, it is intended that the assessment to achieve differentiated by using the didactical game, this can be done in several ways, one of them will be described below.

It can be used a single didactical game, to whom will be composed one or two complications. The competition is individual. Each pupil, depending on his level of knowledge in mathematics, will be directed by the teacher to participate in a setting. Thus, pupils with lower level in mathematics, participating in the basic version of the game, while pupils with a higher level in mathematics, participate to the complications of the game. This variant of differentiated assessment is exemplified in the following.

Example of differentiated summative assessment of pupils (having three levels of difficulty) through didactical game: "Find the correct result"-for the eighth grade - (The exercises of the worksheets for this example are taken from [6]).

Are assessed the formation to pupils the specific competence: 2.1. Using in exercises of the definition of intervals of real numbers and their representation on the axis of numbers.

Purpose: Assessment of knowledge acquired in the learning unit: Intervals of real numbers.

Didactic task: To solve exercises / problems on the worksheet received.

Teaching materials: Worksheets containing exercises / problems on three levels of difficulty.

Game elements: applause.

The gameplay. The teacher tells pupils that the average of grades obtained by them after solving exercises on the worksheet will be counted in the contest weekly organized at school between eighth grade. Then share sheets to each pupil, depending on his mathematics level of knowledge as follows: sheet A, those low achievers, sheet B, those with medium level, and sheet C, those with high level.

Thereafter the pupils working independently write on the worksheets the solving of exercises / problems.

All pupils who obtain correct results will be stand up and applauded by classmates who made mistakes during solving. For pupils who had difficulty in assimilating of knowledge will be given worksheets to eliminate gaps recovery.

Worksheet A (Low level)

1.Determine the sets:

$A=\{x\in R\,|\,x\in(-5;2]\vee x\in(-2;5]\};C=\{x\in R\,|\,x\in(-4;3]\wedge x\in[-3;4)\}.$

2.Let the sets: $A=\{x\in R\,|-\sqrt{3}<x\le 2\};B=\{x\in R\,|\,\sqrt{5}\le x<4\}.$

a) Write the sets A and B as an interval.

b) Determine the sets: $C=\{x\in R\,|\,x\in A\wedge x\in B\};D=\{x\in R\,|\,x\in A\vee x\in B\}.$

Worksheet B (Intermediate)

1.Determine $a\in Z$ in the following situations:

$(-2;2)\cap[a;5]=[-1;2)\quad(-\infty;1]\cup[-1;a]=[-\infty;3]$

2.Let the sets:

$A=\{x\in R\|\,2x-6\,|=0\};\quad B=\{x\in Z\|x\,|\le 3\}.$

a)Determine the elements of the sets A and B.

b)Calculate : $A\cup B;A\cap B;A-B;B-A;A\times B;B\times A.$

Worksheet C (High level)

1.Determine:

$A\cup B\cup C\cup D;A\cap B;A-B;B-A;A\times B;B\times A;C\cup D;C\cap D;C-D;D-C;C\times D,$

where:

$A=\{x\in R\|x-3\,|>2\};\ B=\{x\in Z\,|\,1\le\frac{3x+7}{4}\le 7\};\ C=\{x\in R\|\,4x^2-36\,|+|\,2x-6\,|=0\};$

and $D=\{x\in Z\,\|x-1|\leq 2\}$.

2.If $x\in[-3;2]$ and $y=\frac{x+3}{5}$, than the expression:

$E=\sqrt{x^2+y^2+6x+9}+\sqrt{x^2+y^2-4x-2y+5}$ is constant.

3. DIFFERENTIATED ASSESSMENT THROUGH INTERACTIVE METHODS

By using the interactive methods in order to do a differentiated assessment in some mathematics lessons, there are removed some obstacles of progress, both for pupils with special needs and for other pupils because in this way it can discover more accurately their gaps in mathematics.

Other than the solutions presented below, there are also ways to achieve the differentiation in the assessment process using versions of the known interactive methods which will be chosen according to the needs found in the classroom, and to the learning style of each student.

In the following we want to adapt some of the interactive methods in order to do a differentiated assessment of pupils' knowledge, of those with reduced learning abilities, of those who achieve a medium level and for pupils with performance in mathematics.

3.1. "Gallery tour" is an interactive method, which aids in the formative assessment in mathematics work, carried out by groups of pupils.

A variant of differentiated usage, in order to assess pupils' knowledge in mathematics lessons, of the method "Gallery tour" could be:

The teacher prepares three worksheets: one having problems with low level of difficulty, another having mid-level and third with high level. Then he shares them to the pupils according to their level of knowledge in mathematics, and ask them to group themselves after the number of the sheet received.

It is thus formed a group of pupils of low mathematics level, another group of pupils of middle and a third of those very good at mathematics.The pupils collaborate to solve the problems on the worksheet received and write down the solution that they founded. After the work timeis up, one representative of each group present the founded solution, then the groups analyzes and corrects if necessary these solutions, following that in the end each group have to read the comments they received. This differentiated assessment version is exemplified further.

Example of differentiated assessment of pupils (on three levels of difficulty) through the "Gallery tour" method.

With this sample is checked formation to the pupils of the following specific competences: 5.2. Determination of the solutions of some equations, inequations and systems of equations; 6.2. Identification of some problems that are solved using equations, inequalities and systems of equations, solving them and interpreting the outcome.

The eighth grade

Learning unit: Equations and inequations

The lesson's subject: equations and systems of equations. Recap.

The lesson's type: Assessment lesson.

Stages:

It formed 3 groups of pupils according to their level of knowledge in algebra.

II. Each group receives one worksheet corresponding to the level of the group, as follows:

Worksheet A (Low level)

1.Solve in N the following equation : $-x-4=4x+1.$

2. Solve in RxR the following system of equations: $\begin{cases} x+y=5 \\ x-y=3. \end{cases}$

3.Compose a problem which leads you to the equation: $x+5=0.$

Worksheet B (Intermediate)

1.Solve in N and in Z the equation: $\frac{4x}{3}=\frac{x-2}{2}+\frac{x+3}{6}$

2. In a building are apartments with 1 and 4 rooms. If the total are 30 apartments and 90 rooms, how many apartments are 1 and how are 4 rooms in the building?

3.Compose a problem that lead you to the system of equations: $\begin{cases} 3x-2y=7 \\ 5x+3y=37. \end{cases}$

Worksheet C (High level)

1.Solve in RxR the system of equations: $\begin{cases} 11|x|-2|y|=31 \\ 5|x|+7|y|=22. \end{cases}$

2. A child arrange his stamps in a stamp collectig book. If he placed on a page 50-stamps, then 10 stamps do not occur, and if he puts on a page 60, then 4 pages are empty. How many stamps have the child and how many pages has the stamp collectig book?

3. Compose a problem which leads you to the system of equations: $\begin{cases} 5x+y=55 \\ (x-1)(y+1)=xy+10. \end{cases}$

III. The activities' products of the groups of pupils: 3 sheets with exercises / problems solved on each sheet, they put themselves on the classroom walls.

IV. At the teacher' signal, the pupils groups pass at each sheet by turn, examine the solutions given by their classmates and on a separate sheet placed under the exposed sheet write under the number of their team their critical comments, questions, comments.

V. After the "Gallery tour" ends, groups return to their places and read the opinions from their classmates about what they worked and then review and make the corrections.

3.2. „R.A.I." method could also be used in order to do pupils' differentiated assessment of their knowledge in mathematics lessons. A variant of this method could be: each student is asked to bring to the chair on a note a question formulated by him. When a student throw the ball another student, the teacher will read him a question, of those formulated of the classmates, corresponding to his level of preparation in math.After applying this variant of „R.A.I.", will get two or three sets of questions of varying difficulty.

Example of oral differentiated assessment of pupils (on three levels of difficulty) through the "R.A.I." method- to the eighth grade.

With this sample is checked formation to the pupils of the following specific competence:1.8. The recognition and description of the elements of a circle in a given geometrical configuration.

The lesson's subject: Circle: definition; elements in a circle; angle to the center.

The lesson's type: Assessment lesson.

Variants of questions with varying degrees of difficulty:

1.What is the circle, the radius and the diameter, etc. (Low level)

2.What is the measure of an angle to the center? (Low level)
3.What is the link between radius and diameter? (Low level)
4.What is meant by congruent circles? (Low level)
5. What is the chord of a circle? (Low level)
6. What is a circular arc? (Low level)
7.What is an angle to the center ? (Intermediate)
8.What is meant by inside the circle? But by his outside? (Intermediate)
9.What is meant by disk of center O and radius R? (Intermediate)
10.What is the unit of measure of arches? (Intermediate)
11. What theorem about congruent arcs in a circle do you know? (High level)
12. What theorem about the diameter orthogonal to a chord do you know? (High level)
13. What theorem about arcs equally spaced from the center do you know? (High level)
14. What theorem about arcs comprised between parallel chords do you know? (High level)

3.3. Variants of the "Brainstorming" method used differentially in order to assess pupils knowledge, stimulate imagination and thinking skills, especially its fluidity for all pupils not just for those very good at mathematics.

A variant of „Brainstorming" method could be: the teacher form 2 or 3 groups of pupils according to their level of knowledge (for example the teacher will give each student the class, depending on the level his knowledge in mathematics, a badge, on which he will find written the name of the team he will belong to) and in each group, in which work tasks are appropriate to the level of the group applies this method. This suggestion of differentiated assessment by means of a "Brainstorming'" variant is shown below.

Example of differentiated assessment of pupils (on three levels of difficulty) through the " Brainstorming" method- to the sixth grade.

With this sample is checked formation to the pupils of the following specific competence: 4.3. Applying the rules for calculating and using parentheses in performing operations with integers.

The teacher performs three questions, respectively having three levels of difficulty. Divide one sheet containing one of three questions, to each student depending on his level of knowledge in mathematics. Pupils on the same sheet are grouped together and compose during 10 minutes as many problems. After time runs out, they will discuss all matters composed by pupils. Will be written on the blackboard and notebooks most original compositions at each level.Worksheet 1 (Low level)

Compose problems whose solutions leads to the calculation of the expression:

$1000-1500-800\cdot 5:4.$

Worksheet 2 (Intermediate)

Compose problems whose solutions leads to the calculation of the expression:

$[10000-(1500-80\cdot 5)]:10.$

Worksheet 3 (High level)

Compose problems whose solutions leads to the calculation of the expression:

$[(10000-1500-800)\cdot 5-100]:3.$

3.4. The ,,Cube"method could be applied differentiated to the assessment lessons for algebra but especially for geometry, in which there are more theoretical concepts available due to its adaptability to different subjects but also its positive impact on pupils.

Its use as a method of differentiated assessment in mathematics could be made in several ways.

a) Using a variant of this interactive method, depending on theme, you could assess differentiated in mathematics, as follows: for each face of the cube, the teacher will perform two or three worksheets with two or three difficulty levels. The pupils will be dealt with delicately in two or three homogeneous groups (eg teacher will give each student a card, depending on the level his knowledge in mathematics, to which find written the name or number of the team which he would belong to), and to each group will apply the method of "Cube" with topics appropriate level group.

b) Another way of differentiated assessment using a variant of this method could be: worksheets corresponding to two of verbs contain mild exercises, the other two verbs contain exercises or problems of medium difficulty, and for the last two , difficult issues. They will be dealt pupils into three homogeneous groups and each group will receive two verbs containing exercises having a level appropriate to the level of group.
Depending on the specific situation of the class, they can find other versions of differentiated assessment with this interactive method.
Variant b) is exemplified further.

Example of differentiated assessment of pupils (on three levels of difficulty) through the " Cube" method- to the sixth grade.

With this sample is checked formation to the pupils of the following specific competence: 1.1. Identification of characteristics of natural numbers and of writing form of a natural number in various contexts; 2.1. Use of arithmetical operations and their properties in calculations with natural numbers.

The fifth grade

The lesson's subject:

Recap from the fourth grade: Natural numbers less than or equal to 1 000 000
-the teacher introduce the didactic material for pupils: a cube that will be attached to each face one worksheet;
-it will work differentiated: for low level will be the faces of the cube:,, apply "and "describe,," for medium level:,, associate "and ,, analyze" and for the high level:,, argue "and "compares,, ".
-the teacher will organize pupils on 3 levels, each group receiving its level corresponding tasks.

Low level:

1. "Apply":

Apply the learned algorithms in order to effect the following exercices:

a. $2^4 \times 1000 + 4^2 \times 100 + 2^2 \times 10^2 + 6 =$
b. $65091 - (5076 + 1225) =$

2. "Describe":

Describe how formed the following numbers:

Model: $22468 = 2 \times 10000 + 2 \times 1000 + 4 \times 100 + 6 \times 10 + 8$

a. $45137750 =$
b. $6710104 =$

Intermediate:

3. "Associate ":

Associate, through an arrow, an element from column A with an element from column B:

A		B
1.	986053	a. Thirty-one thousand eight hundred and seventy-fiv
2.	31875	b. Eight thousand eight hundred and eighty-five
		c. Nine hundred eighty-six thousand and fifty-three

,, Analyze":

Analize the rule and continue the strings with more 4 numbers.

a) 2016; 1205; 2016; 1207; …….;
b) 769963; 769 972; 769 981; 769 992; ……..;

High level:

4. "Argue":

Argue the truth value of following statements:

1. The natural numbers written in increasing order: 0, 1, 2, 3, 4 , ……, n, n + 1,..., form the string of natural numbers.

2.134484, 134486, 134489 and 134490 are consecutive even natural numbers.

5. "Compare":

Compare the pairs of numbers:

a) 310104 and 32414
237711 and 237711
b) 375739 and 37839
19344 and 19434

3.5. „Jigsaw" method could also be used in order to do pupils' differentiated assessment of their knowledge in mathematics lessons. Variants of this method could be:

a) Subthemes corresponding the expert-sheet to be chosen so that everyone has different degree of difficulty, ie will be assessed homogeneous groups of pupils.

b) The differentiated assessment activity in Mathematics, can be carried out using this method, as follows: sub-themes corresponding the expert-sheet to be similar in difficulty, but the requirements for each sub-themes to be projected on two or three levels of difficulty, so any pupil from each group be able to contribute to solving it, ie assessment will be done on heterogeneous groups of pupils.

Depending on the needs of the class, you may experience other ways of applying differentiated this interactive methods in order to assess pupils' knowledge.

Variants of differentiated application of this method can be used both in algebra classes and in the geometry.

Variant b) is further exemplified.

Example of differentiated assessment of pupils through the " Jigsaw" method- the seventh grade.

With this sample is checked formation to the pupils of the following specific competence: 5.8. Deduction some properties of circle and regular polygons using geometric representations and concepts studied.

The lesson's subject: Calculation of the side and apotema in regular polygons

The type of lesson:Acquisition of new knowledge

The lesson's event:Feedback

A variant of differentiated assessment performed using the " Jigsaw" method could be: pupils are divided into three teams heterogeneous. The expert sheet contains the sub-themes:

1. The equilateral triangle. 2. The regular hexagon. 3.The square.

The evaluation sheet for each sub-theme contains items of increasing difficulty, so that pupils with a lower level of knowledge in mathematics can contribute to its achieving.

Sub-theme 1.The equilateral triangle.

1. Calculate depending on equilateral triangle side l, the perimeter and apotema of the equilateral triangle. (Low level)
2. On consider an equilateral triangle with side l and R the circumradius. Determine R and equilateral triangle area depending on l, and equilateral triangle apotema depending on R. (Intermediate)

Sub-theme 2. The regular hexagon.

1. Calculate depending on regular hexagon side-l, the perimeter and apotema of the regular hexagon. (Low level)
2. On consider a regular hexagon with side l and R the circumradius. Determine R and regular hexagon area depending on l, and regular hexagon apotema depending on R. (Intermediate)

Sub-theme 3. The square.

1. Calculate depending on square side-l, the perimeter and apotema of the square. (Low level)
2. On consider a square with side l and R the circumradius. Determine R and square area depending on l, and square apotema depending on R. (Intermediate)

Pupils collaborate in each team in order to solve their tasks and then choose one representative to the blackboard to show the results. The teacher observe the entire activity and intervenes to make any clarifications or corrections.

4. DIFFERENTIATED ASSESSMENT THROUGH PRACTICAL TESTS

The practical tests are rarely used in differentiated pupils'assessment in mathematics, but it is good to be used for faster understanding of mathematical concepts. The assessment through the practical tests consists in assessing pupils' capacity of application for certain theoretical knowledge, practical skills and abilities in solving problems.Variants of differentiated assessment using this method could be shown below.

1.It can be assessed simultaneously by two practical tests having different difficulty, applied to two groups of pupils with different levels.

2.It can be assessed by a single practical test with increasing workloads difficulty, applied to the pairs of pupils homogeneous or not, who are deskmates. For the pairs that solve tasks quickly the teacher make available additional sheets of exercises while he can work with pupils who experience difficulties.

Case 1. Example of differentiated assessment of pupils by two practical tests of varying difficulty, applied to two groups of pupils with different level of knowledge –the seventh grade,

Learning unit: Similar triangles.

Assessed sub-capacities:

-Identification of the similarity of triangles in a given configuration and recognizing of the concept of similarity report.

- Association of learned theorems with encountered concrete situations for practical problem solving.

- Transposition of the drawing of pairs of triangles that verifies a criterion of similarity.

Type test: Practical test

Working time: 15 minutes

Performance of the test:

Pupils are divided into two groups according to their knowledge level in geometry and each group gets one sheet whoose items correspond to the level of the group: Practical test 1(Intermediate)

With a pantograph build a triangle similar with the triangle ABC of the model, knowing that the similarity report is $\frac{2}{3}$. After building, knowing that AB = 0,4 dm, AC = 100mm and CB = 8cm, calculate the report of the perimeters of the given triangle and the built one. What do you notice?

Practical test 2 (High level)

Determine the height of a tree using the shadow, considering that at a time of sunny day the sun rays form with the ground congruent angles. It is known the shade of the tree (6m), the height of the observer - pupil (1m and 50cm) and its shadow (1m).

Case 2. Example of differentiated assessment of pupils by a practical test having unique work tasks with increasing difficulty, applied to pairs of pupils who are bank fellow.

Assessment through practical test –the fifth grade

Learning unit: Ordinary fractions.

Specific competence assessed:

2.1.Recognition of equivalent fractions, irreducible fractions and forms of writing a rational number.

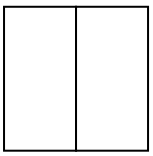
Assessed sub-capacitiy:Use the fractional numbers to express subdivisions of the whole.

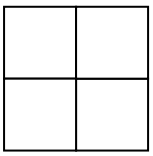
Teaching materials: paper, scissors, circles, rectangles, squares.

Sample content and technology of the deployment:

1.At the beginning of the acquire of new knowledge lesson, entitled "Equivalent Fractions" pupils will be asked to obtain (by cutting) a half of the first sheet and two quarters of the second sheet.

Compare overlapping the half with the two quarters and say what you observed.

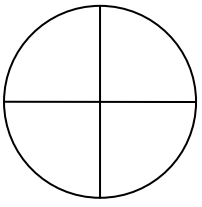


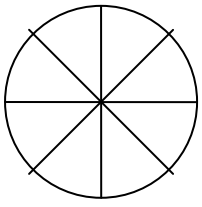


(Low level)

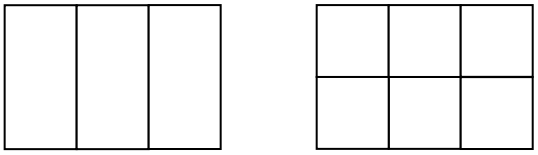
$$\frac{1}{2} = \frac{2}{4}$$

2.Same will apply with circles and rectangles.





$$\frac{1}{4} = \frac{2}{8}$$



(Low level)

$\frac{2}{3}=\frac{4}{6}$.

3.Perform the following operations with the help of didactical materials:

$\frac{5}{6}+\frac{4}{6}$

$\frac{3}{8}+\frac{2}{8}$ (Intermediate)

Work time: 10 minutes

Sheet with additional exercises for pupils who finish the race faster:

1. Get (cut) $\frac{3}{4}$ from the first sheet and $\frac{6}{8}$ from the second sheet. Compare by overlapping the 3 quarters with the 6 eighths and say what have you noticed.

2. Get (cut) $\frac{1}{5}$ from the first sheet and $\frac{2}{10}$ from the second sheet. Compare by overlapping 1 fifth with two tenths and say what have you observed.

3. Perform the following operations with the help of didactical materials: $\frac{2}{3}+\frac{3}{6}$; $\frac{3}{6}+\frac{7}{6}$.

CONCLUSIONS

The assessment of pupils knowledge in math in middle school, used as a strategy of differentiated instruction can be achieved both through teaching math game, and through interactive methods or practical tests, but more often through assessment tests. Assessment can not be made permanently differentiated, because on one hand nor teaching - learning is not made permanently or using differentiated teaching- learning methods, or the didactical means, and on the other hand, noting the low level sample assessment with the high level presents certain inconveniences certain limits that could lead to the demobilization of pupils who have strong knowledge in mathematics. Didactical math game, interactive methods, and practical tests organized differentiated may serve as oral or written assessment methods in algebra or geometry lessons.

There are more variants of the differentiation in the assessment process, using versions of the known interactive methods which will be chosen according to the needs found in the classroom, and to the learning style of each pupil.

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