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HEURISTICAL STRATEGIES ON THE STUDY THEME "THE UNSATURATED HYDROCARBONS – ALKENES"

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Abstract. The influence of heuristical strategies upon the level of two experimental classes is studied in this paper. The didactic experiment took place at secondary school in Cluj-Napoca, in 2008-2009 school year. The study theme "The Unsaturated Hydrocarbons – Alkenes" has been efficiently learned by using the most active methods: laboratory experiment, brain storming, modeling, problematization. The results obtained in the research demonstrate the efficiency of interactive methods in teaching-learning process.

Key Words: heuristical strategies, interactive methods, brain storming, laboratory experiment.

1. Introduction

In recent years, international studies and surveys on science and technology have shown that many countries are increasingly concerned with the lack of attractiveness that scientific careers have among young people and, generally speaking, with the insufficient diffusion of scientific culture (Valente A. et. al., 2008)

Learning science following an inquiry-based methodology is particularly effective in the direction of motivating students to learn how to define the framework for their investigation: to select, evaluate and manage scientific documentation in order to analyze a scientific problem; to look for a debate more than a fast-packaged conclusion (Naumescu A., 1992).

Teaching has importance (meaning) only if it is a communication with the other two functions of the education: learning and evaluation. The learning theories offer many possibilities which are adaptable to the characteristics of the whole class, of each student and of each teacher who plans the didactic measures in conformity with the objectives (aims) and the competence (the abilities) (Naumescu A., 2006). The organization of learning activities has to be in conformity with the objectives, competences and the contents in order to establish an active learning. The teacher has different ways of organization the classroom activities in conformity with the characteristics of the whole class, of the individuals, these activities help the teacher to see the progress of the students in learning chemistry or other sciences (Naumescu Kozan A., Glodian M., 2010**)**. So, the Chemistry teacher has to develop the specific thinking of his students so that the students can be good at other scientific and technological science (Kachan M. et al., 2006). In instructing and teaching the students, the teacher has to have some abilities: a correct and scientific knowledge, a critical analysis of the scientific facts, to motivate and stimulate the students, the project the didactic measures of the learning units in conformity with the students need, the projection of on objective to practice the diagnosis, summative, evaluation, to initiate the students to practice lockstep, individual work (Bell R. L. et al., 2000). Evaluation has to use plenty of theories and more evaluating instruments. The forms of evaluation (oral, written and practical) are focused on the objectives, so that the feed-back takes place in each teaching sequences and thus the continuous evaluation is essential (Zeidler D. L., Nichols B.H., 2009).

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2. Experimental part

The purpose of the experiment

The **main objective** of the didactic research was: the influence of heuristical strategies on the study theme "The Unsaturated Hydrocarbons – Alkenes".

The **hypothesis** of the didactic experiment was: the heuristical strategies and the continuous evaluation will influence the level of the two experimental classes and make the possibility to follow up the feed-back at the end of each lesson.

The didactic experiment took place at Secondary School, from Cluj, in the school year 2008-2009 the first term. Two classes were taken in the experiment: X-A and X-B classes. The tenth classes, A and B, profile: Informatics- Mathematics, with two hours chemistry / week, with 28 students and respectively 30 students. Both of them were experimental classes.

The study theme "The Unsaturated Hydrocarbons – Alkenes" can be efficiently learned by using the inter-active methods: didactic experiment, brain storming, modeling, problematization. The experiment has the role to confirm the verity, the efficiency of using teaching methods having an applicative-creative character.

Choosing this theme is not random because of the following:

a) The familiarization with organic chemistry can cause difficulties for the tenth grade students;

b) Students learn about substances with various practical applications (like ethylene, acetylene, etc);

c) They can use that logic way of deducing the molecular formulas in other chapters of the organic chemistry;

d) The methods used lead to an interdisciplinary way of learning.

The general **objectives** in the didactic experiment have been the following:

1) The stimulation of active participation during the lesson, logical thinking, creativity.

2) Making a bridge between the previous knowledge and the actual ones.

3) Creating of some specific situations in which the student must become its own perfection agent, the students should ask questions, they should have their own ideas.

4) The student can make connection between theoretical and practical knowledge.

5) The permanent evaluation of students' activity and the stimulation for their own evaluation.

In Table 1 the student's marks (XA class) and their percentage are presented.

Tabel 1. The results obtained at the initial test for class XA

Mark	No. of papers	Student's percentage (%)	General mean
1	0	0	7.42
2	0	0	
3	0	0	
4	0	0	
5	0	0	
6	7	20.21	
7	8	26.95	
8	8	30.8	
9	4	17.32	
10	1	4.81	

The results obtained at the initial test for class X A are the following: mark 6: 7 students, mark 7: 8 students; mark 8: 8 students; mark 9: 4 students; mark 10: 1 student, and the general mean is: 7.42.

The results are presented in Figure 1 and Figure 2.

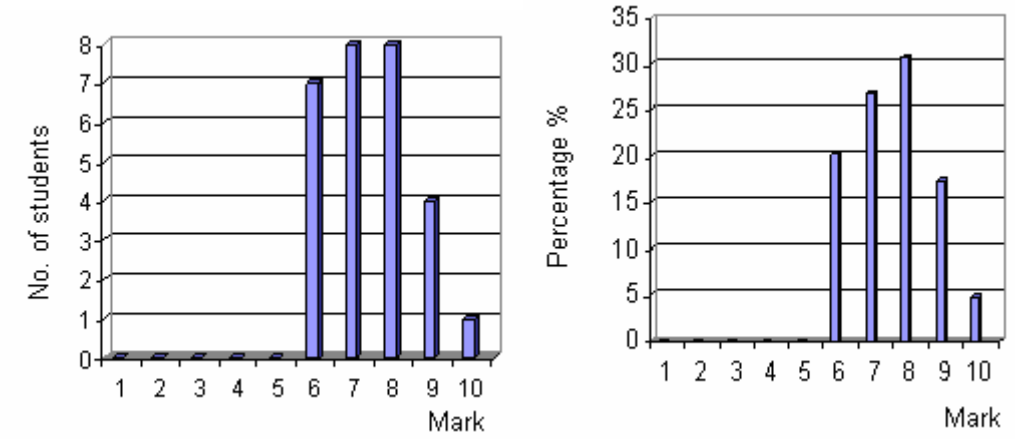

Figure 1. Histograms containing the results obtained at the initial test for class X A

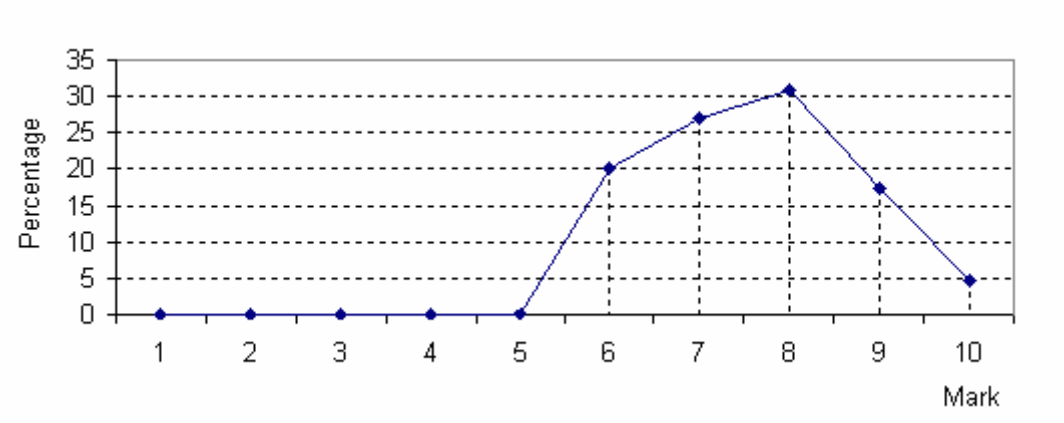

Figure 2.-Gauss Curve containing the results obtained at the initial test for class X A

The results obtained at the initial test for class X B are presented in Table 2.

Table 2. The results obtained at the initial test for class X B

Mark	No. of papers	Student's Percentage (%)	General mean
1	0	0	6.96
2	0	0	
3	0	0	
4	0	0	
5	2	4.78	
6	9	25.86	
7	10	33.52	
8	6	22.94	
9	3	12.92	
10	0	0	

The results obtained at the initial test for class X B are the following: mark 5: 2 students; mark 6: 9 students; mark 7: 10 students; mark 8: 6 students; mark 9: 3 students; mark 10: 0 students, and the general mean is: 6,96

The results are presented in Figure 3.

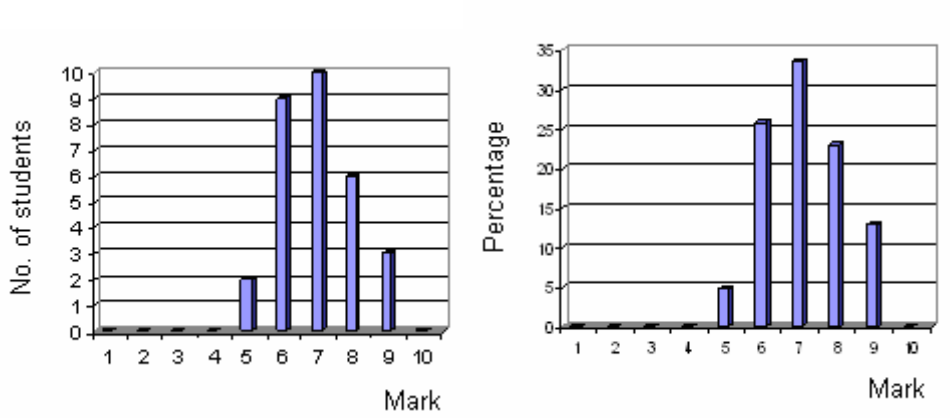

Figure 3. Histograms containing the results obtained at the initial test for class X B

Conclusions after initial test (X-a A and X-a B)

- students can identify different types of hydrocarbons, indicate the conditions necessary for the isomerization of n-butane; and indicate the products obtained in the reaction between CH_4 and chlorine.

-the cause for wick results (III, IV) could be the lack of practice in solving some qualitative (III) and quantitative (IV) problems.

For this reason is recommended:

- give them an exercises list, for each student, to work independent.

- use an entire set of heuristical methods like: problematization, exercise and problem solving.

A comparative representation of the results obtained at the initial test for both classes is presented in Figure 4.

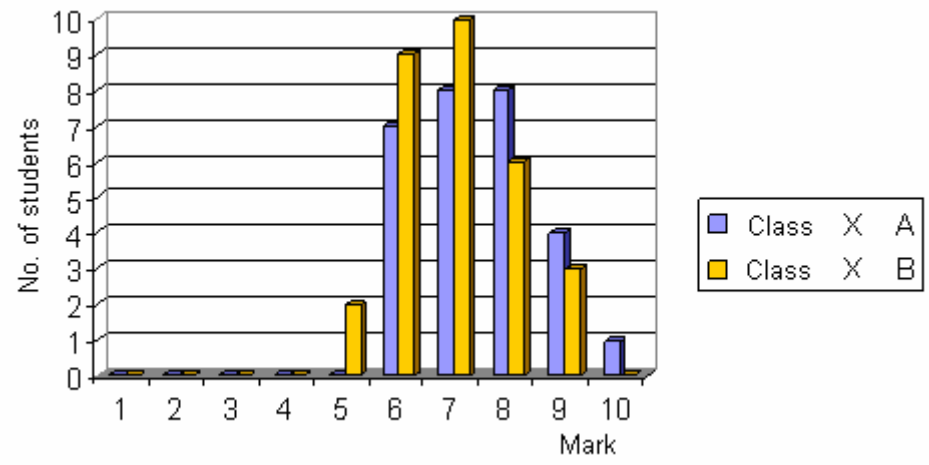

Figure 4. Comparative histograms of the results obtained at the initial test for class X A and X B

Interpretation of the results obtained at the final test for class X A and X B

The results obtained at the final test for class X A are given in Table 3.

Table 3. The results obtained at the final test for X A class

Mark	No. of papers	Student's Percentage (%)	General mean
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	8.03
6	3	8	
7	7	21.77	
8	7	24.88	
9	8	32	
10	3	13.33	

The results obtained at the final test for X A class are presented in Figure 4 and Figure 5.

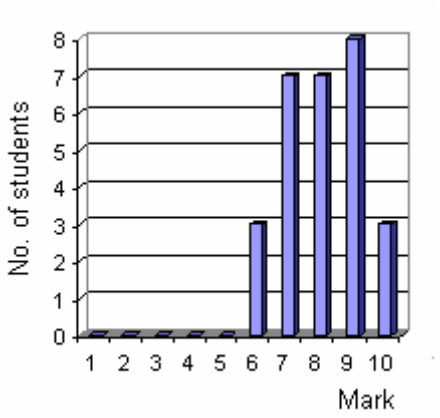

Figure 5. Histogram containing the results obtained at the final test for class X A

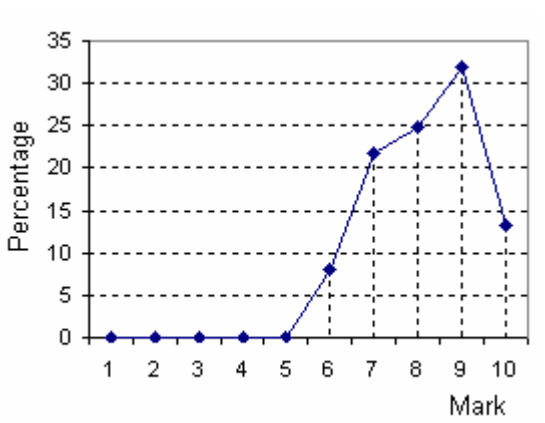

Figure 6. Distribution curve of the results obtained at the final test for class X A

The results obtained at the final test for class X A are the following: mark 6: 3 students; mark 7: 7 students; mark 8: 7 students; mark 9: 9 students; mark 10: 3 students, and the general mean is: 8.03. So, we have 35.71% students having a mark between 5 and 7, 53.57% students having a mark between 7 and 9 and 10.71% students having a mark between 9 and 10.

The results obtained at the final test for class X B are given in Table 4.

Table 4. The results obtained at the final test for class X B

Mark	No. of papers	Student's Percentage (%)	General mean
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	7.64
6	6	20	
7	10	33.33	
8	9	30	
9	4	13.33	
10	1	3.33	

The results obtained at the final test for class X B are presented in Figure 7 and Figure 8.

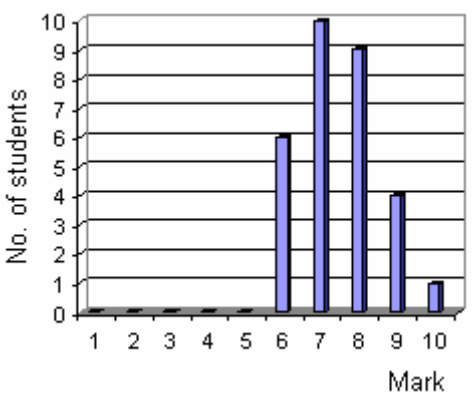

Figure 7. Histogram containing the results obtained at the final test for class X B

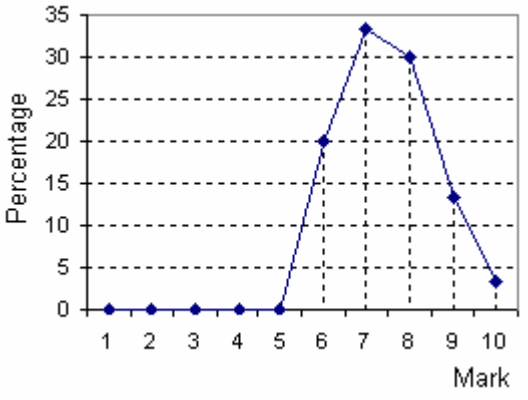

Figure 8. Distribution curve of the results obtained at the final test for class X A

The results obtained at the final test for class X A are the following: mark 6: 6 students; mark 7: 10 students; mark 8: 9 students; mark 9: 4 students; mark 10: 1 student, and the general mean is: 7.64. So, we have 53.33% students having a mark between 5 and 7, 43.33% students having a mark between 7 and 9 and 3.33% students having a mark between 9 and 10.

A comparison between the results obtained at the evaluation final test for class X A and X B.

The results obtained at the final test for both classes are comparative presented in Figure 9 and Figure 10.

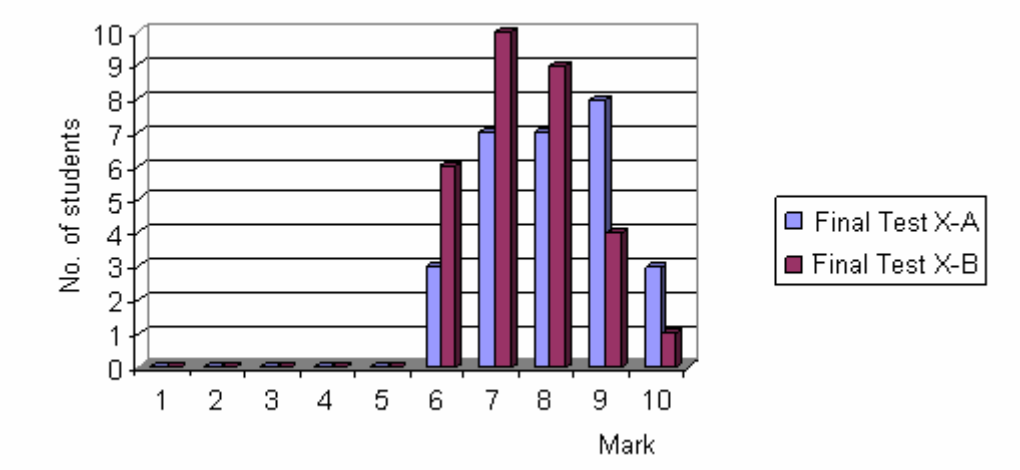

Figure.9. Comparative histogram of the results obtained at the final test for class X A and X B

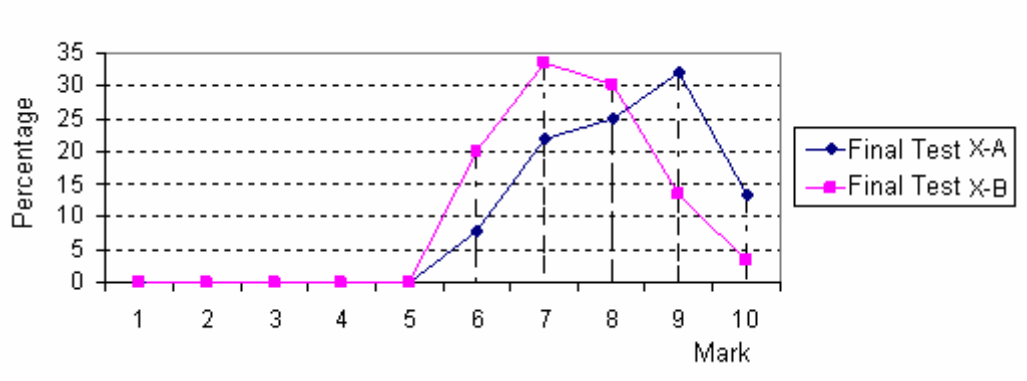

Figure 10. Comparative distribution curves of the results obtained at the final test for class X A and X B

Conclusions after final test (X-a A and X-a B)

- we have 29.77% students having a mark between 5 and 7 in class X A and 53.33% students in class X B;

- we have 56.88% students having a mark between 7 and 9 in class X A and 43.33% students in class X B;

- we have 13.33% students having a mark between 9 and 10 in class X A and 3.33% students in class X B;

-general mean is 8.03 in class X A and 7.64 in class X B

We can see a growth in general mean of about 0.56 points for class X A and of about 0.50 points for class X B, compared with the initial test, which means that the independent activities improve the educational process.

The comparative analysis of the marks obtained at the initial and the final test for class X A is presented in Figure 11.

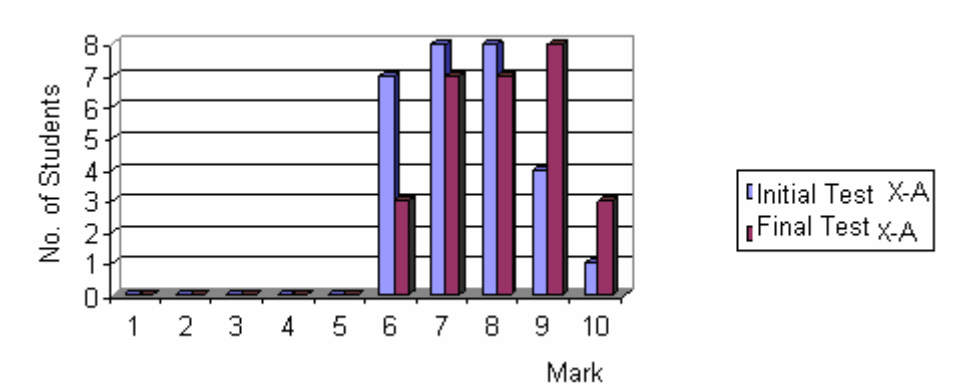

Figure 11. Comparative histogram of the results obtained at the initial and final test for the class XA

The comparative analysis of the marks obtained at the initial and the final test for class X. B is presented in Figure 12.

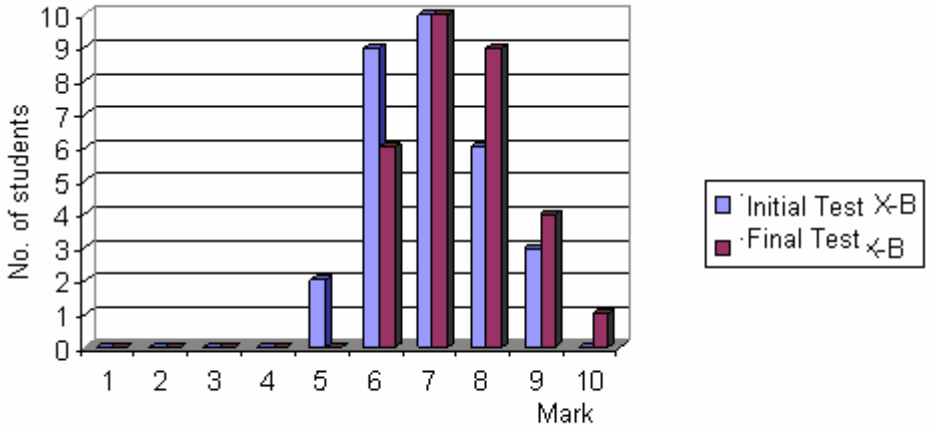

Figure 12. Comparative histogram of the results obtained at the initial and final test for the class X. B

Conclusions

Heuristical methods lead to the improvement of the results obtained by students, expressed quantitative in a significant growth of the marks from the initial to the final test.

Heuristical methods stimulate a more active participation of the students, making them interested, curious, but specially, by growing their motivation for study.

Heuristical methods determine a modification in positive sense student's way of thinking, making them to learn using their own effort in "construction" of new knowledge, and not only simply repeating the teacher's ideas.

Heuristical methods can not be used alone. Not all the concepts, laws and principles can be achieved in a heuristic way. So, the teacher must combine the heuristical methods with the traditional ones (explanation, algorithms), to choose the right content, depending on the given situation.

Heuristical methods must be applied depending on the class level,on the psychological resources of pupils.

Applying heuristical methods needs a very well prepared teacher and a very dedicated one. Students must be appreciated for their results and never severely criticized for the eventual mistakes.

The relationships between teacher and student must be honest, open, based on reciprocal respect taking into account the difficult moments that can appear during the teaching learning process, due to the difficulty of finding a solution.

Applying heuristical methods imposes an interdisciplinary approach. From this point of view we should mention that the chemistry books must also contain notions specific for other domains like biology, physics and mathematics.

Applying heuristical methods imposes a bigger effort for the students, so their timetable is important to be very well organized.

Using heuristical methods implies much more effort from teacher side (content selection, realizing the list of exercises), and from the student side (independent work and a minimum help from the teacher side). But the benefits of using such methods are considerable for the scientific knowledge and for developing a creative way of thinking, which is so important for our future society, don't forget that our students will become "the tomorrow society".

The student must become its own perfection agent, and this can be accomplished only using heuristical methods in the teaching learning-process.

References

[1] Bell R. L., Lederman N. G., Abd-El-Khalick F. (2000), "Developing and acting upon one's conception of the nature of science: A follow-up study", *Journal of Research in Science Teaching*, 37, 563-581.

[2] Naumescu Kozan A., Goldian M. (2010), "The importance of evaluation in teaching science; Applications in the study theme: Alkanes", *Studia Psychologia Paedagogia,* 2, 117-127.

[3] Naumescu A., (1992), "*Noţiuni de metodica predării chimiei",* Ed. Presa Universitară Clujeană Cluj-Napoca.

[4] Naumescu A., (2006), "*Cercetări şi direcţii cu privire la evaluare în didactica ştiinţelor"*, Ed.Casa Cărţii de Ştiinţă Cluj-Napoca.

[5] Kachan M., Guilbert S., Bisanz G. (2006), "Do teachers ask students to read news in secondary science? Evidence from the Canadian context.", *Science Education*, 90 (3), 496-521.

[6] Valente A., Cerbara L., Caravita S., Luzi D. (2008). "Conceptions on evolution in teachers and future teachers: results of an italian investigation." *Proceedings XIII IOSTE Symposium*, Kusadasi, Turkey, 794-802.

[7] Zeidler D. L., Nichols B.H. (2009), "Socioscientific issues: Theory and practice.", *Journal of Elementary Science Teacher Education*, 21(2), 49-58.

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Annex

1. Initial Test

No.	Subject	Score
I.	1. Fill in the blanks the following: Alkanes are hydrocarbons……..having the general formula …..	0.25x2=0.5p
	2. Find the correspondence between chemical formulas and the corresponding names in columns A and B: A B CH_4 heptane C_7H_{16} pentane C_5H_{12} propane C_3H_8 methane	0.25x4=1p
	3. Choose the right answer and specify the chemical reaction: a) at 50-100°C and in the presence of $AlCl_3$ anhydrous b) at 50-100°C c) in the presence of H_2SO_4 d) in the presence of $AlCl_3$ anhydrous	0.5p
II.	Write the reactions between CH_4 and chlorine and name the products	0.75x4=3p
III.	Write the chemical structures for the following alkanes: a)C_4H_{10} b)C_6H_{14}	1x2=2p
IV.	An organic substance has the following mass report: C:H:O=36:6:10. The molecular weight is 98. We have: AH=1, AC=12, AO=16.	2p

2. Final Test

Exercise 1. Chose and name the alkenes form the following.

C_2H_2, C_4H_8, CH_2=CH-CH_3, CH_3-C≡C-CH-CH_3, C_4H_6

CH_3

Exercise 2. Fill in the blanks:

Acetylene can be obtained form...and from....

Exercise 3. Identify and give the name the substances form the following chemical reactions:

a) Propene + Cl_2 → A

b) 2-Butene + H_2O → B

c) Acetylene + $2Br_2$ → C

d) acetylene + H_2 → D

Exercise 4. Write the chemical formulas for the following:

a) 2-Methyl-2-heptenal

b) 2-Butin

c) 2, 2, 3-trichloro-pentane

d) Vinyl Chloride

Exercise 5. Which alkene contains 85.71% C and has molecular weight M = 56. Write the isomers. We have A_c=12, A_H=1.

Working time: 45 minutes

3. Solving Model for the Final Test

Exercise 1. C_2H_2, C_4H_8, CH_2=CH-CH_3, CH_3-C≡C-CH-CH_3, C_4H_6

=== ––– ––––––––– | === **0,5p.**

CH_3

==========

Exercise No. 2. Acetylene can be obtained from *CH_4* and from carbide **0,5p.**

Exercise No. 3. CH_2=CH-CH_3 + Cl2 → CH_2-CH-CH_3

propene | |

Cl Cl **3p.**

1,2-dichloropropane

CH_3-CH=CH-CH_3 + H_2O → CH_3-CH- CH_2-CH_3

2-butene |

OH

2-butanol

Br Br

| |

C_2H_2 + 2Br_2 → HC – CH tetrabromoethane

acetylene | |

Br Br

$HC{\equiv}CH + H_2 \xrightarrow[Pb]{Pd} H_2C{=}CH_2$

acetylene ethylene

Exercise 4. a) CH_3-C=CH-CH_2-CH_2-CH_2-CH_3

|

CH_3 **3p.**

2-methyl-2-heptenal

b) CH_3-C≡C-CH_3

2-Butin

Cl Cl

| |

c) H_3-C-CH-CH_2-CH_2-CH_3

|

Cl

2, 2, 3-trichloro-pentane

d) CH_2=CH

|

Cl Vinyl Chloride

Exercise 5. $M_H = 100-85.71 = 14,29$

$C = 85.71/14 = 7.14$ $C = 7.14/7.14 = 1$

$H = 14.29/1 = 14.29$ $H = 14.29/7.14 = 2$

$F_b = (CH_2)_n$ $n = 56/14 = 4$

$Fm = C_4H_8$

$CH_2=CH-CH_2-CH_3$ 1-Butene **2p**

$CH_3-CH=CH-CH_3$ 2-Butene Bonus **1p**

Total 10p.

4. An example of the lesson plan

Theme: Alkenes. *Definition. Nomenclature. Structure.*

Lesson type: Achieving the new knowledge

Objectives:

O1 : To define the Alkenes using teacher's explications

O2 : To give the Chemical name using the examples from the exercises list

O3 : To explain the Chemical bond with the help of spatial models

Didactic strategies

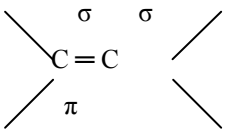
Methodological system: the heuristic conversation, the explication , the modeling, the exercise solving

Material resources: exercises list, spatial models

Ways of organizing the activity: frontally, individually, on level groups

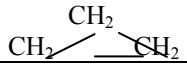
Lesson:

Teacher's Activity	Student's Activity	Observations
Announces the thyme of the lesson: **- Alkenes. Definition. Chemical name. Structure.** -Devices the students in groups, gives the exercises list -Asks the students to complete the first exercise - Asks the students to define alkenes and to establish their general formula	Follow the exercises list and complete the first table *Alkenes are unsaturated* **Hydrocarbons***, acyclic, with a double bond, linear or* **branched** *chain. They have the general formula* C_nH_{2n} *şi NE=1*	Evaluation of the O1
-Asks the students to complete the second exercise and give the naming rule for alkenes - Completes the naming rule: We must indicate the position of the double bond in front of the chemical name We must respect the IUPAC rules	They complete the second table. They make the naming rule of the alkenes: *Starting from the* **Alkane** *having the same number of carbon atoms in molecule and replacing the ending.*	Evaluation of the O2

- Presents the spatial model for **Ethylene** and 1-Butene Asks the students to give the model for propene and 2-butene;	They take notes They give the model for Propene and 2-Butene They characterize the double bond:  *- the carbon atoms from double bound are sp^2 hybridized, so we have three σ bounds and one π bound between them* *- The σ bounds are situated in the same plan* *- The π plan is perpendicular on the σ planand stop the free rotation around the double bound* *- the length of double bond is 1,33Å*	Evaluation of the O3
- Asks the students to complete the third exercise - Gives the homework	Completes the chemical names for substances given They give possible structures for molecular formula C_5H_{10} and chemical names.	Evaluation of the O2

5. Exercises List

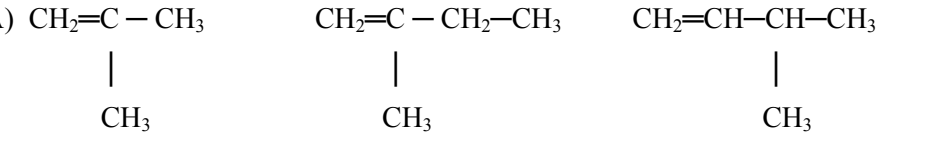
Exercise 1. Analyze the table and fill in the blanks.

Molecular Formula	Number of the carbon atoms	Number of the hydrogen Atoms	Chemical structure	Chain type	**Hydrocarbon type**
C_2H_4	2	4=2*2	$CH_2{=}CH_2$	*Acyclic*	*unsaturated*
C_3H_6	*3*	*6=2*3*	$CH_2{=}CH{-}CH_3$	*Acyclic*	*unsaturated*
C_4H_8	*4*	*8=2*4*	$CH_2{=}CH{-}CH_2{-}CH_3$	*Acyclic linear*	*unsaturated*
C_5H_{10}	*5*	*10=2*5*	$CH_2{=}C(CH_3){-}CH{-}CH_3$	*Acyclic branched*	*unsaturated*
C_3H_6	*3*	*6=2*3*		*Cyclic*	*saturated*
General formula C_nH_{2n}	N	2n		Acyclic linear or *branched*	*unsaturated*

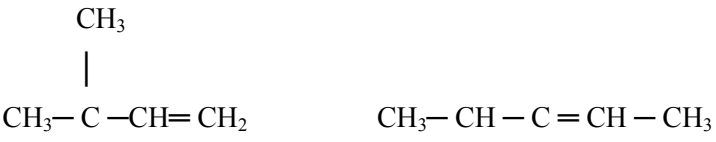
Exercise 2. Analyze the naming rule for the following molecular formulas given in the tabel:

Molecular Formula	Chemical name of the corresponding **Alkane**	Chemical structure	Chemical name of the **Alkene**
C_2H_4	*Ethane*	$CH_2{=}CH_2$	Ethylene
C_3H_6	*Propane*	$CH_2{=}CH{-}CH_3$	*Propene*
C_4H_8	*Butane*	$CH_2{=}CH{-}CH_2{-}CH_3$ $CH3{-}CH{=}CH{-}CH_3$	*1-Butene* 2- Butene
C_5H_{10}	*Pentane*	$CH_2{=}CH{-}CH_2{-}CH_2{-}CH_3$ $CH_3{-}CH{=}CH{-}CH_2{-}CH_3$	*1-Pentene* *2- Pentene*

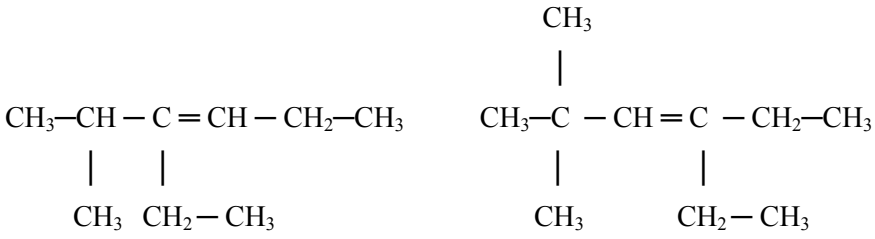
Exercise 3. Analyze the naming rule for the following chemical structures:

A) 

2-methyl-propene *2-methyl-1-butene* *3-methyl-1-butene*

B) 

3,3-dimethyl- 1-butene *3-ethyl-4-methyl-2-pentene*

C) 

3-ethyl-2-methyl-3-hexene 4-*ethyl-2,2-dimethyl-3-hexene*