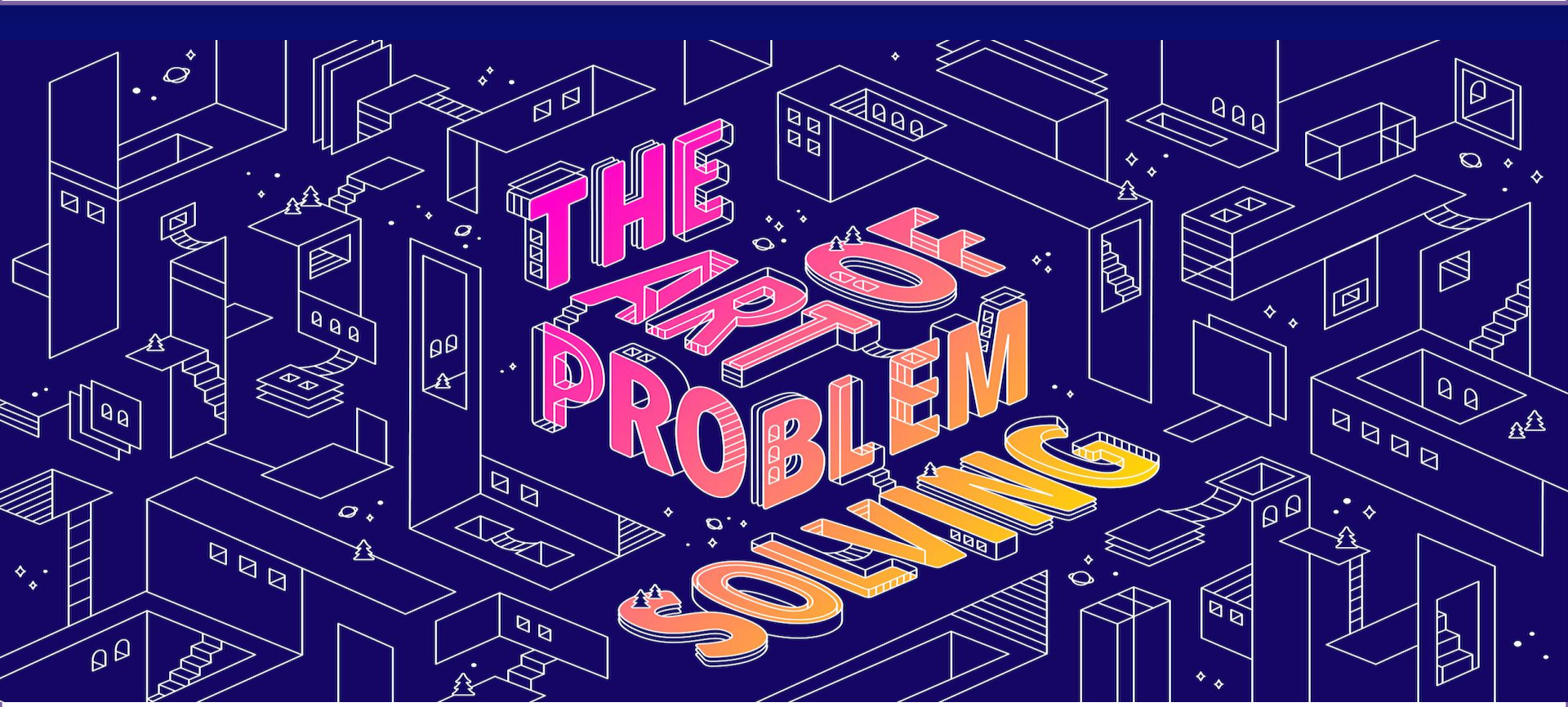
ATTITUDES AND EXPERIENCES OF THE ELEMENTARY SCHOOL PUPILS AS GUIDELINES FOR IMPROVING THE PRE-SEVICE CHEMISTRY TEACHERS' COMPETENCIES FOR THE IMPLEMENTATION OF PROBLEM-BASED TEACHING



Katarina Putica

Introduction

Life in the 21th century is shaped by fast scientific and technological development

Scientific and technological innovations: improving quality of life and/or causing stress?

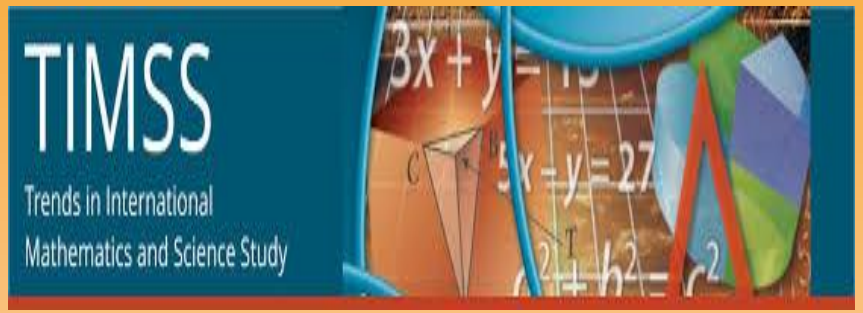
1970

2015

2020

Modern society requires of educational systems to prepare pupils for efficient adaption to the changeable conditions of life and the professional market, which presupposes the ability to apply the knowledge of natural sciences in order to overcome the challenges caused by the fast scientific and technological development.

Whether science education in elementary schools in Serbia meets this requirement?



The results of PISA tests showed that most pupils in Serbia, having completed their elementary school education, are not able to apply the knowledge of natural sciences in solving real-life problems.

The results of a questionnaire concerning the frequency of various pupils' activities during chemistry lessons, which was filled in by Serbian teachers within the framework of a TIMSS survey, showed that pupils are rarely in position to acquire new knowledge through solving problems from everyday life.

Within the study programs for the education of pre-service chemistry teachers, special attention must be paid to the development and advancement of their competencies for problem-based chemistry teaching!!!

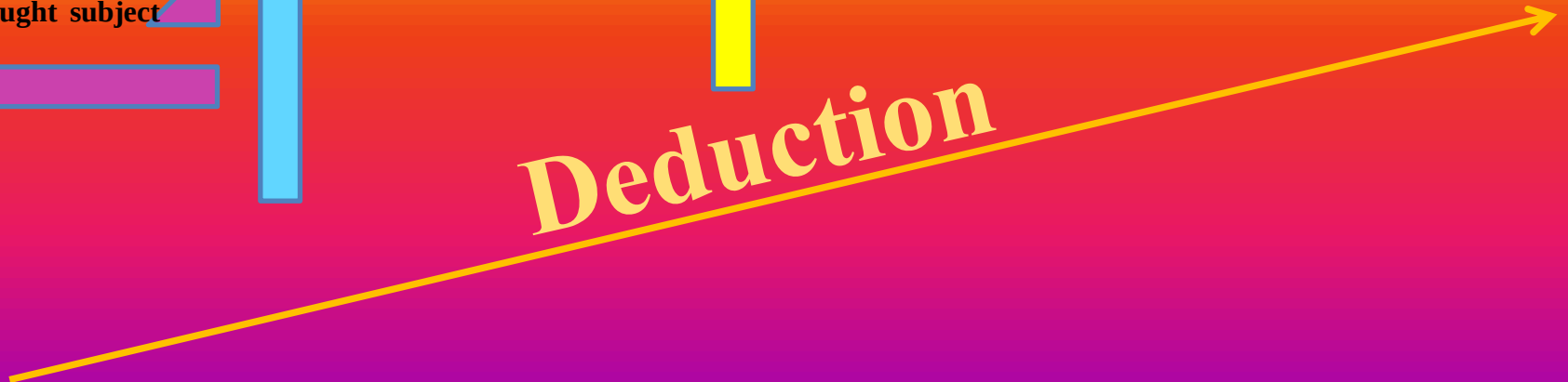
The principles of problem-based teaching/learning

Within the framework of problem-based teaching, one proceeds from a problem-type situation for which there is no direct solution in the previously taught subject material.

Instead, the pupils are expected to find the solution through their own efforts, by using and linking their previously acquired knowledge. In this way, the pupils first arrive at a potential solution to the given problem, a HYPOTHESIS.

Following this, the pupils have to plan and carry out the procedure of its verification.

Based on the results of the verification, the hypothesis is either accepted or rejected, and this represents new knowledge for the pupils.



Benefits of problem-based teaching

- Acquisition of new knowledge with understanding
- Promoting pupils' creative thinking
- Preparing pupils for the responsible application of science knowledge in everyday life
- Promoting the development of self-regulation of the learning process
- Promoting pupils' motivation for science learning

The aim of research

The aim of this research was to enable the pre-service chemistry teachers to gain insight into the elementary school pupils' attitudes and experiences concerning problem-based chemistry teaching and check their preparedness to implement chemistry knowledge in solving problems that can be encountered in everyday life.

Research questions

(1) Do seventh- and eighth-grade elementary school pupils have previous experiences with problem-based chemistry teaching and what are their attitudes towards it?

(2) Are seventh- and eighth-grade elementary school pupils enabled to implement chemistry knowledge in order to solve problems that they can encounter in everyday life?

Research sample

In order to find the answers to the research questions, five students of the study program Chemical Education at the Faculty of Chemistry University of Belgrade conducted research in which 93 seventh-grade pupils and 74 eight-grade pupils from three primary schools in Serbia took part.

Research instruments and research organization

The data in this research were collected by means of a questionnaire and two tests, compiled by pre-service chemistry teachers. The questionnaire was identical for both the seventh- and eighth-grade pupils, whereas the tests were adjusted to the level of knowledge of the two age groups.

The research, featuring both seventh- and eighth-grade pupils, was conducted within the course of a single school lesson, during which the pupils filled in a questionnaire and completed a test aimed at their age group.

Research results

The results of the questionnaire

The questionnaire consisted of four questions that referred to the pupils' attitudes and experiences with problem-based chemistry teaching.

1. Whether, in the course of learning chemistry so far, you had an opportunity to acquire new knowledge through solving problem-based tasks?

	Grade 7				Grade 8			
Question	N(Yes)	%(Yes)	N(No)	%(No)	N(Yes)	%(Yes)	N(No)	%(No)
1	58	62.37	35	37.63	48	64.86	26	35.14

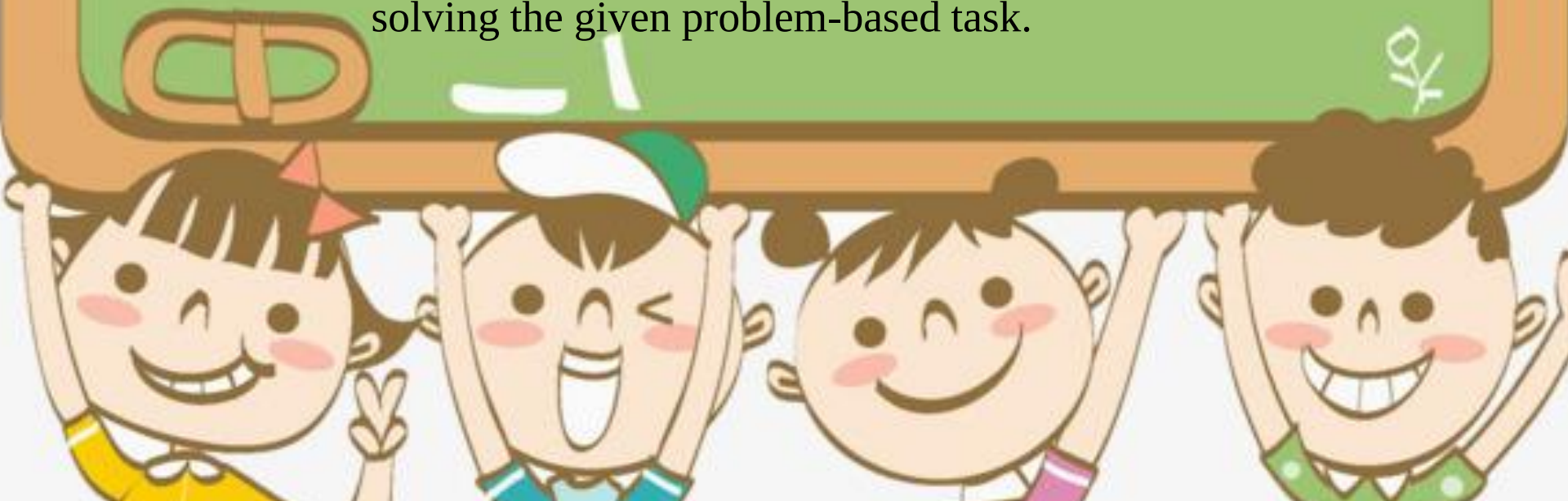
2. Do you agree with the claim that learning within the framework of problem-based teaching is harder, but also more interesting than learning within the framework of classical teacher's lecturing?

	Grade 7						Grade 8					
Question	N(a)	%(a)	N(b)	%	N(c)	%(c)	N(a)	%(a)	N(b)	%(b)	N(c)	%(c)
2	61	65.59	4	4.30	28	30.11	50	67.57	7	9.46	17	22.97

a - I completely agree; b - I partially agree; c - I disagree

Within the third question in the questionnaire, the pupils were expected to recommend to their chemistry teacher how to facilitate their learning, within the framework of problem-based teaching

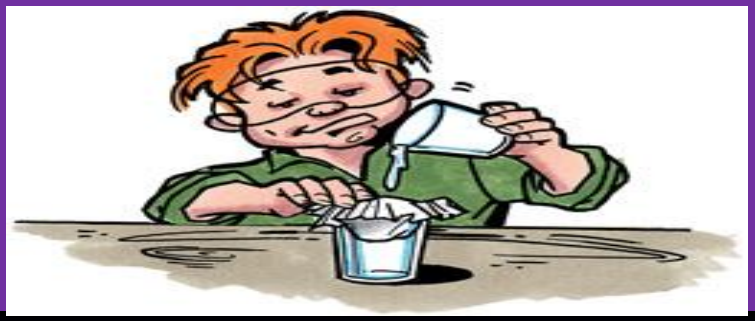
- the problem-based tasks should be solved through group work;
- the teacher should not give too many problem-based tasks at once, for the pupils find it easier to acquire new knowledge gradually;
- the problem-based tasks should be interesting;
- it is of key importance for the teacher to check and review with the pupils all the previously acquired knowledge required for solving the given problem-based task.



4. Do you longer retain knowledge acquired through teacher's lecturing (a), or knowledge acquired through solving problem-based tasks (b)?

	Grade 7				Grade 8			
Question	N(a)	%(a)	N(b)	%(b)	N(a)	%(a)	N(b)	%(b)
4	34	36.56	59	63.44	33	44.60	41	55.40

The test results of the seventh-grade pupils



1. Into a glass containing 100 cm^3 of water Marija, while constantly stirring, gradually began to add white powdery substance X. Initially, no precipitate was formed, but as Marija continued adding substance X, at one point the precipitate began to form, and with the further addition of the substance, its quantity increased.

Item	N (correct answer)	% (correct answer)	N (wrong answer)	% (wrong answer)	N (did not answer)	% (did not answer)
1a)	53	56.99	4	4.30	36	38.71
1b)	40	43.01	18	19.36	35	37.63
1c)	16	17.20	6	6.46	71	76.34

Within item 1a), the pupils were expected to provide the definitions of unsaturated, saturated and supersaturated solutions.

Within item 1b), the pupils were expected to determine what the solution above the precipitate of substance X was like, in terms of saturation.

Within item 1c) it was stated that, after a certain period of time following the appearance of the precipitate, Marija stopped adding substance X. The pupils were required to suggest a method that would enable her to reduce the amount of the precipitate in the glass, without physically removing any of it.

2. During a flu epidemic, Andrija bought a hand disinfectant in a pharmacy. Handing him the disinfectant, the pharmacist explained: "You have here 100 g of a 5% disinfectant solution. To disinfect your hands, use a 2% solution, which you are to prepare using the 5% solution you bought.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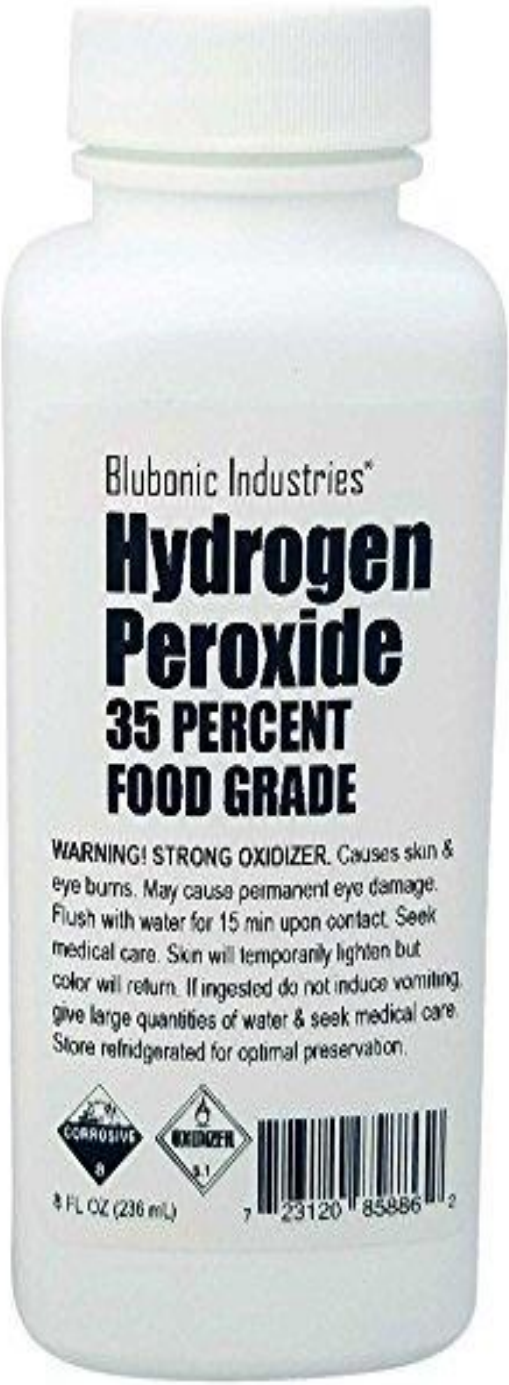
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Item	N (correct answer)	% (correct answer)	N (wrong answer)	% (wrong answer)	N (did not answer)	% (did not answer)
2a)	37	39.79	2	2.15	54	58.06
2b)	21	22.58	2	2.15	70	75.27
2c)	8	8.60	1	1.07	84	90.33

Within item 2a), the pupils were expected to provide a definition of the mass percent composition of a solution.

$$C_{\%} = \frac{m_{solute}}{m_{s\ln}} \cdot 100\% = \frac{m_{solute}}{m_{solute} + m_{solvent}} \cdot 100\%$$

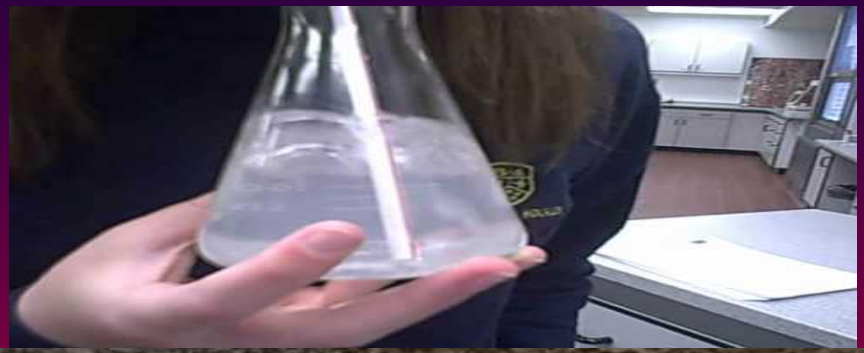
Within item 2b), the pupils were expected to answer what should be done in order to turn a 5% solution of a substance into a 2% solution, that is, whether a certain amount of water should be added to, or removed from it.

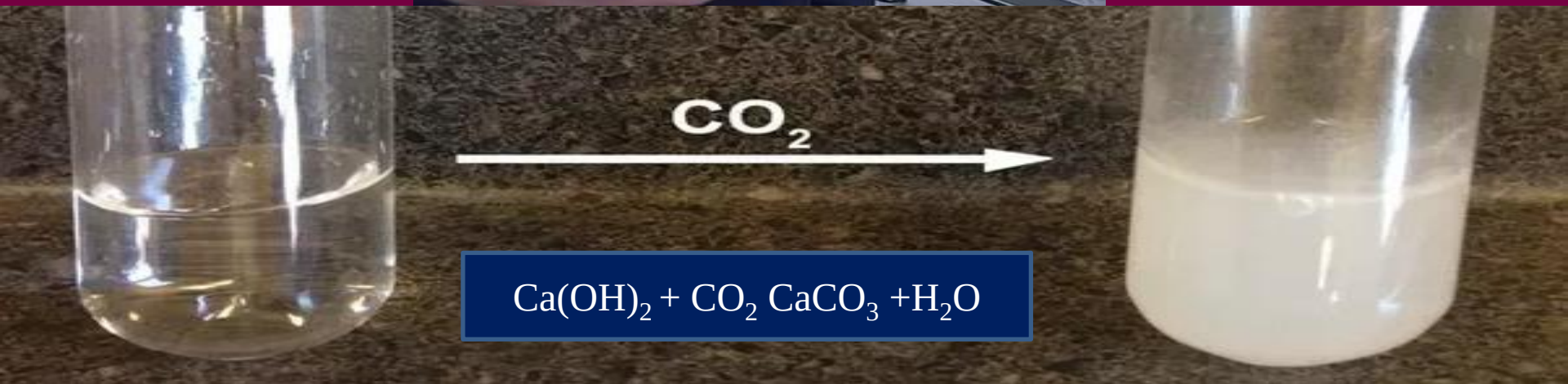
Within item 2c), the pupils were expected to recommend to Andrija the exact procedure for the preparation of the 2% solution of the hand disinfectant, starting from its 5% solution.

5% • X=2% • 100g X=40g 40g of 5% solution and 60g of water

The test results of the eighth-grade pupils

1. In a glass in front of you there is transparent lime water (a water solution of calcium hydroxide). When, using a plastic tube, you blow the air that you exhale into lime water, a white precipitate starts to form in the glass.





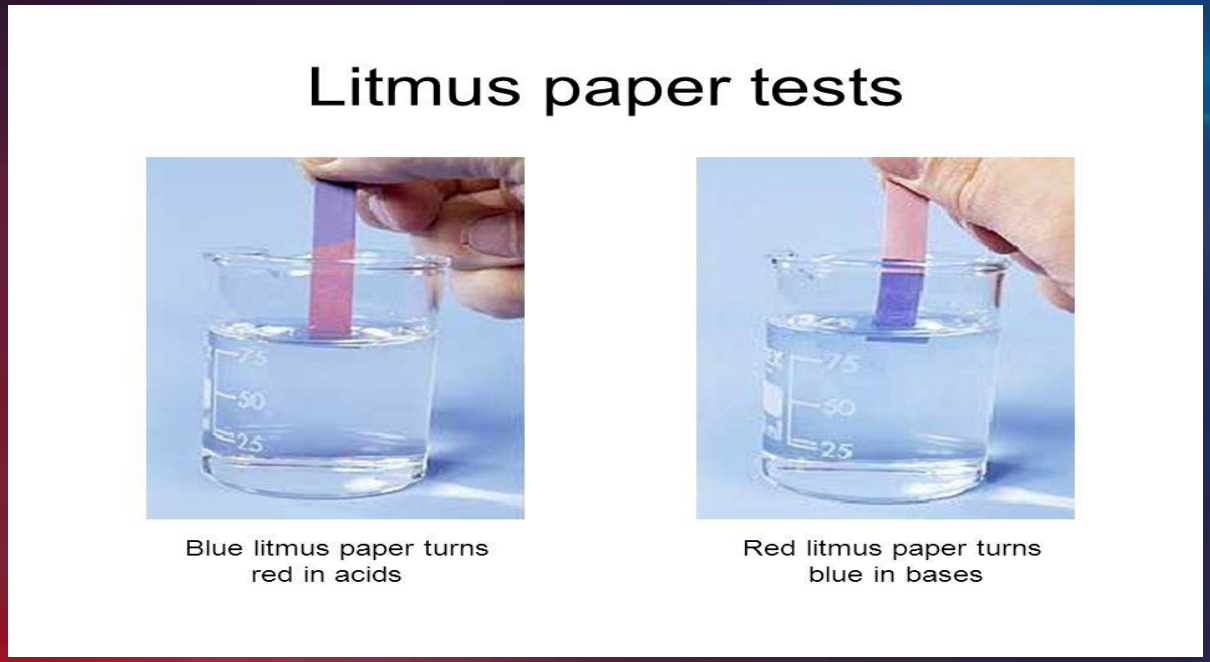
Item	N (correct answer)	% (correct answer)	N (wrong answer)	% (wrong answer)	N (did not answer)	% (did not answer)
1a)	58	78.38	0	0.00	16	21.62
1b)	56	75.68	2	2.70	16	21.62
1c)	44	59.46	0	0.00	30	40.54

Within item 1a), the pupils were expected to answer which substance present in exhaled air, reacted with calcium hydroxide.

Within item 1b), the pupils were expected to state which substance formed the white precipitate.

Within item 1c), in view of the fact that the substance that formed white precipitate also forms layers of lime scale on kitchen dishes, the pupils were expected to conclude whether water is an efficient means of lime scale

2. One drop of a water solution of substance A is transferred onto a piece of blue litmus paper. A red circle appears on the blue litmus paper. Following this, a drop of a water solution of substance B is transferred onto the red circle. The circle turns blue.



The pupils were then presented with two rows of substances, the ones in Row 1 representing the potential substance A, whereas those in Row 2 represented the potential substance B.

Row 1: K_2SO_4, KOH, H_2O, H_2SO_4

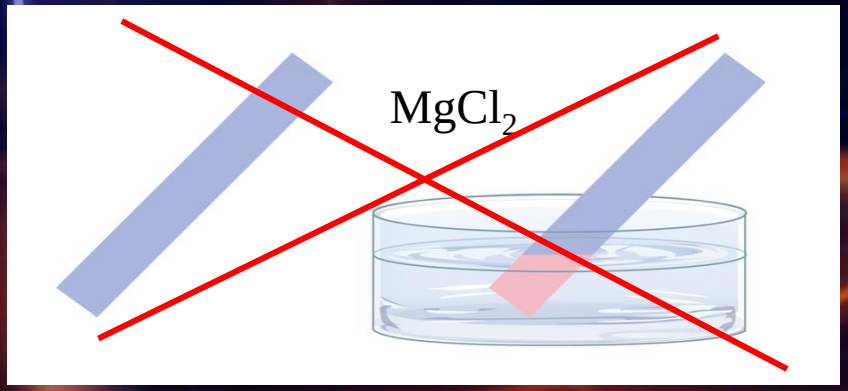
Row 2: $MgCl_2$, $Mg(OH)_2$, H_2O, HCl

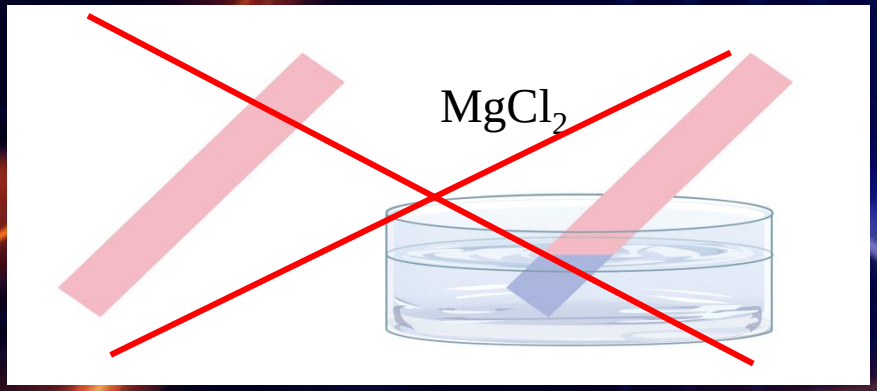
Item	N (correct answer)	% (correct answer)	N (wrong answer)	% (wrong answer)	N (did not answer)	% (did not answer)
2a)	57	77.03	0	0.00	17	22.97
2b)	52	70.27	7	9.46	15	20.27

Within item 2a), the pupils were expected to state under which conditions red litmus paper changes colour to blue.

$MgCl_2$

Within item 2b), the pupils were expected to state whether, in the presence of a water solution of $MgCl_2$, the litmus paper could change colour.





Which substances from Rows 1 and 2 represent substance A and substance B respectively?

Row 1: K_2SO_4, KOH, H_2O H_2SO_4

Row 2: $MgCl_2$, $Mg(OH)_2$, H_2O, HCl

Row	$N(K_2SO_4)$	$\%(K_2SO_4)$	N(KOH)	%(KOH)	$N(H_2O)$	$\%(H_2O)$	$N(H_2SO_4)$	$\%(H_2SO_4)$
1	3	4.06	0	0.00	0	0.00	71	95.94

Row	$N(MgCl_2)$	$\%(MgCl_2)$	N $(Mg(OH)_2)$	% $(Mg(OH)_2)$	$N(H_2O)$	$\%(H_2O)$	N(HCl)	%(HCl)
2	0	0.00	72	97.30	0	0.00	2	2.70

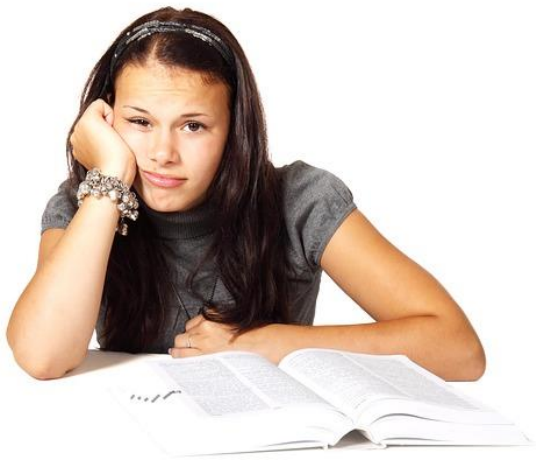
The eight-grade pupils outperformed the seventh-grade pupils on the test.

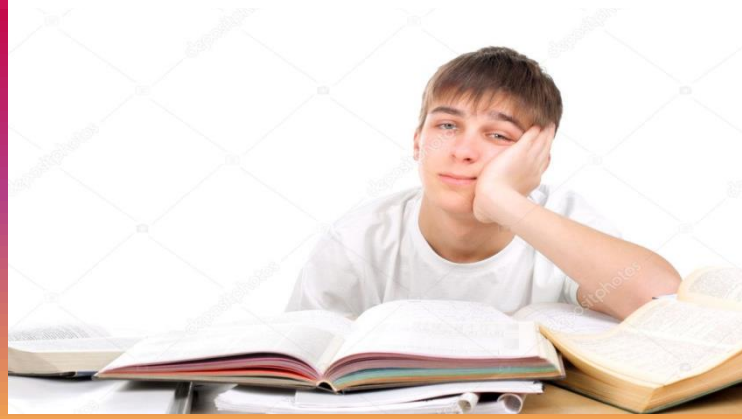
VIII

WHY?

VS.

VII

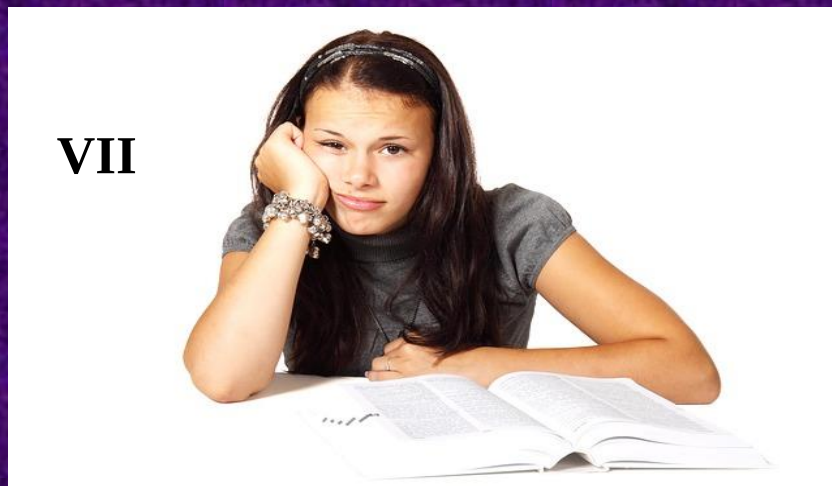


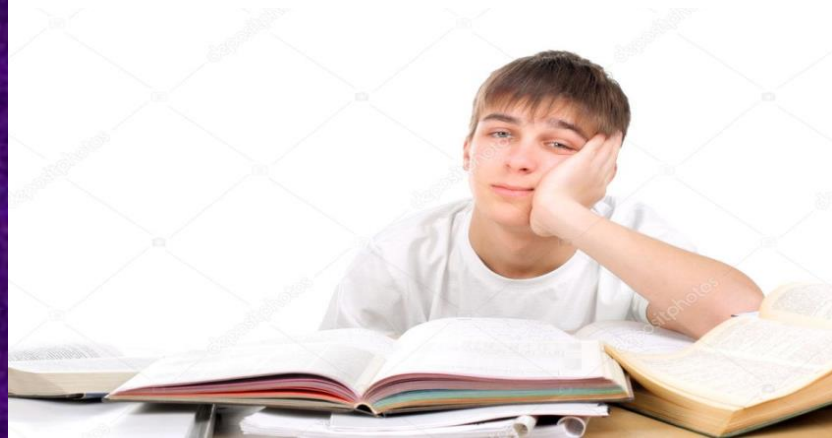


The eighth-grade pupils, through dealing with previously taught teaching topics, both in the eighth and seventh grade, had already acquired certain knowledge about salts (e. g., they learned about acids and bases, the formation of the ionic bond and certain characteristics of ionic compounds). Consequently, it was easier for them to add the new knowledge about salts to this already existing base of knowledge.

The seventh-grade pupils, who had just begu learning chemistry, did not possess any significan previously acquired knowledge related to th teaching topic *Solutions*. This particularly refers t the teaching unit *The mass percent composition o solutions*, where in order to master the definition o this term, the mathematics knowledge (percentag calculus and proportions) which was new to th students, was also required.

VS.





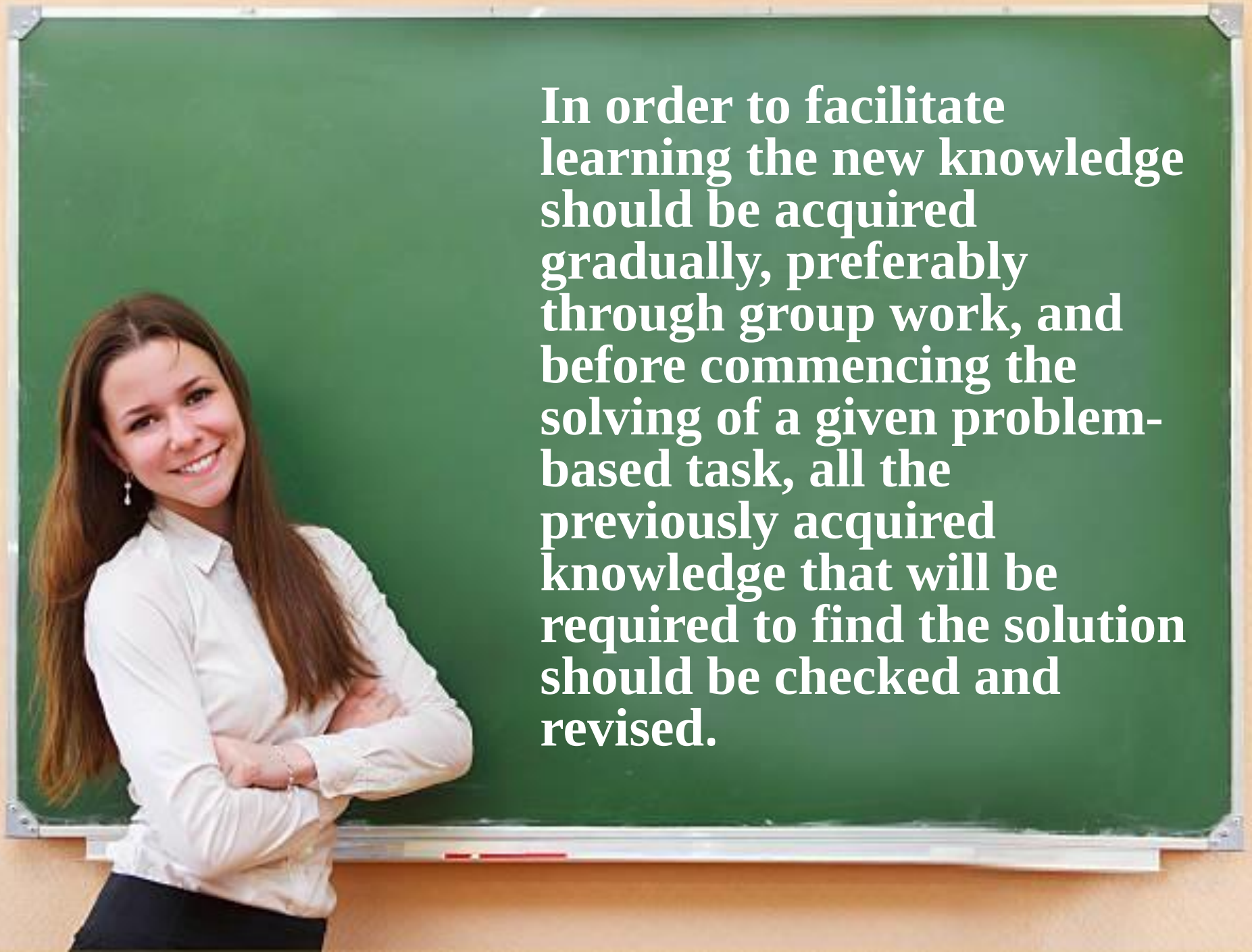
Conclusions

Pupils who took part in this research had previous experience with problem-based chemistry teaching

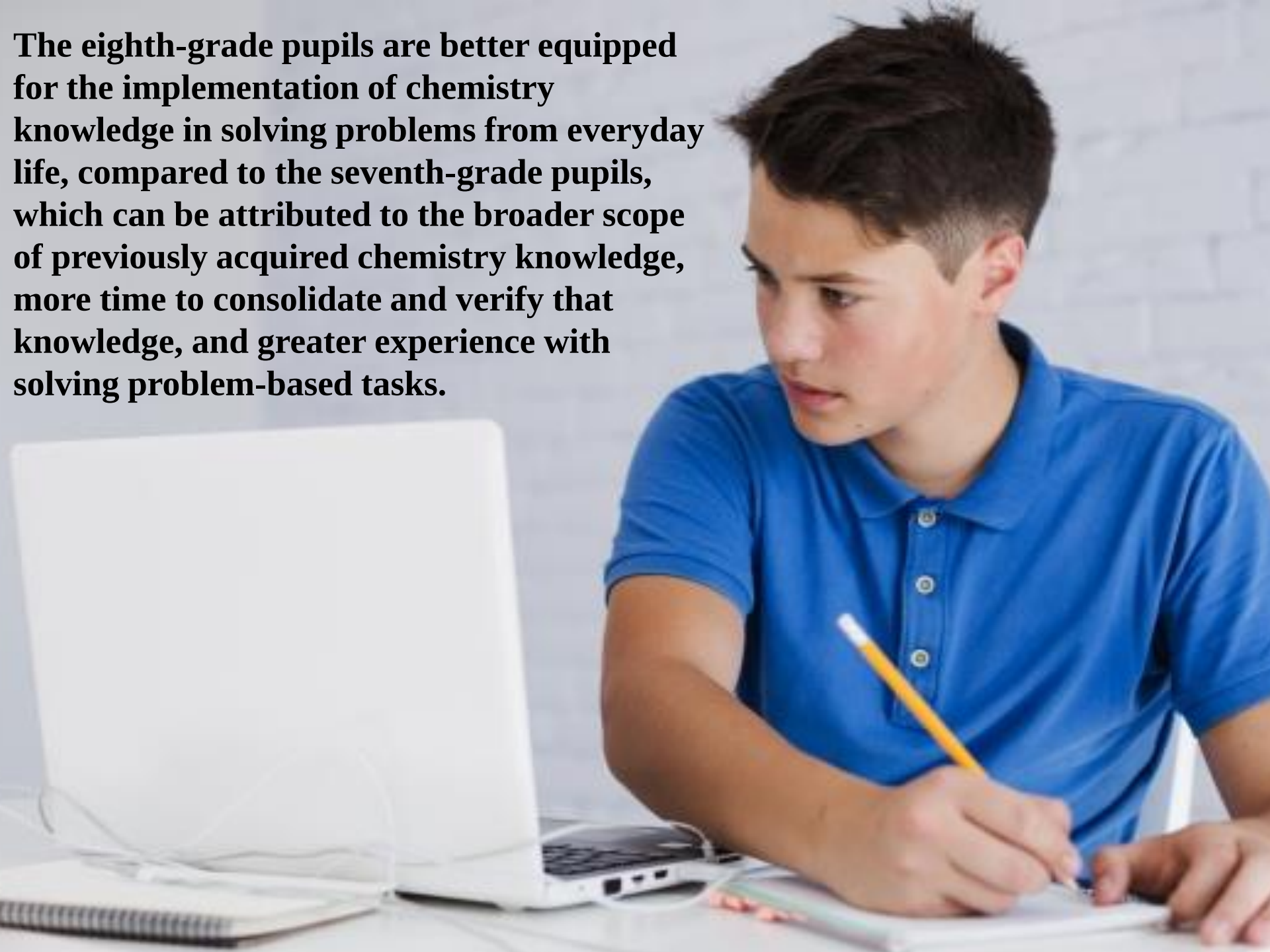
Pupils do not have negative attitude toward problem-based teaching

The knowledge acquired through solving problem-based-tasks is LONGER RETAINED

Learning through solving problem-based tasks is harder in comparison to learning through classical teacher's lecturing, but also **MORE INTERESTING**


In order to facilitate learning the new knowledge should be acquired gradually, preferably through group work, and before commencing the solving of a given problem-based task, all the previously acquired knowledge that will be required to find the solution should be checked and revised.

The eighth-grade pupils are better equipped for the implementation of chemistry knowledge in solving problems from everyday life, compared to the seventh-grade pupils, which can be attributed to the broader scope of previously acquired chemistry knowledge, more time to consolidate and verify that knowledge, and greater experience with solving problem-based tasks.



In view of the fact that they gained insight into the greatest challenges of problem-based teaching, and pupils' recommendations on how to overcome them, the pre-service chemistry teachers will be able to implement problem-based teaching in the most effective way, and thus successfully prepare their pupils for the scientific and technological challenges of life in the 21st century.


Thank you for your attention!!!

puticakatarina@gmail.com