

## Group Work in Teaching Chemistry in Topic PH of Solutions

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### Abstract

*A role of a teacher is to prepare a student for his future occupation. A teacher needs to choose various forms and methods of teaching so that he can develop key competences and manual skills of a student and to give knowledge, experience, skills and etc. to student. One of the possible ways is using of group teaching during which a student learns how to cooperate with other students, to give his opinion, to argue, learns to respect, listen and tolerate other members of the group. In this report we will focus on illustrations of using some teaching methods during chemistry lessons at primary school in two classes of 8th year. We focused mainly on the usage of group teaching because this kind of teaching is often used in chemistry lessons, mainly during the work in labs.*

### Introduction

„What a child can do in cooperation with others today he can do himself tomorrow“ (L. S. Vygotskij in Mokrejšová, 2009)

Every teacher has questions as: „What is the best for my students?“, „Will they really learn in school everything they need for their future life?“, „How to prepare my students for nowadays society?“. Motto of the Australian government in year 2000 defines one of the key areas which is inevitable for creation of knowledge economy: **„Education of the highest quality needs teachers of the highest quality“** (www.dest.gov.au). Level of education is reviewed according to gained competences and level of digital literacy. Key competences of students can only be developed by teachers which are of the high quality, thus competent. It depends on the teacher how are the students (competent, literate, able). We do not get competent students in a way that a teacher will only give them information to write down and which can a student repeat lately. For a young person are good those teaching activities which can be used in his life and which give him quality education meeting the requirements of the labour market. Acquisition and development of key competences is lifelong, individual process which is used for development of personality of a student. According to Belz and Siegrist (in Javorová a kol., 2010) there are available many teaching methods for teachers by which students can gain and develop their key competences: informative methods (eg. mind-mapping), narrative (eg. work in small groups), operative (eg. micro-teaching), integrative (eg. projects), intuitive (eg. ABC method) and others. Teachers can also use various teaching strategies as problem teaching, project teaching, group teaching, cooperative teaching, exploring teaching (eg. IBSE), etc.

In this report we will focus on illustrations of using some teaching methods during chemistry lessons at primary school in two classes of 8th year. We focused mainly on the usage of group teaching because this kind of teaching is often used in chemistry lessons, mainly during the work in labs. Besides the group work teachers let students to work on their own but they cannot talk to each other during the



lesson because they are „interrupting“, they cannot help a classmate because „he should know“ ... . Society nowadays needs people who know how to work in group – team but only a few students know how to cooperate with a classmate or someone else. Many times a student decides for cooperation on the basis of sympathy, popularity, friendship and etc. Cooperation with others is inevitable for all of us. It is needed to teach students to work in a group and prepare them for their future occupation, eg. manager of a large enterprise. The aim of this report is to show ways of using the group teaching mainly in labs but also in regular lessons.

## Group work

As it is stated by Turek (2009) and Mokrejšová (2009) group teaching belongs to teaching methods used in chemistry lessons for primary schools, mainly in labs. The aim of group teaching is that students work in small groups at tasks given by teacher, they gain knowledge and practice, cooperate and learn with each other (peer learning) and etc. In various literature we can find also the name cooperative teaching which starts to be very popular and is used also at our schools. (Turek, 2009; Nezvalová, 2006)

From the point of the preparation of a lesson and a teacher the group work is more difficult. Groups can work undifferentiated, all groups work on the same tasks or differentiated, each group solves partial tasks from the unit at which the whole class works. A teacher has to think about the planning of the group work very well and he should know his students mainly from the point of their performance, speed of work, level of knowledge so that he can prevent inconvenience caused by dividing students into groups.

Mokrejšová (2009) states following recommendations for group teaching:

- a) The ideal amount of students in a group is 3-4 students, 5 is also manageable (in 5-member group it is probable that one of the members does not contribute to work sufficiently).
- b) Groups should be heterogeneous.
- c) Different initial level of knowledge and experiences is beneficial for all members of a group.
- d) A teacher divides students into groups, members of a group does not choose their collaborators.
- e) Each group should formulate their aims and ways by which they want to get results.

Appropriate preparation of students for group teaching are various strategies of learning, for example::

- Alone – Two – All (Mokrejšová, 2009)
- Think – Create a pair - Share an answer
- Formulate – Share – Listen – Create
- Roundtable
- 3 level interview and etc. (Nezvalová, 2006)

Group teaching has also negative aspects of which a teacher should be aware because they could influence a result of work:

- the option of anonymity for some students
- hiding of a performance of weaker students
- weaker students cannot show themselves
- wrong organization of time in a group
- stress in a group which is not functional

Group teaching is used also in project teaching, solving of problematic tasks, during the work with scientific text and textbook, during games and competitions.

## Illustrations and using

**Topic:** pH solution

**year:** 8

**Thematic unit:** Chemical compounds

ŠVP ISCED 2

### Aim of the lesson:

To gain manual skills in pipetting and preparation of solutions by decimal dilution. To know how to work with various pH indicators: universal indicator paper (UIP), litmus paper, natural indicator (cabbage extract) and measurement equipment Vernier and with pH sensor. Know to predict and differentiate between acid, neutral and alkaline solution with the help of universal pH paper, natural indicator. To determine the values of pH of various substances in home with the help of measurement equipment Vernier and pH sensor. To repeat terms: acid, base, neutral, acid, alkaline solution, pH, pipetting through game – competition. To strengthen social relationships in class through game – competition.

### Methods and forms of teaching:

Practicals, work with measurement equipment Vernier LabQuest, brainstorming, work in group, method Alone – Group – Whole class (Third part of practicals), discussion (Third part of practicals), peer learning, game – competition of groups (regular lesson).

### Resources:

Equipment for practicals (see Protocol for laboratory exercises), worksheet – protocol for laboratory exercises, protective equipment (lab coat, gloves, glasses), worksheet – tasks for revision, stationery (markers, card of couples, word find, puzzle, maze, interactive board, demonstration workbook with tasks, computers (at least one for group).

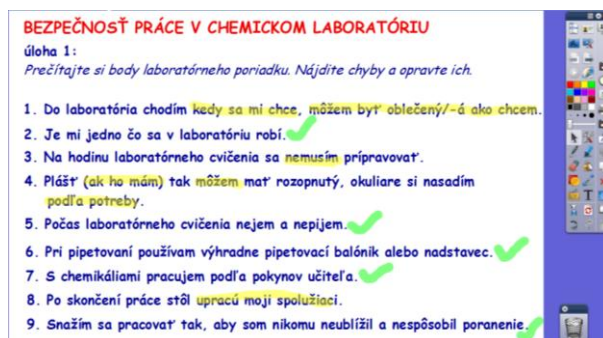
Note: It is assumed that laboratory lesson goes as divided lesson (12-15 students). Students already know the term acid, base (according to Arrheni theory). Laboratory exercise is divided into three parts which can also be realized separately.

## LABORATORY EXERCISE – PH of solutions

At the beginning of the lesson – laboratory exercise, a teacher divides students into two groups. One group will have the topic Acids and the second Bases. Then the teacher revise the principles of safety during the work in chemical laboratory with students. Each group is handed the list of tasks or it can be shown by dataprojector (or interactive board, Pic.1). Groups have time limit for solving the tasks (1 – 3 minutes), after this limit they have to tell the solution. According to the accuracy of the answer a group gain points 0-1-2.

### Task 1:

*Read the points of laboratory schedules. Find mistakes and correct them.*



**Pic. 1** Illustration of task 1 for interactive board (autor: Javorová)

**Task 2:**

*Group 1: write down everything you know about acids.*

*Group 2: write down everything you know about bases.*

Note: Task 2 is solved on the paper, after a time interval students read their solution. They gain points for accuracy. If the second group can add the information. They also gain bonus point.

**I.PART:** Frontal demonstration of decimal dilution follows – preparation of solutions for pH range. Teacher makes the demonstration because it is needed to work with concentrated solutions (1M HCl and 1M NaOH). Students continue on their own after the first dilution which is done by teacher. They prepare solutions into prepared beaker. The first group prepares solutions of hydrochloric acid (pH 1-6) and the second group solutions of sodium hydroxide (pH 8-13). Each student prepares one solution (pic.2). This is how students create the whole scale of pH.



**Pic. 2** Preparation of diluted solution NaOH (foto: Šponiar)

**II. PART:** Students verify the accuracy of the scale after preparation of the whole pH scale with the help of indicators available (as follows): litmus paper, UIP, extract of red cabbage (Pic. 3) and in the end with pH sensor of measurement equipment Vernier Lab Quest (Pic. 5). Students write results into

their notebooks (or protocols, Pic.6).



**Pic. 3** Verification of pH scale with available indicators – extract of red cabbage (foto: Šponiar)

**III. PART:** Students examine the substances which they bring from home in the last part of laboratory exercise (tea, mineral water, milk, Coca-Cola, dilution of soda bicarbonate, soap water, detergent, salty solution, coffee, vinegar, ...). Before examination students formulate hypothesis, each of them writes down estimated pH for each substance and then they have a group discussion about it. They verify their guess with the help of indicators and pH sensor (according to Part II.) (Pic.4, Pic.5).



**Pic. 4** Finding out of pH of substances from home (foto: Šponiar)



**Pic. 5** Measuring of pH by pH sensor (foto: Šponiar)

Students compare their guess with the results from measurements and write the values and differences with their guess into notebooks (protocols). After finishing the third part of laboratory exercise, students summarise their results and both groups compare the results from the third part and notify the other group with results from the second part of the exercise. At last students clean up the tables, clean glassware.

Note: Students can make photos or videos from the measurements. Laboratory protocol is given by each student in the next lesson.

**LABORATORNÉ CVIČENIE - Určenie pH roztokov**

Čo myslíš. Majú všetky kyselky rovnaké pH? Je výsluh z černejkej kyskej vody černej? Ako praxie vieme zmerať pH?

**Pomôcky:**  
Kádčiky (sada skúmaviek + stojan na skúmavky), sklenená pipeta (2ml), plastové pipety, sklenené tyčičky, striekača s dezinfekčnou vodou, meracie zariadenie Vernier LabQuest, pH senzor, filtračný papier.

**Chemikálie:**  
Roztok kyseliny chlorovodíkovej (1 M), hydroxid sodný (1 M), univerzálny indikačný papierik, lakmusový papierik, roztok prírodného indikátora (červená kapusta, ľahne kvetov, plody bratry, bobule čerešňovej kôstky...), roztoky kyseliek z domácnosti: Citrónky, octy, pracieho prášku, mydla, vody (dážďová, z potoka, z vodovodu, minerálna), Coca-cola, a. t.

**I. Časť**  
Pracovný postup:  
1. Do očíslovaných kádčiek (skúmaviek) priprav dezinfekčnou roztokom pH škálu z 1M roztoku HCl a 1M roztoku NaOH. Prvé roztoky určí učiteľ!

**II. Časť**  
Pracovný postup:  
1. Pomocou dostupných indikačtorov zisti pH prírodných roztokov z I. Časti: použi lakmusový papier, UVP, výsluh z černejkej kyskej.  
2. Pomocou pH senzora a meracieho zariadenia LabQuest Vernier zisti presné hodnoty pH prírodných roztokov.  
3. Výsledky (farebnú zmenu, hodnoty pH) zapíš do tabuľky.

skúmavka	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
chemikálie	byde odšetr z														
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
lakmus															
UVP															
kapusta															
pH senzor															

**III. Časť**  
Pracovný postup:  
1. Do tabuľky napíš najprv svoje hypotézy, ktoré z uvedených roztokov je podľa teba kyslé, neutrálny alebo zásaditý.  
2. Pomocou dostupných indikačtorov zisti pH škálu z domácnosti: použi lakmusový papier, UVP, výsluh z černejkej kyskej.  
3. Pomocou pH senzora a meracieho zariadenia LabQuest Vernier zisti presné hodnoty pH prírodných roztokov.  
4. Výsledky (farebnú zmenu, hodnoty pH) zapíš do tabuľky.  
5. Porovnaj svoje hypotézy s výsledkami merania s indikačtorami a hodnotami pH z merania pH senzora a zapíš ich do tabuľky (DOKUÁ - 18221004).

skúmavka	1	2	3	4	5	6	7	8
Hypotéza								
Č. kys. z.								
Lakmus								
UVP								
kapusta								
pH senzor								
DOKUÁ - 18221004								

**UPOZ:**  
 Porovnaj farebné zmeny v roztokoch.  
 Ktoré zo zameraných hodôt pH je najpresnejšie.  
 Čo robíš aplikácií prírodné roztoky pri meraniach?  
 Usporiadaj kyselky z domácnosti podľa rňspájajúcej hodnoty pH. Dopíš kyselky do pH škály.

**Pic. 6** Illustration of laboratory protocol (autor: Javorová)

## Regular Lesson

Teacher takes laboratory protocols from students at the beginning of the second lesson. The protocols are evaluated with the help of scoreboard (Javorová a kol., 2010).

Teacher divides students into 4 groups (one group, 4 students) so that in one group are always two students from the first group of laboratory exercise (group Acids) and two students from second group (group Bases). The lesson goes as a game – competition between groups. Students gradually solve



the tasks. Each group can use one joker – advice.

**Task 1a:**

Sort substances on the cards (Pic.7). Whether they are acidic, neutral or alkaline.

Note: Each student has in front of him cards. After the signal he turns the cards and sorts them. He is evaluated according to time and accuracy of sorting. The group which solves the task correctly as first gains 3 points, other groups gain 2, 1 or 0 points.

**Task 1b:**

Substances on cards sort according to its increasing pH.

Note: A student sorts the substances according to its increasing pH after the signal. Evaluated is time and accuracy of sorting. The group which solves the task correctly as first gains 3 points, other groups gain 2, 1 or 0 points.



**Pic. 7** Illustration of cards from task 1a and 1b (autor: Javorová)

**Task 2:**

Assemble the puzzle in the shortest time. State what is showed at a picture and give missing information.

Note: You can print out the puzzle or assemble it on the computer (we created the puzzle from pH scale in the program Jigs&wPuzzle) (Pic.8). Evaluated is time and accuracy of assembling the puzzle. The group which solves the task correctly as first gains 3 points, other groups gain 2, 1 or 0 points

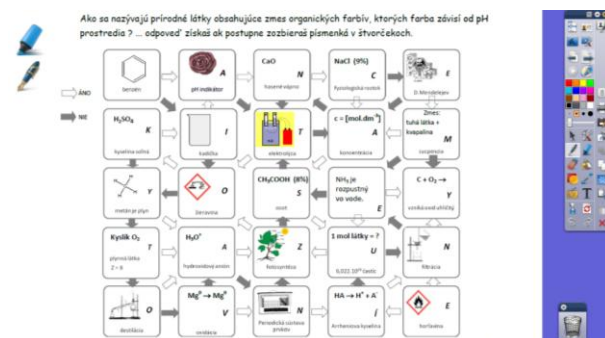


**Pic. 8** Illustration of the puzzle on the topic of pH scale (autor: Javorová)

**Task 3:**

Go through the maze and find out the answer for question: How do we call substances – natural indicators?

Note: Each student has maze printed out in front of him (it can be laminated and the way through is marked by marker) (Pic.9). Evaluated is time and accuracy of result. The group which solves the task correctly as first gains 3 points, other groups gain 2, 1 or 0 points.



**Pic. 9** Illustration of task 3 – maze created for interactive board (autor: Javorová)

**Task 4:**

In Find Word find all the terms and explain them.

Note: Each student has Find Word printed out in front of him (it can be laminated, a student uses marker) Evaluated is time and accuracy. Each group which finds all the terms and know to explain them gains 3 points. First group which solves the tasks get 2 bonus points. Task is more difficult according to fact, that the explanation has to be brief and cannot be repeated what the previous student said.

If all the tasks are solved the game – competition ends. Teacher counts points of each group and evaluate the best group. Students of group which wins are evaluated by marks, other students by



bonus points.

## Conclusion

The aim of the report was to show how group teaching can be used in laboratory exercises and in the regular lesson. Laboratory exercise was taught in two classes (8. A – 16 students and 8. B – 14 students). Course of laboratory exercise was the same in both classes, with one difference that explanation and demonstration of decimal dilution of solutions in second class was done by student of the first class (under the supervision of a teacher). We used peer learning. Students liked the work during laboratory exercise, they followed the instructions and were disciplined. Small problems occurred in the first part of laboratory exercise during the decimal dilution. Students lacked skills in pipetting so there was little time delay. From interviews with students we know that they did not like the first part of the exercise very much because they had to wait for other classmates from group and they lacked skills in pipetting. They liked the most the second part during which they created colour scale by using extract from red cabbage and in the third part they liked measurement of pH values of substances by pH sensor. They discussed passionately when formulating hypothesis about the estimated pH of given substances. Most of the values were good. During the laboratory exercise all students actively contributed to its solving, even the weaker ones. Overall the laboratory exercise was positively rated and most of the students were interested in having another such lesson. As it was proposed the second lesson was taught only in one class (8. A) because the second class participated in school activity. The lesson was realised as game – competition. We divided students into 4 groups with 4 students and the groups were mixed (two students from group Acids and two students from group Bases) to create heterogeneous groups. Students liked the tasks. They were so interested in game so they did not hear the bell ringing. They liked the most the game with cards – sorting and classifying even though they considered it as the most difficult one. We used only paper forms of materials during lesson, we did not have chance to get to classroom with interactive board to use electronic forms of materials. Overall we rate the lesson positively. The group with the biggest amount of points got mark and other students were given bonus point for work in the classroom and we verbally complimented their activity in the lesson and the great atmosphere. Even though the preparation for the lesson with group teaching is difficult for a teacher it is worth it. Your reward will be happy and content students. Some advices at the end: it is needed for teacher to think and plan of his tasks, he needs to emphasize the rehearsal of various strategies of learning (he cannot expect that student will know all the methods and procedures); he needs to take attention to division of students into groups, needs to control time, needs to take time for weaker students, create good atmosphere without the stress.

## Resources

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