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# Practical Homework Assignments As Part Of Chemistry Teaching And Learning

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*Abstract* – The paper presents two examples of classroom practices when practical research tasks in primary and secondary school are assigned as homework. The task for primary school students was aimed at developing divergent thinking, which is evidenced and illustrated by some examples of students' solutions. The task for secondary school students illustrates how these students are able to apply their classroom knowledge of acids, bases and indicators on the substances they can find in everyday life. The students performed the following activities: problem analysis, action planning, and equipment selection/assembling, performing the experiment, measuring (mass, volume), data recording, and drawing conclusions. The results of both tasks served as a basis for introducing new contents in the classroom and stimulated active participation of a larger number of students.
*Keywords:* homework, chemistry, research activities, primary school, secondary school.

## Introduction

The homework assignments include students' activities which originate from the teaching process, and which contribute to the realization of learning goals of the curricular contents after adequate instruction (Cooper, 1989). A well designed homework task can strengthen classroom learning by posing challenges to the student who will thus gain better understanding of the essence of the matter and further develop their ability to apply theoretically gained knowledge in practice.

Students' activities in carrying out homework assignments can be in different forms and nature, from lesson revising aimed at memorizing the contents or practising skills to

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productive ones which stimulate and develop their independence, creativity and responsibility. Students can do the tasks individually, in pairs, or in groups.

Homework assignments can serve different purposes: revision, extending and deepening of the acquired knowledge, gaining experience necessary for processing new contents, arousing interest in particular contents, forming and developing skills and habits, testing knowledge, hypotheses, and ideas. Homework analysis should have a special slot in lesson structure, since it can be an invaluable basis for discussion, checking, consolidation and systematization of the acquired knowledge.

Some research reports cite teachers' attitudes on the reasons why homework assignments are important in primary and secondary schools: personality development, the development of child-parents relationship, enhancement of parents-teacher and peer communication, developing action planning skills, developing the sense of responsibility, raising the awareness of the importance of fulfilling one's obligations, and the awareness of the fact that non-fulfilling of obligations leads to certain consequences (Epstein & Van Voorhis, 2001). Parents express attitudes similar to those of teachers'. They hold that homework assignments strengthen learning, enable better understanding of what has been studied at school, and enhance the development of the sense of responsibility for performing daily chores, too. The students, however, see things differently. For them, homework assignments mean "study more, write more carefully, and fulfil the tasks more successfully".

Homework assignments should be planned in accordance with the learning goals of a particular teaching content. Students can be stimulated to do homework assignments regularly and responsibly by including the application of their results into the teaching/learning of new contents, and by providing opportunities to apply them in everyday life. Further, the positive influence of the teacher's feedback has been confirmed by research (Elawar & Corno, 1985; Levin & Peterson, 1984). Feedback information on the quality of the response and applied procedures, respect for students' evaluation of the task difficulty, and consideration of the reasons for non-fulfilling a task all contribute to the realization of the learning goals.

Despite long history of homework assignments and different researches of the factors that contribute to students' attainments, the role of homework assignment has not been clearly defined yet. Attitudes towards homework assignments have been swaying from "FOR" to "AGAINST", back and forth (Trautwein & Koller, 2003). Some hold they should be banned since both students and parents are overloaded (Farrow *et al*., 1999) and that, instead of them, after-class tuition should be provided, or that they should be assigned on voluntary basis

(including teachers as well as students). Others think that they should be practiced, but after more serious planning which should be founded on modern teaching/learning theories.

Much research of the twentieth century was focused on examining the effects of homework assignments on students' attainments. The applied methodology usually included homework assignment as a variable in the experimental group of students. A control group would usually study the same contents, with the use of the same methodology by the same teachers, the only difference being the students in the control group would not get homework assignments. After a time the attainments in both groups would be measured.

The majority of researches showed that the students in experimental groups obtained better results, and that the positive effects of doing homework assignments were more expressive in senior classes. Further, it was shown that primary school students are more motivated for performing homework assignments by outer reasons, while secondary school students have integrated these reasons into intrinsic motivation. This might be one of the explanations for a higher positive correlation between attainment and homework assignments of secondary school students compared to primary school students. The researches have shown that the positive effect of homework assignments was three times higher if experimental procedures were included (Cooper, 1989). This might be explained as being dependent on the difference in goals of homework assignments for junior and senior students and the frequency of homework assigning.

One examination of purposes for doing homework has shown that intrinsic reasons was related to lower frequency of incomplete homework and to higher self-reported grade. Older students and students who did not receive homework help were more likely to disagree that they did homework for extrinsic reasons (Xu, 2005).

By summarizing the time necessary for performing homework assignments in the field of science in each country – the participants of the TIMSS 2003 research, TIMSS constructed an index of the time students spend doing science homework (Martin *et al.*, 2004). According to the index, i.e. the frequency and amount of science homework assignments per week, the students were classified into high, medium, and low level groups. Students at the high level reported that they were assigned more than thirty minutes of homework at least three to four times per week. The low level students stated that they were assigned not more than thirty minutes of homework twice a week, while the medium level group included all other combinations of responses.

Based on the responses of the eighth-grade primary school students related to science homework assignments in each country the TIMSS determined the percentages for each category: in 13% of the countries students were in the category of "high level of time spent on homework assignments", in 44% of the countries students belonged to "medium level" and in 43% to "low level". The countries where homework assignments are frequent are Ghana, Egypt, Palestine, and Malaysia. In these countries, 20% and more of students were in the "high level" category, and homework assignments are considered as very important part of educational strategy. Contrary to these countries, in Australia, Chile, Hong Kong, Iran, Japan, Chorea, Saudi Arabia, Scotland and Tunisia, and Canadian provinces of Ontario and Quebec, less than 10% of students were in this category. The students' test attainments showed that the countries with low frequency of homework assignments per week achieved better scores at testing.

The TIMSS 2007 findings showed that the most common form of science homework were question sets and reading from a textbook (38 percent and 35 percent of students, respectively). The less common form of science homework was short writing assignments (23%) or work on small investigations (10%) (Martin *et al.*, 2008).

When the effects of homework assignments were examined, different factors were considered: motivation, socio-economic status, parents' involvement in homework assignment performance (Keith *et al.*, 1993) and students' attainments. Doing homework assignments requires complex activities in which different actors are involved: teachers, students, parents. However, students often need support and help, and parents usually feel inadequate to substitute teachers and incompetent for such a task. They usually state that they lack knowledge of the particular field of science, or that they lack the skills for transmitting knowledge which the teachers have. The conclusion was that the more parents are involved in homework assignments the more time is needed for performance, which again leads to higher attainment. Junior students showed greater need for parental help when doing homework assignments.

Some researchers report that homework assignments are most commonly given in the form of pen & paper requirements aimed to refresh classroom learning. They intercede in favour of practical homework assignments, and have examined the effects of parental help during the student's homework assignment performance (Trahan & Lawier-Prince, 1999). Also, some emphasize that learning during fulfilling practical homework tasks contributes most to students' attainment (Bredekamp & Copple, 1997). They suggest that trainings for

parents should be organized for supporting students in their practical research activities. These activities lean on cooperative learning, i.e. learning via cooperation with parents during fulfilling homework tasks. Special instructions could be prepared for parents, together with necessary equipment, and a form for monitoring and evaluating the performed activities.

*Practical Homework Assignments In Chemistry Teaching*

Practical homework assignments, presented in this paper, were planned according to the intention to encourage students to apply their classroom knowledge and, by the solutions they come up with, to deepen (by discovering new relations) and broaden that knowledge, which all will be taken as the starting point for studying new contents of the following lesson. The first case concerns the theme "Solutions" within the seventh grade chemistry curriculum for primary schools (age 13), and the second covers the theme "Acids and bases" from the first year (the ninth grade) chemistry curriculum for gymnasia (age 15).

Our working goal was to develop homework assignments that would enable:

- revision and application of classroom knowledge on the examples from everyday life,
- the application of the experimental skills acquired at school in everyday situations and with the equipment that usually exists in homes,
- the development of the ability to find the ways how to solve tasks, plan and perform the necessary activities,
- the development of the ability for planning and using time,
- the development of personal responsibility and independence in task fulfilling,
- the development of sense for cooperation, and
- preparation for studying new contents.

The planned students' activities also required skills such as problem analysis, action planning, selecting/assembling equipment, performing the experiment, measuring (mass, volume), data recording, and drawing conclusions.

Students were instructed that they could do the experiments individually, in pairs or groups, and that they could seek help from their families.

*Description Of The Practice*

*Experimental Task For The Seventh Grade Students*

During the first lesson on the teaching unit "Solutions" in the seventh grade of primary school the students got the task to determine the solubility of sugar and salt in water at room

temperature, based on the definition of substance solubility. They were expected to devise the experiment by themselves, use any available equipment, perform the procedure, and record the results.

The students' results were analyzed during the introductory part of the following lesson related to quantitative composition of solutions. The results were compared from the aspect of different procedures which had been applied in the experiments.

Several students' procedural solutions are presented here as an illustration of how a homework assignment of this type enhances the development of divergent thinking, i.e. generation different ideas related to the ways of measurement of mass and volume of the substances. The presented procedural solutions show the ability of students to apply the acquired knowledge and creativity of students. In a direct contact with substances and measuring, the students discovered by themselves that substances differ according to their solubility in water, and they used the substances which are part of their everyday experience. While doing the task the students performed and exercised the procedures important for everyday life such as measuring the volume and mass of substances.

*Illustration of The Students' Procedures*

Procedure 1: I put the glass on the scale and turned the scale back to 0 (zero). Then I poured 100g of water into the glass and again turned the scale back to 0. Into the glass with water I poured slowly sugar, mixing the water all the time. When sugar dissolved I read the weight. At that moment there was 210g of sugar in the glass.

Procedure 2: I took a baby bottle and measured 100g of water. It read 100cm³. Then I weighed 300g of sugar on the scale and added sugar into the glass spoon by spoon, mixing water all the time. When I finished I saw that there was still 110g of sugar on the scale, which means that sugar solubility is 190g per 100 cm³ of water.

Procedure 3: In order to measure 100cm³ of water I took a sour-cream plastic cup and filled a half of its volume with water. Then I checked it on the scale, too. It turned out to be right. Then I weighed one spoonful of sugar on the scale. I used the spoon to pour sugar into water, one by one, until I got the saturated solution. I determined the total mass of sugar by multiplying the content of one spoon by the number of spoonfuls I poured.

Procedure 4: Using a measuring cup for cakes I weighed out 100g of water and 500g of sugar. I poured sugar into water and, at the end I recorded how much sugar remained in the cup.

Procedure 5: I could not weigh a plastic sour-cream cup precisely on our scale, so I took it to the supermarket and had it weighed there. It weighed 1g. I went home, put the cup on the

scale, and poured water slowly in it until the scale showed 100g. Then I added salt into the water. At the end of the experiment I weighed the mass of the cup again. It read 137g. By subtracting 101g (the mass of the cup and the mass of water) I got the mass of the salt dissolved in 100g of water and it was 36g.

Procedure 6: The volume and mass of water (density 1000kg/m$^3$) I weighed out by the use of Nescafe cup which has weight checking lines on it. I weighed out 100g of salt and added it slowly into the water. In the end I saw that the quantity of salt reduced for 40g.

At the next classroom meeting all students learned, by listening to their peers' reports, that one task can be performed in different ways. They compared their findings on sugar and salt solubility in water with data in the literature (solubility of sugar is 204g per 100g of water and solubility of salt is 36g per 100g of water, measured at 20°C) and discussed the advantages and disadvantages of the applied procedures.

This homework assignment proved to be not only a good means for the revision of the content studied at the previous class but also a useful introduction to a lesson on quantitative aspects of solutions. After this introduction, the responses of the majority of students showed that they understood that solutions differ in quantitative composition and how the quantities of the ingredients can be measured and expressed.

*Experimental Task For The First-Year Gymnasia Students (the ninth grade students)*

The experimental homework assignment was given to the first-year gymnasia students within the frame of the elaboration of the theme "Acids and Bases". Five tasks were devised for five groups of students, and appropriate worksheets (Fig.1) were provided.

The tasks to extract acid-base indicators from natural products (red rose, grapefruit, blueberry, red cabbage) and use them to examine the acid-base properties of water solutions of the "everyday-life substances" (vinegar, lemon juice, sodium bicarbonate, soap, etc.). Each group was also given one of the indicators that were used in class (to be able to compare colour changes in the experimental environment with the changes of colour of the indicators extracted from flowers, fruit and vegetables).

<table>
<tr><th colspan="8">WORKSHEET (homework assignment)</th></tr>
<tr><td>Goal:</td><td colspan="7">Preparation of acid-base indicators and investigation of acid-base properties of different substances.</td></tr>
<tr><td>Substances:</td><td colspan="7">red rose leaves, ethanol, vinegar, lemon juice, distilled water, baking soda ($NaHCO_3$), soap, red and blue litmus paper</td></tr>
<tr><td>Equipment:</td><td colspan="7">two pots, five glasses, a small flask, a teaspoon, a tray.</td></tr>
<tr><td>Procedure:</td><td colspan="7">a) Put red rose leaves into a pot. Heat ethanol in the other pot to the boiling point and pour it on the rose leaves. Leave it until it cools down to room temperature. Pour the obtained solution into the flask and leave it in the refrigerator until later use.<br>b) Pour one fourth teaspoon of baking soda into a glass, add distilled water and mix until soda dissolves. Dissolve a piece of soap in distilled water in another glass. Pour vinegar, lemon juice, and distilled water into the third, fourth and fifth glass. Immerse the red litmus paper into each glass up to its half, then the blue litmus paper, and place them both on the tray. Note down their colours. Then add a few drops of the prepared indicator in each glass. Note down the colours.</td></tr>
<tr><td rowspan="6">Questions:</td><td colspan="7">1. Paint the rectangles in the table with adequate colours. In the last row write down the acid-base properties of the examined solutions.</td></tr>
<tr><td colspan="2">Substances</td><td>vinegar</td><td>lemon juice</td><td>distilled water</td><td>baking soda solution</td><td>soap solution</td></tr>
<tr><td rowspan="3">Indicator colour</td><td>red litmus</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>blue litmus</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>red rose extract</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Solution properties</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">2. Using the same indicators examine acid-base properties of other “everyday-life” substances of your choice.</td></tr>
</table>

Figure 1. An example of a worksheet.

By performing experimental tasks students gain better understanding of the properties of substances they encounter in everyday life, and revalue the significance of gaining knowledge of chemistry. The applied type of the students’ engagement stimulated classroom studying additionally and stressed the usefulness of the contents regarding their application in everyday life.

## Conclusion

By presenting some examples of practical homework assignments for primary and secondary schools we hope to have illustrated how students' divergent thinking can be stimulated, and how knowledge and skills, acquired in classroom can be applied to determine the properties of substances in everyday life.

The students performed the following activities: problem analysis, action planning, and equipment selection/assembling, performing the experiment, measuring (mass, volume), data recording, and drawing conclusions. The presented tasks are of various guidance levels. In the case of primary school tasks divergent thinking technique was used in procedure planning and mass & volume measuring of the substances, while the task for secondary school students required divergent thinking in the selection of the substances.

The results of both tasks served as a basis for introducing new contents in the classroom, stimulated active participation of a larger number of students and contributed to their correct responses during classroom work.

The above positive experiences indicate that practical homework assignments can be used as a valuable addition to instructional work in order to enhance, the development of the student's abilities to apply acquired knowledge and skills in everyday life, teamwork and communication skills (peers, parents, teachers), and gaining a better understanding of the world we live in.

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