

# Demonstration in Teaching Chemistry: The Case of Two High-Schools from Sarajevo Canton

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## Abstract

For understanding fundamental chemical principles and gaining knowledge in chemistry, observation of chemical changes during experiment are crucial. Demonstration in teaching chemistry is particularly important in primary school where students meet chemistry for the first time, but also in secondary school for more demanding and complicated experiments. This study included 60 secondary school students from two schools in Sarajevo region. We have used test of knowledge regarding demonstration experiments prescribed by Curriculum, and questionnaire for students regarding the frequency of performed experiments. Results of this study showed that teachers performed experiments prescribed by Curriculum for 1<sup>st</sup> semester of 1<sup>st</sup> grade, and those students mostly do remember what happened during experiments; results of questionnaire showed that experiments in these two schools are performed on regular basis and that students and teachers recognize the importance of demonstration in chemistry.

**Keywords**-demonstration; experiments; teaching chemistry; secondary school; test of knowledge; questionnaire.

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## 1 Introduction

Chemistry has to be considered through the demonstration and laboratory work during teaching, so it could fully be understood and appreciated [1].

Demonstration in teaching chemistry applied through demonstration experiments is essential part of chemical education. These experiments do not require so much time out of lesson time and are suitable for presenting chemical law or a process. They are selected in order to be short, comprehensive and not too demanding when laboratory equipment is considered.

Studies showed that there are examples of lack of the experiments in chemistry education in many developed countries. In Germany, for example, research shows that the majority of teachers continue to use outdated system of teaching "ex cathedra" [2].

Experiments are very popular among students – in one survey [3] large percentage of students agreed that experiments helped them to understand the theory and develop the interest for chemistry, no one said that they are a loss of time - which shows an encouraging link

between the experiments and their educational value. There are also critics on the use of demonstrations, making the point that they are time-consuming and often are merely present for entertainment rather than educational reasons of using demonstration in chemistry education [3].

Frontal teaching is often in our school; teaching chemistry is not the exception. It is convenient for teacher and not time- or resource- consuming, but the biggest flaw is the absence of experiment that is crucial for chemistry as science and as well as a teaching subject. It is necessary to involve students into teaching activities in order to empower their learning possibilities and to reduce difficulties during learning and misconceptions that often arise from them.

Teaching methods that involve students and teachers are proven to be better. This aspect is outlined in demonstration [4]. It facilitates showing concrete experiences and emphasizes important facts. Teacher can stress the relevant issues within the teaching content so students can perceive chemistry as experimental science that emphasize the importance of experimental proof of a

hypothesis. "Thus while in lecture method teacher merely talks in demonstration method he really teaches" [4].

In order for demonstration to be successful both in experimental part ("experiment needs to work") and in engaging learners, here are some relevant aspects that teachers need to address [4]:

- Laboratory equipment, chemicals and everything relevant to demonstration should be seen from every part of a classroom. An alternative is to use overhead projector to demonstrate experiment or a large mirror placed at a suitable angle above the teachers' table. Also, if students are well disciplined, they can come near the teacher's table and observe the experiment.
- Visibility of a demonstration desk should be good. Teacher should provide enough light in the room or only on the table where demonstration takes place, depending on the room or experiment (sometimes the rest of the room should be in the dark).
- Teacher needs to systematize his working place. All clean laboratory equipment should be put on one side of the table in order it is needed during demonstration. After the use they should be put on the other side.
- Before the demonstration, students need corresponding introduction, instructions and explanations. However, this does not mean that teacher should say what is going to happen or to serve the conclusion before experiment.
- Teacher needs to be skillful experimenter, because he needs to pay attention to his students' activity during experiments, using proper questions and highlighting the important parts of experiment that students need to focus on.
- In order for demonstration to be clear, interesting and to keep the students' attention, it should be short, concise and adapted for corresponding students' age.
- Even though teacher has performed some experiment many times, nevertheless he needs to perform it again before every demonstration in front of students. There are many reasons that can lead to a failure, and failure needs to be avoided. If it happens anyway, the reason of a failure should

be found and experiment performed again. Extra lab equipment should always be prepared. Sometimes useful conclusion can be derived from an experiment that failed.

- Demonstration should be linked to everyday life, if possible. It should be direct and "live", since students are eager to see the experiment and every delay can result in weakening attention.
- Diagrams or sketches that come from experiment should be drawn on the blackboard.

Some common mistakes teacher can make before or during demonstration are as follow [4]:

- Laboratory equipment or chemicals (corresponding solutions) are not ready.
- Experiment is not related to the teaching topic.
- Teacher rushes students when they are discussing observations and make conclusion.
- Question teachers poses are not related to demonstration or teaching topic.
- Too much talking during demonstration can confuse students and redirect their attention away from demonstration.

However, one teaching method cannot be universal and applicable for every teaching topic or content. Demonstration method has some disadvantages that also should be considered when preparing for teaching and choosing right methods. This method is more economic than students' hands-on activities, but their value is also unquestionable in chemistry.

There is poor individualization of a process, and same teaching content is taught the same way for students who learn somewhat slower than their colleagues. Visibility in every part of a classroom is also one aspect that sometimes is not addressed properly [5].

After demonstration students should be encouraged to formulate their own observations and to say them aloud [6]. There is also opportunity for teacher to correct some possible non-scientific expressions of his students. Teacher should keep the discussion live by posing questions and activating every student. He should not tell them conclusion but should put accent to relevant observations and to lead discussion towards the right conclusion related to teaching topic.

As pointed out from Johnstone (1982), there are three levels of representation in teaching science: macroscopic, submicroscopic and symbolic level. All three levels should interchange in students' memory in order to achieve complete understanding of chemical phenomena [8], [9]. Macroscopic level is phenomenological and demonstration is clearly directed to this level. Whenever possible, teacher should address submicroscopic and symbolic level after demonstration.

Every experiment is related to safety measurements. In classroom, teacher is responsible for himself as well as for his students. Therefore, he should pay special attention to safety precautions. During demonstration, both teachers and students should wear goggles and lab coats, to be careful if burner is used, etc. Teacher should take care that his student are safe during demonstration and to have control over experiment. It is particularly important not to panic if something goes wrong [10].

## 2 Methodology

The study was primarily diagnostic. One of the aims was to determine the extent of use of demonstration experiments in teaching chemistry in 1<sup>st</sup> grade of selected secondary schools. In our earlier study [11] we have proven that demonstration and especially laboratory experiments are rarely performed in primary schools in Bosnia and Herzegovina.

Data collection during this study took place in two randomly selected high-schools in Canton Sarajevo. Chemistry teachers in both schools teach by the same Curriculum approved for this kind and this level of education. Data were confidential and used for the purpose of this research only.

### 2.1 Instruments and participants

Test of knowledge (TK) regarding demonstration experiments contained 6 multiple choice items. Items were selected according to experiments prescribed by Curriculum, and formulated according to expected observation of these experiments. This test was administered to 60 1<sup>st</sup> grade secondary school students at the end of 1<sup>st</sup> grade.

Questionnaire for students (Qs) was administered to 120 1<sup>st</sup> grade secondary school students also at the end of 1<sup>st</sup> grade. It contained 15 items regarding frequency of demonstration experiments and students activities during and after the experiment.

## 3 Results

Results of test of knowledge (Fig. 1) show substantial students' knowledge on demonstration experiments prescribed by Curriculum.

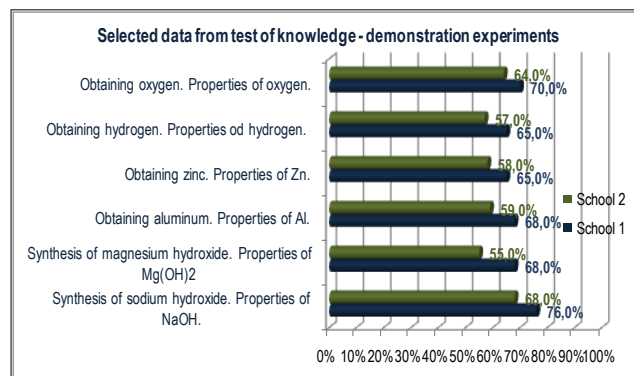


Figure 1. Selected data from test of knowledge

There is high percent of correct answers in both secondary schools. There was low percent of answers "I do not know" (from 0% up to 8%), but a greater percent of answer "Teacher did not perform this experiment". However, it is unusual for 20% of students (item 2, Synthesis of magnesium hydroxide) to say that their teacher did not perform experiment, while 55% answered correctly to this item.

Results of a questionnaire for students (Fig. 2) are comparable between schools.

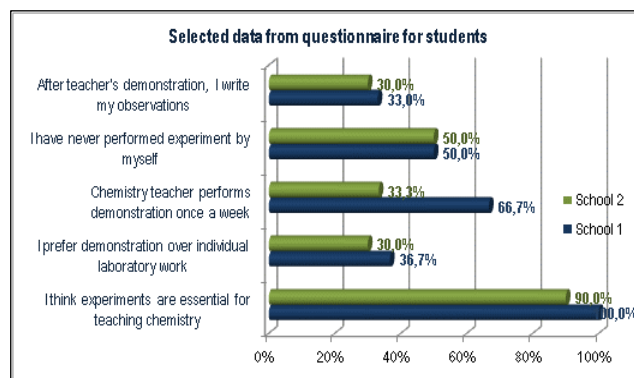


Figure 2. Selected data from questionnaire for students

The only significant difference is on the item about frequency of demonstration, since students of School 1 said that their teacher performs demonstration more often than students in School 2. They mostly believe that experiments are necessary and essential for teaching chemistry, but 50% of them in both schools have never performed experiment by themselves.

## 4 Conclusion

Demonstration experiments prescribed by curriculum were performed in school research has been conducted in. These experiments are rather simple and do not require complicated or expensive laboratory equipment, so it was somewhat expected that they were performed regularly. However, experiments are not performed regularly in primary schools, even though they also are simple, so we can conclude that teachers' role is crucial.

Teachers believe that demonstration experiments should be more extensively applied but they do not have resources they need. However, creativity of a teacher is required especially in these kinds of activities. Today, Internet resources are available and many experiments are given with non-expensive or non-toxic chemicals from everyday life.

Students remember performed demonstration experiments and knowledge acquired with use of demonstration experiments is more permanent than theoretical facts. We saw that there was a high percent of correct answers regarding concepts explained using demonstration experiments on test of knowledge. It is interesting that students prefer demonstration over individual laboratory work. Perhaps we can explain it by the lack of experience or teachers' continuous instructions for safety during experimenting, so these students prefer to watch their teacher.

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