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Virtual Analytical Chemistry Software

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ABSTRACT

Chemistry subjects are in the most cases strongly interconnected with experiments, both on a fundamental level, but also in the process of teaching/learning. Many high schools in Serbia have a problem with lack of laboratory space and chemicals, which significantly complicates teaching/ learning of practical skills. This work aims to present innovation in high school chemistry teaching as an excellent way to overcome these obstacles. Virtual analytical chemistry software was designed in order to help students in learning qualitative analytical chemistry without entering laboratories.

Keywords: Chemistry, Teaching, Virtual analytical chemistry, Software

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Introduction

Chemistry is an essential basis for many sciences but also allows understanding the world around us. If someone wants to know how materials and drugs are made, how cooking affects substances from food or how detergents work, he/she must consult chemistry. As an experimental science, chemistry should encourage the inclination towards research, logical deduction that leads to results and chemical process analyses with the outcome of applying the knowledge and connections to other disciplines. Chemistry, science, and technology are in tight connections to economies of each highly developed industrialized and technologically advanced society (Burmeister et al., 2012).

Traditionally teaching chemistry way may leave the students with a lack of motivation. The results of PISA tests show that Serbia is falling behind in science education comparing to the countries in the EU. The problem, facing chemistry teachers in many schools in Serbia, has been lack of laboratory space and chemicals. From these reasons, chemistry in schools is taught mostly in classrooms, without entering laboratories. Practical experience is an integral part of chemistry science. The availability of laboratory equipment, chemicals and materials, laboratory personnel, working conditions in the laboratory and safety measures, substantially recommended textbooks and certain periods allocated for the teaching of the subjects are necessary (Adefunke, 2008). The conducted research among one thousand students shows that studying chemistry is a repetition of what has been taught. That fact is the apparent sign that the concept of teaching needs change.

To the best of author's knowledge, this paper is the first report on virtual qualitative analytical laboratory, created to bring closer laboratory work to the high school students in Serbia.

Virtual analytical chemistry software

This whole concept aims to introduce the basics of analytical chemistry in a more interactive way to students with no laboratory access. They will be able to use the software in order to learn through virtual simulation and visualization qualitative analytical laboratory.

The base of the software is its engine. The engine used to develop this software is « Unity Engine ».

The language used and combined with the engine is Microsoft Visual C#. The 3D Models used are a combination of different assets that are compatible with the Unity Engine. The 2D designs were custom made to fit the style of the software.

Virtual analytical chemistry is a software which shows chemical reactions of anions (Cl^-, SO_4^{2-}, NO_3^-, CO_3^{2-}, CH_3COO^-) and cations (Ag^+, Pb^{2+}, Hg^{2+}, Cu^{2+},Fe^{3+}, Al^{3+}, Ca^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+) presence with suitable reagents in an interactive way.

For the schools, which do not have well-equipped laboratories, this software can serve as a removable teaching tool. The software is designed for students of Gymnasium, medicinal, and chemistry schools, which learn analytical chemistry. It should help students to visualize chemical reactions that are the basis of qualitative analytical chemistry. Also, it can help teachers and students in preparations for chemistry competitions.

The simulation of chemical processes is conducted in a chemical laboratory with 3D modeled test tubes (equipment) and reagents through the formation of residue and gases.

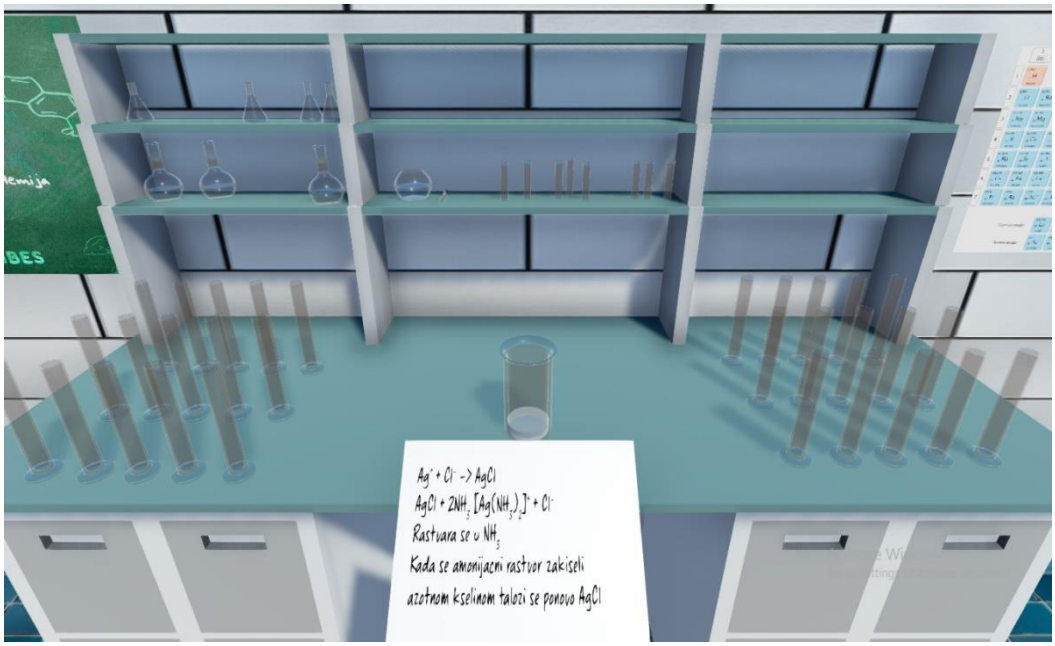

Figure 1. Virtual analytical chemistry software – chloride test reaction

The program consists of two sets of test tubes on the right-hand and left-hand sides. The test tubes are marked with numbers, and the combination of two numbers leads to a specific reaction. When the combination of two numbers does not give the expected reaction, that is, when for a certain anion or cation a wrong reagent is used, a ’virtual explosion’ happens in the virtual laboratory.

Figure 2. Virtual analytical chemistry software – wrong reagent used

There are many advantages of using this software. The virtual chemistry laboratory is always available to students in Serbia. With the combination of the right reagents, we get correct reactions of cations and anions, which makes the process much more economical and functional for use outside a physical laboratory. The students are more motivated to use and implement the software into new chemical situations safely.

The goal is modernizing and increasing the openness in teaching chemistry, increasing the interest of students and improving the education of chemistry.

Conclusion

The software is designed for pupils from Gymnasium, Medical and Chemistry schools in qualitative chemical analysis aimed to serve as a portable teaching tool. It should help students to visualize the chemical reactions that are the basis of qualitative analytical chemistry. The described way of teaching enables students to understand the chemical laws in a modern way, which is in line with the modern world, new technologies, and scientific achievements, without entering the chemical laboratory. We expect that modernization and increasing visualization of chemistry can

increase the interest of students and improve the level of knowledge in chemistry. It can also help teachers and students to prepare for chemistry competitions.

It is necessary to inspect the influence of the software on student interests for chemistry and in the level of knowledge in this area using the parallel group method. In case the results are positive, there is a possibility that similar software is made for different topics in chemistry and other sciences.

Conflict-of-Interest Statement

Author declares no conflict of interest.

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