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# Educational Website REDOXMASTER: A Digital Platform for Teaching Redox Reactions

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## ABSTRACT

*This article presents the development of RedoxMaster, an educational website designed to support secondary school students in learning redox processes in chemistry. The platform integrates four modules: a digital chemistry textbook, a redox reaction calculator, a set of interactive quizzes, and an interactive periodic table. The website provides a comprehensive learning environment by combining theoretical resources, automated problem-solving tools, and visualization features. The development process, applied technologies, and educational benefits of the system are described. The results demonstrate how RedoxMaster facilitates the understanding of complex chemical reactions and supports modern digital learning practices.*

*Keywords: redox reactions, digital learning, interactive chemistry, educational website, web technologies.*

## INTRODUCTION

Redox processes represent a fundamental yet challenging concept in chemistry education. Balancing redox reactions often creates difficulties for high school students due to the complexity of oxidation states, electron transfer, and chemical equation balancing. Traditional teaching methods, primarily based on printed textbooks and lectures, provide limited opportunities for interactive practice and visualization. In recent years, digital tools have become increasingly important in education, offering opportunities to enhance learning outcomes through interactivity and visualization. However, many existing resources are fragmented, focusing on either theory or problem-solving, without integrating them into a single, coherent platform. The aim of this project was to design and develop RedoxMaster, a web-based platform that addresses these challenges by combining theory, practice, and automation. The system provides students with a unified learning environment that improves accessibility, understanding, and motivation to study chemistry [1, 2].

## EXPERIMENTAL

The development of RedoxMaster required combining knowledge from chemistry and computer science. A strong understanding of oxidation states, electron transfer, and redox

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balancing methods was essential to design the calculator algorithm and ensure scientific accuracy in the textbook content. At the same time, programming and web development skills were required to transform these concepts into an interactive educational platform.

The process of creation included several stages. First, a conceptual design phase was carried out, during which the team identified student difficulties in redox chemistry and defined the four main modules of the platform. After this, the algorithm development phase focused on implementing parsing and balancing of chemical reactions for the calculator.

The third stage involved interactive visualizations, where animations and the periodic table were created using Unity. This was followed by web integration, which ensured a user-friendly interface through HTML, CSS, and JavaScript. Finally, testing and validation were performed to check chemical correctness and usability, with valuable feedback gathered from both students and teachers [3, 4].

In its final form, the RedoxMaster platform consists of four main modules. The textbook module presents theoretical concepts of redox chemistry in a structured and accessible way, including diagrams and examples aligned with the curriculum. The redox reaction calculator automatically balances redox reactions and illustrates electron transfer. The quiz module provides exercises with automated feedback to help learners track progress. Lastly, the interactive periodic table, built with Unity, allows exploration of element properties and visualization of redox interactions [4].

The implementation relied on modern software tools. Unity was used for interactive simulations, while HTML, CSS, and JavaScript provided the structure and interactivity of the website. Visual Studio and Visual Studio Code served as the main development environments for coding, and Git with GitHub ensured version control and effective collaboration.

## RESULTS AND DISCUSSION

The implementation of RedoxMaster demonstrates the potential of web-based systems to improve chemistry education. Fig. 1. shows the textbook module, where students can read theory with integrated visual

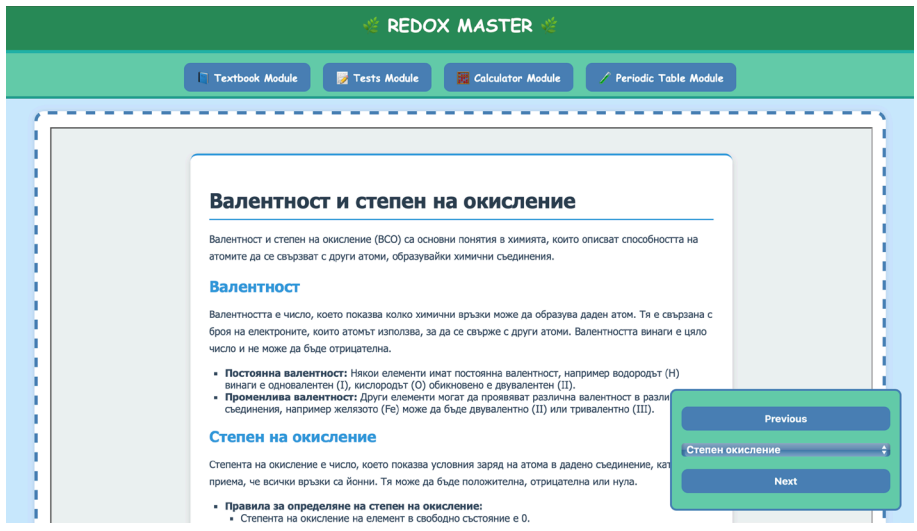


Fig. 1. The textbook module with lessons written in Bulgarian.

diagrams.

Fig. 2. demonstrates the quiz module, on which the students can test their knowledge.

Fig. 3, 4, and 5 illustrate the calculator module. Employing a specialized algorithm for balancing and comparing different elements, the module computes the given first half of the reaction and completes it while providing additional details about the electron flow.

Fig. 6 and 7 represent the interactive periodic table.

Students who tested the platform reported that the combination of theory, practice, and visualization enhanced their understanding of redox processes. Automated calculations allowed them to focus on conceptual understanding rather than mechanical balancing, while the quizzes and periodic table encouraged exploration and self-learning. The system's modular architecture makes it flexible and extendable. Future upgrades may include mobile application development, additional chemical simulations, and personalized learning

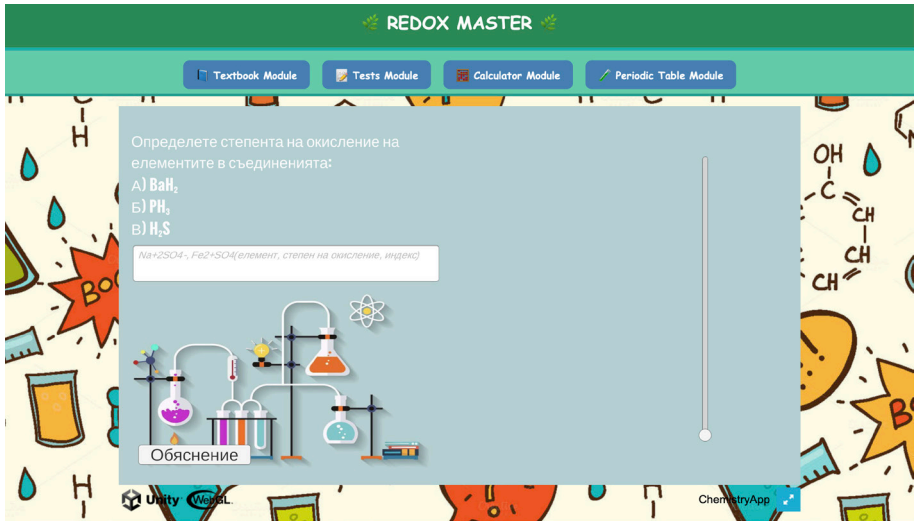


Fig. 2. A question from the quiz module in Bulgarian.

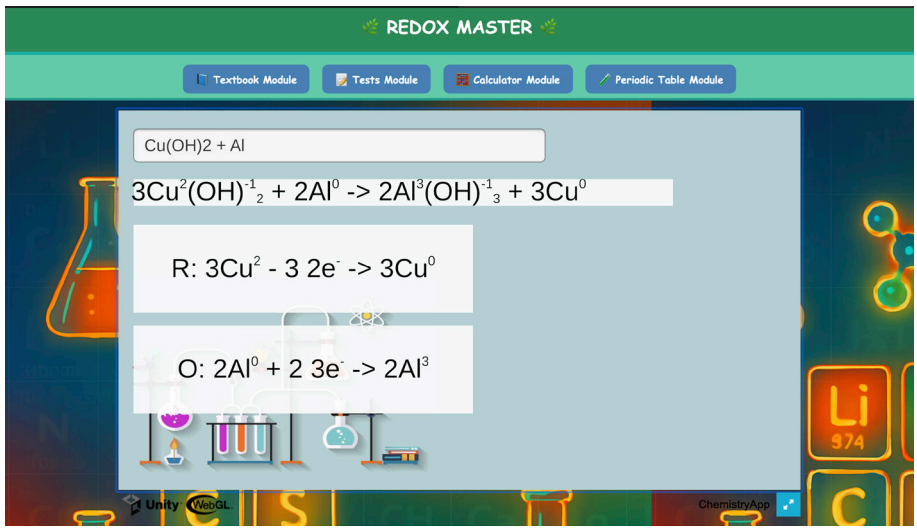


Fig. 3. Reaction between $Cu(OH)_2$ and Al.

pathways based on student performance [4].

Fig. 3 shows the reaction between $Cu(OH)_2$ and Al. As shown, the reaction is presented in its balanced form thanks to the algorithm responsible for balancing the equation. Fig. 4. shows the $Cu(OH)_2$ + Au reaction, which is impossible due to the activity series of metals. The result for the $Cu(OH)_2$ + Mg reaction. It is not balanced due to the nature of the equation (Fig. 5).

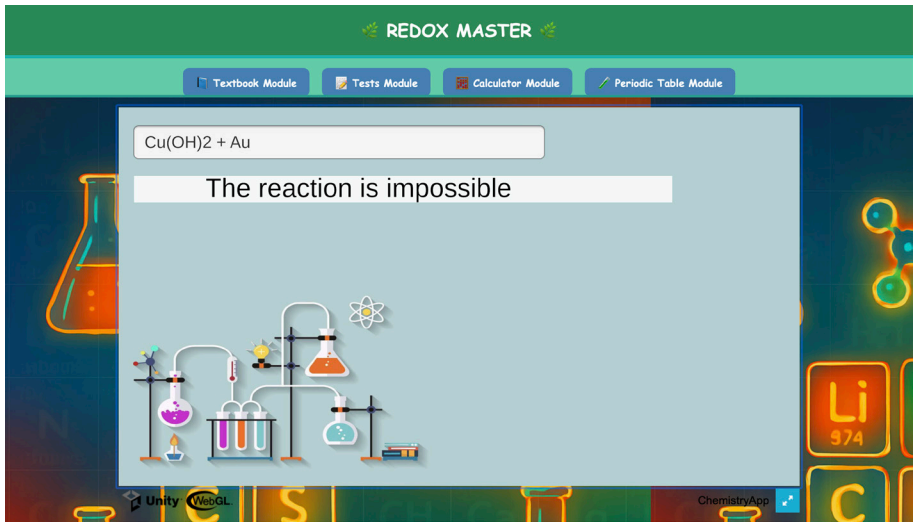


Fig. 4. $Cu(OH)_2$ + Au reaction.

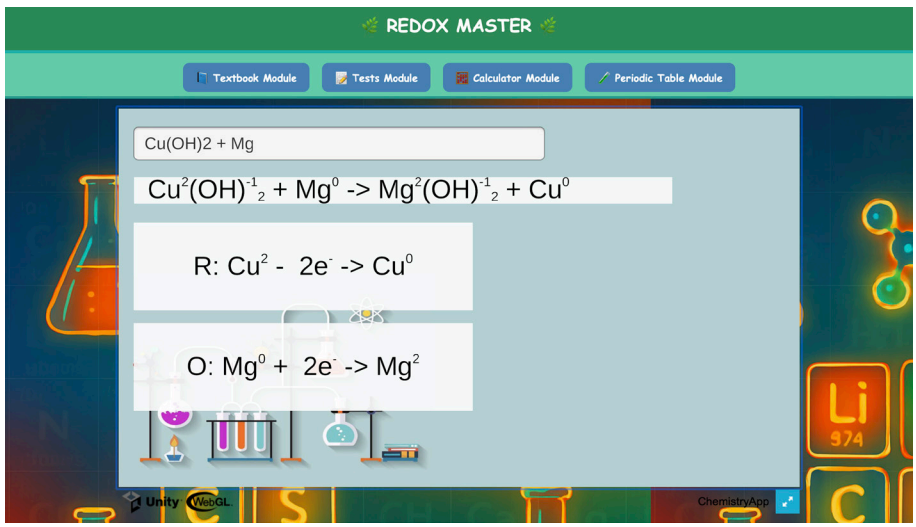


Fig. 5. $Cu(OH)_2$ + Mg reaction.


Fig. 6. Periodic Table Module when the mouse is not hovering an element.

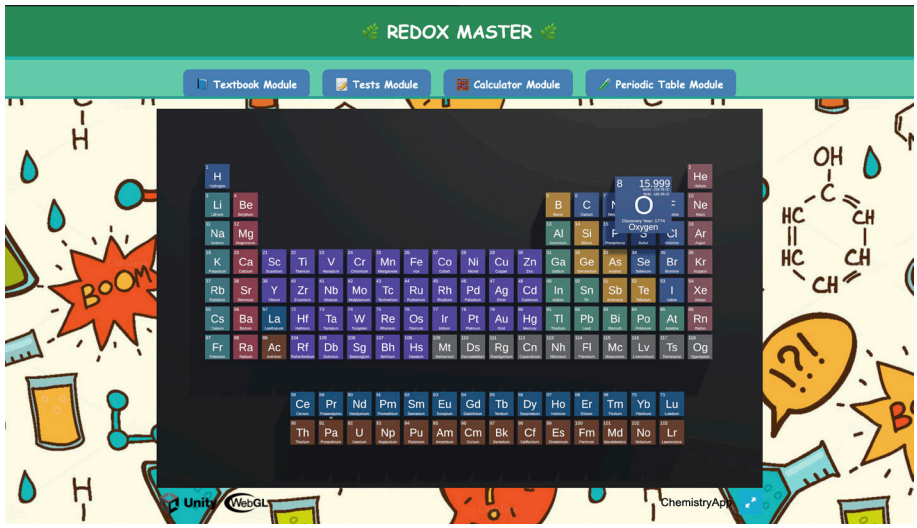


Fig. 7. The Periodic Table Module when the mouse is hovering an element.

## CONCLUSIONS

The RedoxMaster platform provides an innovative approach to teaching and learning redox chemistry in secondary education. By integrating theoretical resources, automated tools, and interactive visualizations, it offers a comprehensive solution that supports both teachers and students. [5].

The development demonstrates how modern web technologies can be effectively applied in educational contexts, ensuring accessibility, interactivity, and motivation. With further development, RedoxMaster can evolve into a complete digital ecosystem for chemistry education.

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