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THE AVOGADRO MOLECULAR VISUALIZATION SOFTWARE APPLICATION IN THE STUDY OF CHEMICAL DISCIPLINES AT THE FACULTY OF PHARMACY

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Introduction. Digital learning tools are an integral part of the modern educational process, and the Avogadro service is widely used in chemistry education. Its implementation in a basic chemistry course helps students develop 3D visualization skills, understand molecular properties and new chemical concepts, and foster academic motivation through active engagement in learning [1].

Studying topics using molecular visualization software allows students to combine their high cognitive potential with a certain degree of complexity in implementation, due to the challenges that arise when using the software [2]. The introduction of modeling tools, such as Avogadro, improves the perception of educational material, promotes the development of conceptual understanding of chemistry, and optimizes learning outcomes [3].

Avogadro is a modern, open-source molecule editor and visualizer. Its main advantages include: ease of installation (compatibility with Windows, Linux, and Mac OS X), availability as a free open-source resource, an intuitive interface, and fast, flexible performance, etc. Due to the above-mentioned advantages, the service is used in research in the field of molecular modeling and for educational purposes in teaching chemistry [4]. This study is devoted to the application of this digital tool in the study of chemical disciplines.

Aim of the study: to investigate the advantages and disadvantages of using the Avogadro molecular visualization software in teaching chemical disciplines to students at the Faculty of Pharmacy.

Materials and methods. Analysis and overview of the Avogadro software application by students and teachers in the process of studying chemical disciplines.

Results and discussion. For pharmacy students, the ability to construct and understand the chemical structure of medicines has become an important component of the educational process. Using Avogadro in teaching Organic, Pharmaceutical

Chemistry, small organic molecules as well as molecules of drugs with organic structures were visualized, which facilitated a deep cognitive analysis of their spatial structure, specifically the arrangement of functional groups, bonds, molecular geometry, and physicochemical properties. Its implementation was particularly appropriate as a supplementary digital resource for topics in Organic Chemistry, such as "Chemical bond and interatomic interactions in organic molecules. Elemental analysis", "Isomerism of organic compounds. Spatial structure of molecules. Determination of physical constants of organic compounds" as well as to sections on specific classes of organic compounds.

3D visualization of molecules has enabled a deeper understanding of the mechanisms of drug action, explained the interaction of medicinal substances with biological targets, and clarified the relationship between their structure and pharmacological effects, as well as side effects, thereby fostering a comprehensive understanding of the complex processes involved in Organic, Pharmaceutical Chemistry, Pharmacology, Medicinal Toxicology, Toxicological and Forensic Chemistry. The implementation of Avogadro improved future Masters' of Pharmacy understanding of the study material, helped them develop skills in using new software, and prepared them for upcoming course papers.

In our opinion, the drawbacks of this program include the need for preliminary preparation before downloading it, specifically reviewing the user manual. We agree with our colleagues [5] that the effective implementation of this and similar software requires active participation by teachers and planning of appropriate work with it. In addition, basic knowledge of English and the mandatory use of a computer or laptop are necessary; however, the aforementioned drawbacks did not significantly affect the effectiveness of using this service.

Conclusions. The Avogadro molecular visualization software was used in the study of chemical disciplines by students of the Faculty of Pharmacy and contributed to a better understanding of the basic concepts of the structure of organic compounds and the relationship between the structure and action of medicines. We consider it an effective supplementary digital tool for teaching chemical disciplines to future Masters of Pharmacy.

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