DEVELOPMENT OF AN INTERACTIVE SIMULATOR AND CREATIVE ASSIGNMENTS ON HYDROCARBONS USING ARTIFICIAL INTELLIGENCE

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ANNOTATION:

This article investigates how to improve the teaching and learning of hydrocarbons by the development and use of an AI-based interactive simulator and creative projects. The simulator offers a dynamic and captivating platform for visualising hydrocarbons' commercial uses, chemical processes, and molecular structures. The innovative assignments use gamification, real-world situations, and group projects to help students become more creative and enhance their problem-solving abilities. The significance of individualised learning experiences in chemistry education is emphasised as methods for incorporating AI technologies and enhancing instructional strategies are examined.

Introduction. The instruction of hydrocarbons, a fundamental subject in chemistry, is essential for comprehending organic compounds, their characteristics, and their applications across diverse industries. Conventional pedagogical approaches, although somewhat effective, frequently do not adequately engage pupils or accommodate their varied learning requirements. The swift progression of technology, especially artificial intelligence (AI), offers novel prospects to revolutionise the educational experience by enhancing interactivity, personalisation, and effectiveness.This article examines the creation and execution of an AI-driven interactive simulator designed for the study of hydrocarbons. The simulator enables students to visualise molecular structures in three dimensions, investigate diverse chemical reactions, and comprehend industrial applications through interactive and immersive simulations. Moreover, creative tasks with real-world applicability and gamified components are introduced into the educational process to enhance engagement, critical thinking, and collaboration among students.This methodology seeks to transform conventional hydrocarbons education by utilising AI, enabling students to comprehend theoretical topics while cultivating practical problem-solving abilities and an inventive mentality. This study delineates the methodology, instruments, and strategies utilised in the development of the simulator and assignments, as well as the prospective advantages of such a system in contemporary chemistry education.

Artificial Intelligence (AI), a transformative field in education, is generating novel prospects in the instruction of chemistry. AI tools are employed to enhance student engagement and augment the quality and efficiency of education. Research substantiates the role of AI in education. Mendez's study indicated that students acknowledged the utility of AI tools in chemistry education: “AI tools can provide additional support for students in the learning process and help clarify complex chemical concepts” (Mendez, 2024).Ethical considerations and educator preparation. Blonder and Feldman-Maggor's research indicates the necessity of training educators in the ethical utilisation of AI tools: “It is important that teachers use AI technologies in an ethical and responsible manner in their teaching” (Blonder & Feldman-Maggor, 2024).Student involvement and cutting-edge platforms. The AI-driven development model created by Yildirim and Akcan enables educators to instruct chemistry using innovative platforms: “AI presents new opportunities for chemistry instructors and enhances the quality of the teaching process” (Yildirim & Akcan, 2024).Exemplary methodologies and artificial intelligence instruments. Research by Alasadi and Baiz has proposed innovative methods for addressing intricate visual challenges in chemical processes with multimodal AI tools: “Generative AI tools can be effective in elucidating complex chemical processes in chemistry education” (Alasadi & Baiz, 2024).

Methodology:The creation of an interactive hydrocarbon simulator utilising artificial intelligence necessitates a methodical strategy to guarantee functionality, usability, and teaching efficacy. The approach commences with a comprehensive investigation of the issue, pinpointing essential ideas such the classifications, characteristics, and applications of hydrocarbons (figure 1). This study guides the simulator's design, guaranteeing alignment with instructional objectives and facilitating a thorough comprehension of the subject matter.

The simulator's foundation is centred on 3D molecular visualisation, enabling users to engage with and modify hydrocarbon molecules. This encompasses functionalities such as rotating and zooming into chemical structures, building isomers, and examining bond angles and lengths. AI algorithms improve this experience by providing adaptive feedback and recommendations depending on user activities, thereby fostering a personalised learning environment. Additionally, the simulator features dynamic depictions of chemical reactions, allowing users to investigate processes such as combustion, substitution, and addition reactions. Animations illustrate reaction mechanisms sequentially, connecting theoretical knowledge with practical comprehension.

The simulator has gamified components to enhance user engagement, including problem-solving exercises, quizzes, and challenges that incentivise users for accurate responses. These components promote active engagement and enhance educational results. The development process entails thorough testing and refinement to resolve usability concerns, enhance performance, and integrate feedback from instructors and students.

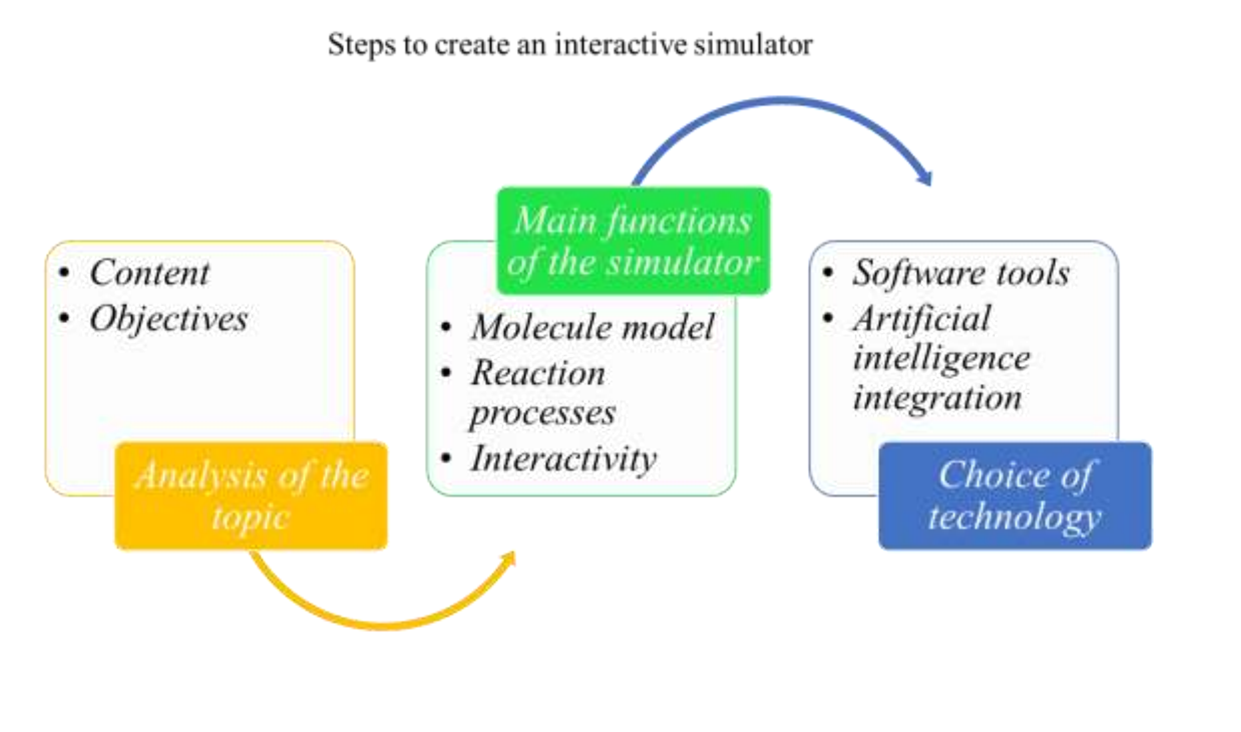

Figure 1: steps to create interactive simulator

The simulator's technology stack utilises programming languages including Python and JavaScript, as well as tools like WebGL and Unity for three-dimensional rendering. Artificial intelligence is incorporated via machine learning frameworks such as TensorFlow, facilitating adaptive learning capabilities and real-time analytics. This method guarantees that the simulator is technically sound and educationally effective, serving as a valuable resource for contemporary chemistry education.

The development of assignments related to hydrocarbons emphasises student engagement via real-world applications, gamification, and collaborative problem-solving. The assignments aim to link theoretical concepts with practical applications, including the examination of industrial uses of hydrocarbons and the exploration of environmental concerns associated with their extraction and combustion. Each task is designed to foster critical thinking and innovation, prompting students to develop solutions or construct models based on their comprehension (figure 2).

Assignments utilise gamification to enhance motivation, integrating components such as points, levels, and virtual rewards for task completion. Students may analyse reaction pathways to optimise the production of specific hydrocarbons or design sustainable processes to reduce emissions associated with hydrocarbon usage. Collaborative tasks are emphasised, enabling groups to collectively address complex problems, thereby enhancing teamwork and communication skills.

AI algorithms assess individual progress and recommend tailored challenges that correspond to the learner's proficiency level, thereby ensuring adaptability. This method guarantees that assignments are engaging and suitably challenging, fostering a deeper understanding and application of hydrocarbon chemistry concepts. The methodology combines creativity and scientific rigour, equipping students to address real-world chemical challenges through innovative strategies.

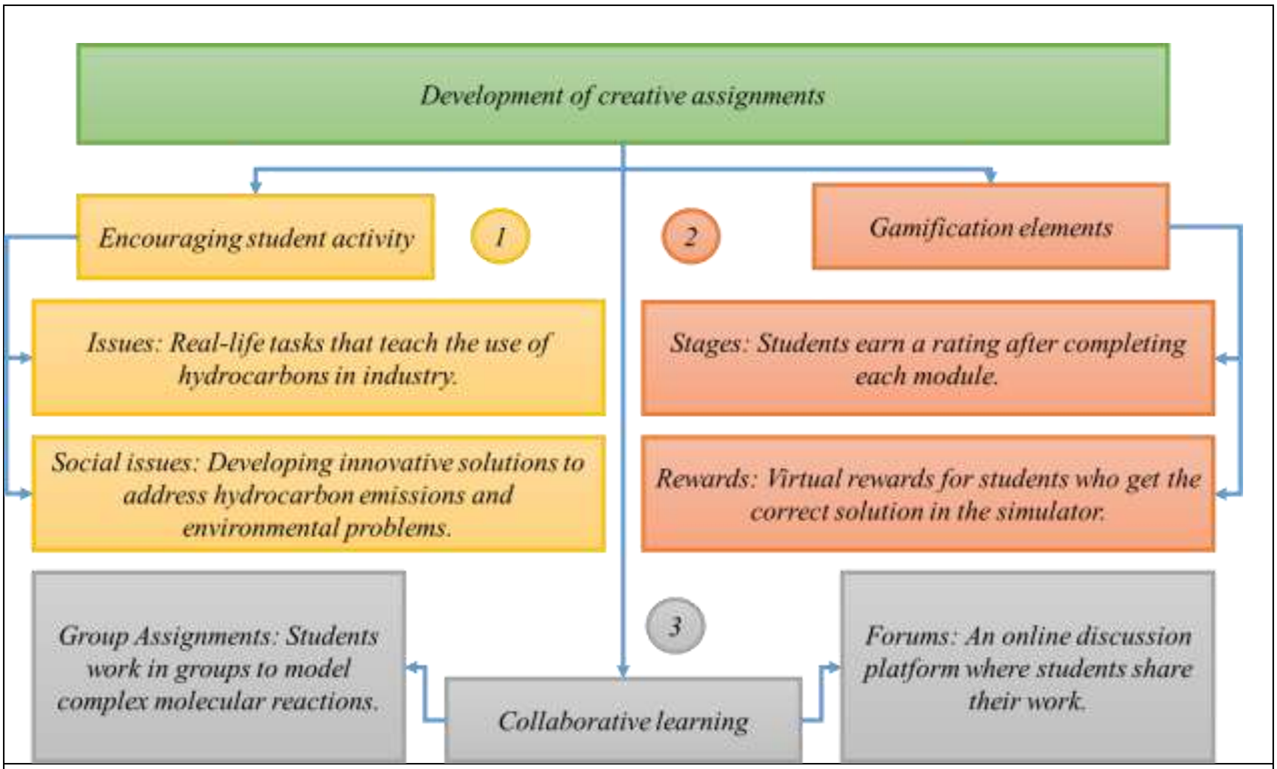

Figure 2: Methodology for developing creative assignments

To augment the methodology for instructing hydrocarbons using interactive simulators and innovative assignments, numerous pivotal enhancements can be instituted. Initially, the incorporation of modern technologies like virtual reality (VR) and augmented reality (AR) can offer an immersive educational experience. These instruments enable students to investigate molecular structures and chemical reactions inside a virtual setting, rendering abstract topics more concrete and captivating.

The integration of artificial intelligence (AI) facilitates personalised learning trajectories, allowing the system to adjust to individual advancement and offer customised suggestions for additional study or practice. AI-driven analytics can assist educators in identifying prevalent issues encountered by students and modifying the content or complexity of assignments accordingly.

An further facet of enhancement is the incorporation of interdisciplinary methodologies, connecting hydrocarbons to domains such as environmental science, engineering, and economics. Assignments may entail addressing real-world challenges, such as developing eco-friendly fuels or assessing the sustainability of industrial operations. This method expands students' viewpoints and underscores the significance of hydrocarbons in worldwide contexts.

Consistent changes to the simulator and assignments, informed by input from students and educators, guarantee the tools' relevance and efficacy. Furthermore, creating a collaborative learning platform that enables students to share their work, discuss solutions, and engage in peer reviews cultivates a feeling of community and promotes deeper involvement.

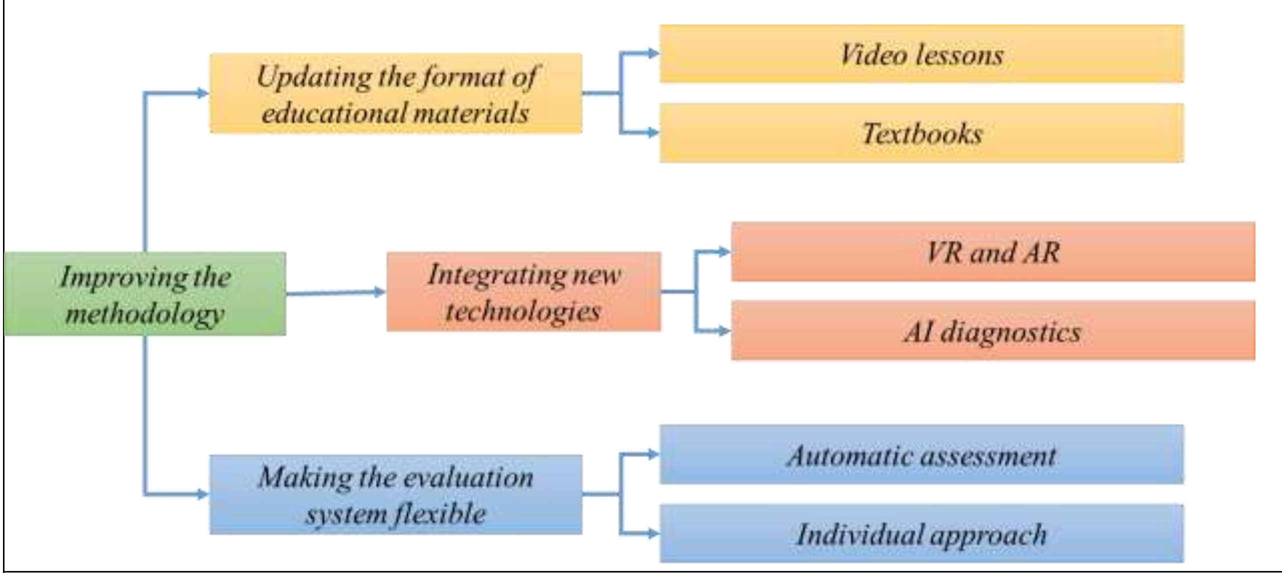

Figure 3: Improving the methodology

The incorporation of assessment instruments, including automated grading systems and interactive quizzes, optimises the evaluation process and delivers immediate feedback to students. Through the ongoing enhancement of these techniques, hydrocarbon education can evolve to be more dynamic, participatory, and congruent with contemporary educational requirements.

The implementation of artificial intelligence (AI) in chemistry education has markedly enhanced the teaching and learning process in recent years. AI technologies facilitate students' comprehension of intricate chemical topics in a straightforward and entertaining manner. AI tools can offer personalised strategies for students, elucidate intricate chemical processes, and enhance cognitive skills.Makinde and Oyeniyi underscore the need of developing resources that cater to students' requirements and facilitate independent learning. Wenyan has examined the impact of AI-based platforms on the cultivation of analytical thinking skills. These systems facilitate active student engagement in experiments, enhancing their comprehension of chemistry.Perezzan and Montalvo-Quirós have demonstrated in their research that AI tools can enhance students' engagement in addressing challenging challenges. They contend that these instruments ought to be extensively implemented in higher education. Divya and Aparna emphasised the significance of visualisation tools in elucidating intricate chemical processes, demonstrating that students can acquire concepts more swiftly and effortlessly with the assistance of AI. Iyamuremye et al. highlighted the significance of AI and machine learning techniques in enhancing their comprehension of scientific issues and devising solutions. Generative artificial intelligence is generating novel prospects in chemistry teaching. Alasadi and Baiz introduced novel methodologies for addressing intricate chemical issues through the utilisation of generative technologies.

In conclusion, artificial intelligence simplifies chemistry instruction, enhances student engagement, and provides convenience for educators. Nevertheless, the appropriate utilisation and ethical considerations of these technologies must not be overlooked. The proper and efficient utilisation of AI tools can elevate the quality of schooling significantly.

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