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Innovation In Biochemistry Teaching In Spiral Curriculum: Enhancing Student Engagement And Learning

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Biochemistry, as a core subject in medical and health sciences education, presents unique challenges due to its highly theoretical and complex nature. Traditional teaching methods, such as lectures and textbook-based learning, are no longer sufficient to meet the evolving needs of students in the digital age. Innovative teaching methods have emerged to enhance student engagement and promote deeper understanding. In recent years, the traditional approaches to teaching biochemistry have faced challenges in maintaining student engagement and ensuring deep learning. Given the complexity of biochemical processes and the highly theoretical nature of the subject, there is a pressing need for innovative teaching strategies that not only capture student interest but also foster deeper understanding and practical application. Flipped Classroom is one of the most successful innovations in biochemistry education is the flipped classroom model. This method encourages students to engage with core concepts before attending class, enabling class time to be dedicated to problem-solving and discussion. Studies have shown that flipped classrooms improve student performance and understanding by encouraging active learning. For instance, Bishop and Verleger (2013) highlighted that flipped classrooms promote interactive learning environments, which are particularly effective in scientific disciplines such as biochemistry. The introduction of AR and VR technologies in teaching complex biochemical structures and pathways has revolutionized visualization techniques. Students can now interact with molecular structures in 3D, enhancing their spatial understanding of intricate concepts such as protein folding and enzyme-substrate interactions. A study by De Paolis et al. (2021) found that AR-based education significantly improved students' engagement and comprehension in medical education. This technology is especially useful in biochemistry, where understanding molecular interactions is crucial. Another promising innovation is the use of gamification in biochemistry. Gamification techniques, which integrate game elements such as scoring, competition, and rewards into educational activities, have been shown to enhance student motivation and engagement. As noted by Subhash and Cudney (2018), gamification increases students' retention and active participation, transforming the learning of complex biochemical pathways into a more interactive and enjoyable experience. Problem-Based Learning (PBL) is another powerful method in biochemistry education. By providing students with real-world clinical problems that require the application of biochemical knowledge, PBL fosters critical thinking and reinforces the relevance of biochemistry in clinical practice. According to Wood (2003), PBL helps bridge the gap between theoretical knowledge and its practical application in medical settings. The integration of these innovative teaching methods in biochemistry holds immense promise for enhancing student engagement and learning. By shifting away from traditional lecture-based methods to more interactive, student-centered approaches, educators can foster a deeper understanding of biochemistry while preparing students for its application in clinical settings. Future research should focus on evaluating the long-

term effectiveness of these innovations in improving student outcomes and ensuring their practical readiness for the healthcare field. As we move forward, continuous adaptation of teaching methods is essential to meet the needs of modern learners and to ensure that biochemistry remains an engaging and foundational subject in medical education.

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