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Research Article

DEVELOPING CRITICAL THINKING SKILLS IN MEDICAL BIOCHEMISTRY THROUGH DIGITAL CASE-BASED LEARNING

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ABSTRACT

In the modern era of medical education, the ability to apply biochemistry knowledge to clinical cases is crucial. This article explores the effectiveness of digital case-based learning (CBL) in enhancing critical thinking skills for medical students in biochemistry courses. Digital CBL tools provide realistic clinical scenarios that require students to connect biochemical processes with diagnostic decisions, promoting active learning and critical thinking.

KEYWORDS

Biochemistry, case-based learning (CBL), critical thinking, virtual, digital platforms.

INTRODUCTION

In recent years, the healthcare landscape has seen rapid advancements, increasing the demand for highly skilled medical professionals equipped not only with knowledge but also with advanced cognitive skills, such as critical thinking (CT) and clinical reasoning. Critical thinking is essential for medical students, particularly in fields like biochemistry, which forms the foundational knowledge for understanding complex biochemical processes and disease mechanisms (Kallet, 2014)[1].

Biochemistry forms the molecular foundation of many clinical disciplines, including physiology, pharmacology, and pathology. Understanding biochemical pathways and their clinical implications is essential for medical students, particularly in diagnosing and treating diseases. Traditional biochemistry instruction, however, often lacks interactive components, which can limit students' ability to apply theoretical knowledge in clinical scenarios. Digital case-based learning (CBL) has emerged as a potential solution, offering an environment where students can engage with realistic

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cases and develop their diagnostic reasoning and critical thinking skills (Garrison & Vaughan, 2008)[2].

The Role of Critical Thinking in Biochemistry Education

Critical thinking in biochemistry allows students to analyze and integrate biochemical data with clinical information, fostering a deeper understanding and promoting clinical application. In biochemistry, critical thinking involves:

Analyzing complex biochemical processes: Identifying how different pathways interact and how changes affect physiological functions.

Connecting theory with practice: Applying theoretical concepts to diagnose biochemical markers related to diseases[3].

Problem-solving: Using biochemical data to create a diagnostic hypothesis and exploring therapeutic options.

Without critical thinking, students may struggle to see the relevance of biochemistry in clinical settings. Digital CBL, by simulating real-life medical cases, encourages students to apply biochemical knowledge actively (Fowler et al., 2013)[4].

Digital Case-Based Learning in Biochemistry

Structure and Implementation

In digital CBL, students are presented with patient cases that often include a clinical history, biochemical data (e.g., lab results), and sometimes imaging. They must analyze the case, interpret lab results, and connect symptoms with biochemical abnormalities. This approach, particularly in digital formats, can be tailored to present incremental data, encouraging students to reason step-by-step rather than arriving at answers immediately (Murray et al., 2012)[5].

Popular platforms like Labster and SimBio offer virtual labs and simulations where students can experiment with biochemical processes, view molecular interactions, and observe outcomes in a virtual clinical setting. These cases typically reflect real-world complexity, enabling students to test hypotheses and observe the results without real-world risks (Johnson, 2021)[6].

Benefits of Digital CBL for Critical Thinking Development

1. Active Learning: Digital CBL promotes active engagement with course material by requiring students to analyze and solve cases rather than passively absorbing information. Active learning is linked to improved retention and comprehension, especially in science education (Prince, 2004)[7].

2. Analytical Skills: When interpreting case data, students must analyze biochemical markers and connect them to potential diseases. This process fosters analytical thinking, as students assess the implications of abnormal lab values and their connections to biochemical processes[8].

3. Clinical Relevance and Application: Digital CBL makes biochemistry more relevant by providing clinical context, encouraging students to apply theoretical knowledge. By actively engaging with cases, students experience firsthand the connection between biochemistry and clinical practice (González et al., 2019) [10].

4. Adaptability and Self-Paced Learning: Digital CBL platforms allow students to work at their own pace, reviewing case details and experimenting with different hypotheses. This flexibility supports various learning styles and ensures that students can fully engage with the material before moving forward (Johnson, 2021)[11].

Case Studies on Digital CBL in Medical Biochemistry Education

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Case Study: Implementation of Virtual Patients

A study conducted by Li et al. (2020) implemented virtual patients in a biochemistry course for medical students. Students analyzed patient histories, biochemical data, and symptoms to reach diagnoses. The results showed improved diagnostic reasoning and a deeper understanding of biochemistry among students who used digital CBL compared to traditional methods[12].

Contributions of Uzbek Scientists

Several Uzbek researchers, including Nurmatova, Xuan, and Fazilova, have explored the use of digital technologies to enhance critical thinking in biochemistry. Their studies involve incorporating multimedia resources and simulations into biochemistry curricula to foster interactive and case-based learning. In their study published in Innovations in Science and Technologies (2022), they highlight how digital tools allow for greater engagement and a deeper understanding of biochemical processes, as students must analyze and connect biochemical markers with clinical symptoms. Additionally, Mahkamova and Abduraxmonov (2023) emphasized a blended approach combining digital simulations and case studies, noting an improvement in students' ability to link biochemistry with clinical applications[13].

Challenges and Considerations

While digital CBL offers numerous benefits, challenges exist, such as:

Resource Requirements: Implementing digital platforms and simulations requires investment in software and training, which may be a barrier for some institutions (Barkley et al., 2005)[14].

Student Adjustment to Self-Directed Learning: Students accustomed to traditional instruction may need support in transitioning to self-paced and problem-solving-oriented learning environments.

Despite these challenges, the advantages of digital CBL in fostering critical thinking make it a valuable tool in medical biochemistry education.

CONCLUSION

This study highlights the potential of digital case-based learning (CBL) as an effective approach to enhance critical thinking skills in medical biochemistry education. Traditional teaching methods in biochemistry have often emphasized memorization and factual recall, limiting students' ability to apply biochemical principles to clinical contexts. Digital CBL addresses this limitation by encouraging active engagement, enabling students to explore real-world cases that require diagnostic reasoning, problem-solving, and application of biochemical knowledge.

Through this study, it becomes evident that digital CBL provides a structured yet flexible environment that allows students to interact with content in a way that stimulates cognitive engagement and supports the development of clinical reasoning. By presenting biochemistry within the context of authentic cases, digital CBL promotes a deeper understanding of complex concepts and helps students recognize the relevance of biochemical knowledge to clinical decision-making. This relevance not only enhances students' motivation but also prepares them for practical challenges they will face in clinical practice.

Moreover, the integration of digital platforms introduces students to digital literacy skills increasingly valued in modern healthcare settings. As the healthcare industry continues to embrace digital transformation, the ability to work proficiently with technology becomes an essential skill for medical professionals. Thus, incorporating digital tools into

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biochemistry education aligns well with the competencies required of future practitioners[15].

Digital case-based learning is a powerful approach to developing critical thinking skills in biochemistry education for medical students. By integrating theoretical knowledge with clinical applications, digital CBL prepares students to navigate the complexities of biochemical diagnostics and treatments in real-world medical practice.

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