

Basic Principles in the Application of Problem-Based Learning in Medical Biochemistry Education

Tıbbi Biyokimya Eğitiminde Probleme Dayalı Öğrenim Uygulamasında Temel Esaslar

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ABSTRACT

Although the methods of applied education vary, it is well-known that medical faculties are among the faculties with the most intensive curriculum across all universities. In the medical education system applied throughout our country, the aim is to build a strong medical foundation by starting with an intensive theoretical curriculum, with basic science courses predominantly taught during the first three years. Following this, the objective is to provide clinical training through practical rotations in clinics, building on the acquired foundational knowledge. However, some challenges are encountered in the traditional lecture-based approach, particularly in delivering theoretical courses during the first three terms. As an alternative to the traditional teaching method, the problem-based learning (PBL) model, which was first introduced in the 1960s at McMaster University Faculty of Medicine in Canada, has been developed. Today, this model is widely used in medical education globally, either as a standalone method or in combination with traditional approaches. Medical biochemistry, which evolved in the 19th and 20th centuries and has become a significant field that bridges basic and clinical medical knowledge in the 21st century, has a detailed and comprehensive curriculum. Given its importance in medical education, as well as its broad and detailed scope, different teaching methods are required for the effective and long-lasting retention of medical biochemistry knowledge. The problem-based learning method, which promotes interactive learning, encourages students to research and access new information, and motivates them to work collaboratively in a student-centered, brainstorming-based group setting, offers a strong alternative to classical lecture-based teaching in medical biochemistry. Research has also highlighted the numerous benefits of using problem-based learning in medical biochemistry education. Incorporating problem-based learning into the curriculum of faculties offering medical biochemistry education could enhance the quality of education. In this study, it is aimed to discuss the effects of problem-based learning method on medical biochemistry education with the current literature.

Keywords: Education, Medical biochemistry, Medical faculty, Problem-based learning

ÖZET

Uygulanan eğitim metotları değişkenlik gösterse de bütün üniversitelerde en yoğun müfredatın verildiği fakülteler arasında tıp fakültelerinin ilk sıralarda yerini aldığı bilinmektedir. Ülkemiz genelindeki tıp fakültelerinde uygulanan eğitimde de yoğun teorik müfredatla başlanarak, ilk 3 yıl boyunca temel bilimler derslerinin ağırlıklı olarak verilerek tıbbi alt yapının oluşturulması amaçlanmaktadır. Ardından edinilen temel alt yapı üzerine kliniklerde rotasyona girilerek pratikler eşliğinde klinik yaklaşım verilmesi hedeflenmektedir. İlk üç dönemde verilen teorik derslerin aktarımında geleneksel ders öğretim uygulamasında bazı problemlerle karşılaşmaktadır. Kanada'daki McMaster Üniversitesi Tıp Fakültesinde 1960'lı yıllarda ilk olarak tıbbi alanda uygulanan PDÖ modeli, geleneksel ders metoduna alternatif olarak geliştirilmiştir. Günümüzde birçok ülkenin tıp eğitiminde salt veya karma kullanımı söz konusu olacak şekilde yaygın kazanmıştır. 19 ve 20. yüzyıllarda gelişen ve 21. yüzyılda tıp biliminin temel ve klinik bilgilerini birleştiren çok önemli bir bilim haline gelen tıbbi biyokimya eğitimi detaylı ve geniş kapsamlı bir müfredata sahiptir. Hem tıp eğitimindeki önemi hem de geniş kapsamı ve detaylı sebepleriyle tıbbi biyokimyanın kalıcı ve etkili öğretilmesi için farklı eğitim metotları kullanılmasına ihtiyaç bulunmaktadır. İnteraktif öğrenme imkânı veren, araştırmaya ve yeni bilgiye ulaşmaya yönlendiren, öğrenci merkezli ve beyin fırtınasına dayalı grup çalışmasına motive eden probleme dayalı öğrenim metodu tıbbi biyokimya eğitiminde klasik teorik derslere iyi bir alternatif olarak görülmektedir. Yapılan araştırmalar da probleme dayalı öğrenim metodunun tıbbi biyokimya eğitimindeki çok sayıda faydasını detaylı olarak ortaya koymuştur. Tıbbi biyokimya eğitimi veren fakültelerin müfredatlarının kapsamına probleme dayalı öğrenim metodunu almaları daha üstün bir eğitim verilmesini sağlayabilir. Bu çalışmada, probleme dayalı öğrenim metodunun tıbbi biyokimya eğitimine etkilerinin güncel literatür eşliğinde tartışılması amaçlanmıştır.

Anahtar Kelimeler: Eğitim, Probleme dayalı öğrenim, Tıbbi biyokimya, Tıp fakültesi

INTRODUCTION

Medical education has a deep-rooted and institutionalized systematic structure that has persisted from ancient times to the present day. Although the methods of education vary, medical faculties are recognized as having some of the most intensive curriculum among all university faculties. In the medical education system throughout our country, the goal is to build a solid medical foundation by beginning with an intensive theoretical curriculum, primarily consisting of basic science courses in the first three years. After this foundation is established, clinical training is introduced through rotations in clinics, allowing students to apply their acquired knowledge in practice. However, challenges arise in the traditional lecture-based teaching method, particularly in transferring the heavy theoretical load presented during the first three terms. Due to the one-sided, instructor-centered, and monotonous nature of traditional teaching, it becomes difficult to maintain students' attention and interest in the courses. While the integrated board or committee system remains a prevalent model in medical faculties across the country, various new approaches—such as "Outcome-Based Education", "Case-Based Learning," and "Problem-Based Learning" (PBL)—are being integrated into existing systems.¹

The sources related to the subject in the current literature were examined and the subject was explained by considering the articles that would be useful for a better expression of the subject. In this study, it is aimed to discuss the effects of problem-based learning method on medical biochemistry education with the current literature.

The rapid developments in medical sciences, driven by intensive research, have led to an exponential increase in theoretical knowledge. This situation necessitates more effective methods for knowledge transfer in medical education. Several educational models have been developed and documented in the literature to address this need, and among these, problem-based learning (PBL) stands out as one of the most commonly used approaches.

PBL is a teaching method similar to, yet distinct from, the previously developed Case-Based Learning (CBL) model. Although the two methods are sometimes used interchangeably in the literature, leading to confusion, they are indeed different. CBL was first introduced in

1870 by Professor Christopher Columbus Langdell, Dean of Harvard University Law School at the time. In contrast, PBL was first implemented at McMaster University in the late 1960s, almost a century later. Studies have explored how these methods influence one another, highlighting their similarities and differences.²

Problem-based learning: History and application principles

The PBL model, first implemented in the medical field in the late 1960s at McMaster University Medical School in Canada, was developed as an alternative to the traditional lecture-based approach.^{3,4} Today, it has become widespread in medical education worldwide, either as a standalone method or in combination with other models. In Turkey, PBL was first introduced at Dokuz Eylül University Medical School during the 1997-1998 academic year. Since then, it has spread to other universities, such as Pamukkale University, Ondokuz Mayıs University, and Istanbul University. Currently, there are many medical faculties where PBL is at the forefront, as well as universities like Akdeniz University and Mardin Artuklu University, where PBL is blended with the integrated model in a hybrid approach.⁵⁻⁷

Although PBL can be applied in various forms, its core structure is shaped by a few common principles:^{4,5}

1. Problems that align with the teaching objectives are prepared in advance, either as fictional cases or real-life patient cases.
2. 5-10 students participate in a group, supervised by an instructor.
3. Learning is student-initiated, making it an active learning model.
4. The facilitator asks guiding questions to encourage comprehensive discussion of the case.
5. Students independently research the case and perform analyses both individually and as a group.
6. A key distinction between PBL and CBL is that students are not informed about the case beforehand.

An important factor in the success of PBL is ensuring that the prepared case is aligned with the learning objectives and the students' prior knowledge. Some studies have highlighted the need for standardized case preparation guides to ensure consistency in case design.⁸

Application of problem-based learning in medical biochemistry education

As in many parts of the world, the first three terms of medical education in our country consist of an intensive

curriculum covering basic science disciplines. Following the foundational knowledge gained through basic sciences, clinical education, which includes surgical and internal medicine disciplines, is carried out practically in the final three terms through internships. Among the basic sciences, Medical Biochemistry is one of the courses with the most extensive lecture hours during the first three years. Medical Biochemistry is a rapidly evolving field that is open to new developments, with much of its theoretical content centered around metabolic cycles and processes. Because the course covers a vast array of proteins, enzymes, molecules, pathways, cycles, steps, and reactions related to metabolic processes, its content can become quite complex. This complexity can make Medical Biochemistry—a course that requires extensive memorization due to its dense and intricate content—less engaging, more challenging, and harder to learn compared to other courses from the students' perspective.⁹

When the traditional classroom method is applied, the monotonous lecture environment created by the instructor further diminishes students' interest and focus, making it harder to sustain attention and enthusiasm in the subject. Therefore, Medical Biochemistry is one of the courses where alternatives to the passive, traditional education methods commonly used in medical education can have the greatest impact and significance. Indeed, a review of the literature reveals numerous studies from various institutions where problem-based learning (PBL) methods have been applied to the Medical Biochemistry course with similar concerns, often comparing PBL to traditional teaching methods.⁹⁻¹⁴

In these studies, feedback from both students and faculty members, collected through surveys, shows that PBL is generally considered more engaging. Furthermore, many studies report that when comparing test results between student groups that received traditional lectures and those that experienced PBL or hybrid PBL models, the latter demonstrated higher success rates in learning.^{10,12,14,15} Given the inherent complexity of Medical Biochemistry, it has been suggested that exposing students to well-designed and thoughtfully planned cases during the learning process, with a clear scope and purpose, can make learning more interesting and the course easier to understand.^{10,11}

As a result of the positive feedback and improved learning outcomes achieved through the PBL method,

some researchers have concluded that this method should be considered a necessity and integrated as a required component of the medical curriculum.¹²

Nearly all of these studies focus on the application of the PBL model in the theoretical aspects of Medical Biochemistry, sharing comparisons and results. However, researchers at Dokuz Eylül University Faculty of Medicine took the PBL method a step further by applying it to biochemistry laboratory practices using a "dry laboratory" model, aiming to increase the efficiency of experimental practices. This approach was adopted to address the lack of relevance of certain experiments conducted in what they referred to as the "flowing laboratory." In medical education, which aims to train medical doctors, the use of PBL in dry laboratory practices, designed with clinical relevance, was found to be much more effective compared to flowing laboratory experiments that lack direct clinical connection.¹³

As demonstrated by this application, the PBL model not only facilitates the teaching of the theoretical aspects of Medical Biochemistry but also stands out as an effective teaching method in practical settings, such as in the dry laboratory model. PBL includes group work. It is interactive. However, not every individual in the group may actively participate to the same extent. For this reason, it may not be equally instructive for every student. The aim is to learn the subject through a concrete problem. However, learning the subject may be limited to the problem. Important details of the subject may not be emphasized enough. Using the PBL method by synthesizing it with other classical and modern learning methods may be beneficial for better learning.^{16,17}

CONCLUSION

Medical biochemistry, which developed in the 19th and 20th centuries and has become a critical science combining basic and clinical knowledge in the 21st century, possesses a detailed and comprehensive curriculum. Given its importance in medical education, as well as its broad and complex content, there is a need for diverse educational methods to ensure the permanent and effective teaching of medical biochemistry. The problem-based learning (PBL) method, which fosters interactive learning, encourages students to conduct research and acquire new information, and motivates them to engage in group work based on brainstorming in a student-centered environment, appears to be an excellent alternative to traditional lecture-based courses

in medical biochemistry education. Numerous studies have highlighted the many benefits of the PBL method in medical biochemistry instruction. Incorporating PBL into the curriculum of medical biochemistry programs can significantly enhance the quality of education. Further detailed scientific research is needed to continue exploring and assessing the impact of the problem-based learning method on medical biochemistry education.

Authorship contribution statement

Designed the study: HBS.

Performed study and collected data: HBS and BS.

Discussed the results and strategy: HBS, BS, SB.

Supervised, directed and managed the study: HBS.

Final approved of the version to be published: HBS, BS, SB.

Declaration of competing interest

None of the authors have potential conflicts of interest to be disclosed.

Ethical approval:

This study wasn't need approved by the Local Research Ethics Committee because this paper is a review study.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

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