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The Effect of the Case-Based Learning Method on the Achievement Motivation of Medical Students

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Abstract

Background: Medical education requires continuous improvements in teaching methods to ensure higher-quality learning outcomes for students. Case-Based Learning (CBL) has gained attention as an innovative method to enhance student engagement and achievement motivation. This study aimed to evaluate the effect of CBL on the achievement motivation of medical students.

Methods: This quasi-experimental study employed a two-group pre-test-post-test design. The study sample consisted of 70 medical students (36 in the control group and 34 in the intervention group), selected using simple random sampling. The Herman's Academic Achievement Motivation Questionnaire (Cronbach's alpha = 0.84) was used to measure achievement motivation. Data were analyzed using SPSS software. The intervention group participated in a CBL-based teaching approach.

Results: Results revealed a significant difference in achievement motivation scores between the pre-test and post-test in the intervention group ($P = 0.001$), indicating the positive effect of CBL on students' motivation. However, no significant difference was observed in the control group ($P = 0.726$). The results of the independent t-test showed that the achievement motivation scores between the intervention and control groups were not significantly different ($P = 0.556$).

Conclusion: CBL significantly enhanced achievement motivation in medical students. Integrating CBL into basic science courses, such as biochemistry, is recommended to foster higher motivation and academic success.

Keywords: Case-based teaching, Basic sciences, achievement motivation, Medical students

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Introduction

Motivation is a key factor in medical education, influencing students' engagement, academic success, and long-term learning outcomes. Despite its importance, many medical students lack sufficient motivation when facing challenging basic science courses, such as biochemistry. This study investigates the impact of the Case-Based Learning (CBL) method on enhancing medical students' achievement motivation (1).

In the educational system of medical sciences universities, teaching quality is of particular importance due to the specialized nature of the courses offered. Improving educational quality requires innovation in teaching methods.

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↑*What is "already known" in this topic:*
Traditional lecture-based methods are widely used in medical education but often fail to maintain long-term student motivation and engagement, especially in challenging courses like biochemistry. Case-Based Learning (CBL) has been previously recognized for its potential to enhance learning by fostering critical thinking, problem-solving, and clinical relevance. Prior studies suggest that active learning approaches may positively influence student motivation.

→*What this article adds:*
This study provides empirical evidence from a quasi-experimental design showing that the CBL method significantly improves achievement motivation among medical students in basic science courses. It highlights the impact of CBL in biochemistry education, bridging the gap between theoretical knowledge and clinical application, and suggests its broader implementation to enhance academic outcomes.

Despite the continued dominance of lecture-based instruction, studies show that nearly 80% of lecture content is forgotten within 8 weeks. This inefficiency has led educators to seek more effective, student-centered approaches to teaching (2).

Over recent decades, there has been a growing need to shift from traditional to active learning strategies. Active learning engages students in cooperative, high-level cognitive tasks, fostering critical thinking and deeper understanding (3). An essential goal of education is to nurture individuals with the motivation and capacity to solve complex problems and expand their scientific knowledge (4).

Teaching basic sciences using innovative methods—especially those connecting theoretical content to clinical contexts—can increase students' interest and motivation to learn (3). Case-Based Learning (CBL) is one such approach that promotes problem-solving and performance competence in a fast-changing, globalized world. From a structuralist perspective, active learning encourages meaningful learning through problem-oriented tasks. Moreover, CBL aligns with behaviorist, cognitivist, and structuralist theories, supporting skill acquisition across diverse learning domains (5, 6).

Biochemistry, a key course in medical curricula, aims to familiarize students with metabolic diseases and diagnostic testing related to the liver, kidneys, cardiovascular system, endocrine disorders, and acid-base imbalances. Despite its relevance, many medical students perceive biochemistry as one of the most difficult subjects and struggle with it, which negatively impacts their learning experience and academic outcomes (7). CBL has shown promise in bridging the gap between theory and practice, enhancing students' analytical, clinical, and communication skills. It serves as an effective strategy for increasing engagement, critical thinking, and motivation (8, 9). Numerous studies have confirmed CBL's positive effects on learning outcomes, student interaction, participation, and satisfaction across medical courses, including pharmacology (9–15).

Given the importance of biochemistry, the challenges students face, and the low levels of engagement reported, innovative teaching strategies like CBL, Inquiry-Based Learning, and Problem-Based Learning can significantly enhance deep learning, motivation, and academic performance (7, 11). Therefore, the present study aims to examine the impact of Case-Based Learning on medical students' achievement motivation.

Methods

Design and setting(s)

This quasi-experimental study utilized a pre-test-post-test control group design to assess the effect of Case-Based Learning (CBL) on the achievement motivation of medical students. The research was conducted in 2022–2023 at Iran University of Medical Sciences. This study was designed as a quasi-experimental study. Randomization was not used to assign participants to the groups. Instead, a random allocation method was applied to assign participants to either the intervention or control group, which does not meet the criteria for a fully randomized controlled trial (RCT).

Participants and sampling

The study population consisted of all medical students enrolled in a basic sciences course during the academic year 2022.

Recruitment was conducted based on predetermined inclusion and exclusion standards,

not randomly from the entire student population. Inclusion criteria included: (1) enrollment in the basic science course, (2) willingness to participate, and (3) providing informed consent. Exclusion criteria were: (1) unwillingness to participate, (2) being an intern or in clinical stage, and (3) incomplete questionnaire responses.

Sample Size

The required sample size was calculated using G*Power software, with a confidence level of 95%, a test power of 90%, and based on data from a previous similar study by Heidari et al. (27). Considering a 20% potential dropout, 36 students were assigned to each group (total = 72). Eventually, 34 students remained in the intervention group and 36 in the control group. In this study, a statistical power of 90% was used to detect significant differences between groups. This value is commonly chosen in medical research to ensure that the probability of detecting a true difference, as opposed to a random fluctuation, is sufficiently high. A 20% dropout rate was accounted for in the sample size calculation. This percentage is commonly used to adjust for participant attrition or incomplete data during the course of the study.

Group Allocation and Intervention

Participants were divided into two classes by the university. One class was assigned to the intervention group (CBL method), and the other served as the control group (traditional lecture-based method). The allocation was done using block randomization via Excel software, ensuring group equivalence. The intervention (CBL) was conducted over six sessions, each lasting 90 minutes, focusing on clinical biochemistry cases relevant to course objectives (Appendix). In this study, random allocation was used for assigning participants to groups. A random number table was employed to assign one class to the intervention group and another to the control group. This method was chosen to ensure unbiased distribution and avoid selection bias in group allocation.

Pre-test and Post-test

Before the intervention, both groups completed an achievement motivation questionnaire. The same questionnaire was administered again at the end of the 6-week intervention to assess the impact. The pre-test and post-test were conducted using a standardized achievement motivation questionnaire. The intervention consisted of Case-Based Learning (CBL) implemented over a period of 4 weeks. The CBL approach was designed to engage students in problem-solving tasks related to basic science topics. The primary outcome measured was the change in achievement motivation scores from pre-test to post-test.

Data Analysis

The collected data were analyzed using SPSS version 23. Descriptive statistics (mean, SD) were used to summarize data. Paired t-tests were used to compare pre- and post-test scores within groups, and independent t-tests were used to compare differences between groups. A *P*-value < 0.05 was considered statistically significant.

Tools/Instruments

The instrument used was the Hermans (1970) academic achievement motivation questionnaire. This questionnaire initially included 92 questions, but based on the existing research, 10 characteristics that differentiated people with high achievement motivation from those with low achievement motivation were taken into consideration to create the questionnaire, and based on the number of achievement coefficients, the number of questions in the questionnaire was reduced to 29 questions. The questions of this questionnaire were presented in the form of 29 incomplete sentences with four options (Self-confidence (1-7), perseverance and choosing a job (8- 13), foresight (14- 19), and hard work (20-29)). The scoring of the questionnaire was conducted according to the nine characteristics on which the questions were prepared. In this scale, high and low scores indicated high and low achievement motivations, respectively. To calculate validity, Hermans used content validity, which was based on previous research on motivation for achievement, and he also calculated the correlation coefficient of each item with achievement-oriented behaviors. The coefficients were in the range of 0.3 to 0.5 according to the questionnaire questions. In 1970, Hermans calculated the reliability of the academic achievement motivation test using Cronbach's alpha test method. This questionnaire was psychometrically evaluated in Iran in Akbari et al.'s study. Cronbach's alpha was 0.84, and it also had acceptable face and content validity (18).

Data collection methods

At the outset of the study, the researcher introduced himself and provided a concise overview of the research, including its objectives and potential applications. Students who met the eligibility criteria and expressed willingness to participate were then invited to complete the informed consent form.

This study was done in three phases:

First, before the intervention, an initial pre-test was conducted using the academic achievement motivation questionnaire in both intervention and control groups. Then, in the intervention group, the CBL teaching method was used. In this way, the topics were presented in 8 sessions by a professor. The sessions were held in person. During the class, several short scenarios relevant to the course material for students were presented. After allowing time for evaluation, a series of questions was presented using an online voting system. Real-time results were displayed, and based on them, both incorrect and correct answers were discussed with the class.

The control group received the traditional method of teaching (lecture), and 2 weeks after the intervention, a post-test (identical to the pre-test using the Hermans Academic Achievement Motivation Questionnaire) was administered to both the intervention group and the control group. Following data collection, analysis was conducted using descriptive and analytical statistics.

The purpose of case-based learning is to prepare students for clinical practice using real clinical cases. In the case-based method, a specific case is presented about a real situation in the form of a scenario, which requires the solution of the problem and making a decision. The professor proposes the scenario, and the students are required to listen attentively and take notes. Afterward, the students are allowed to reflect on the topic. Then the professor starts his questions with an open question, and asks the students to take part in the discussions, and if needed, the professor gives further information, such as symptoms and diagnostic tests. In this method, the teacher plays the role of the initiator, mediator, and facilitator of the learning process and guides the students toward the goals of the class (13).

Results

The data were analyzed using both descriptive and inferential statistics. The Kolmogorov-Smirnov test was used to assess the normality of the data, and parametric tests, including t-tests and analysis of variance (ANOVA), were applied to evaluate the research questions. The research sample consisted of 36 students in the control group (0.51) and 34 students in the intervention group (0.49).

The data presented in the table indicate that, in both groups, the majority of participants were around 20 years old. Results from the independent t-test revealed no statistically significant difference in mean age between the two groups (*P* = 0.059). Regarding gender distribution, 50% of participants in the intervention group were male and 50% were female, while the control group consisted of 53% males and 47% females. In terms of marital status, there were 33 single participants in the control group and 32 in the intervention group. The chi-square test results showed no statistically significant difference between the groups in gender composition (*P* = 0.738) (Table 1).

The data in the above table shows the average variable of the average of the sample in two groups, which shows that the Academic average of the majority of the samples of both groups is in the range of 16.90, and there was no statistically significant difference between the two groups. According to the Kolmogorov-Smirnov test, the significance levels obtained for the main variable of the research, which is greater than 0.05, indicate that the data of the variable is normal, and parametric tests should be used to test it (Table 2).

At the baseline (pre-test), there were no statistically significant differences between the two groups. The results of the independent t-test showed that the achievement motivation scores between the intervention and control groups were not significantly different (*P* = 0.556) (Table 3).

While there was a statistically significant difference in achievement motivation scores at the pre-test stage (*P* = 0.0001), this difference was not between the groups, but rather within each group, suggesting that both groups initially had some variation in their baseline levels of motivation. This finding justifies the need for further investigation of

Table 1. Distribution of participants in terms of age and gender for both groups

Age	Control Group (Common/speech)		Intervention Group (CBL)	
Independent T-test Results	Mean±SD 20.52 ±4.91 T=1.930 df=69 P = 0.059		Mean±SD 19.41 ± 1.10	
Gender	Frequency	Percentage	Frequency	Percentage
Male	17	50%	19	53%
Female	17	50%	17	47%
Total	34	100%	36	36%

Chi-Square Test Results X^2=0.602 Df=1 P =0.738

Table 2. Distribution of statistical sample according to Academic average GPA in two groups

	Intervention Group	Control Group
	Mean And Standard Deviation	Mean And Standard Deviation
Academic average	16.87 ±1.75	16.91 ±1.05
Independent T-Test Results	T=1.306 Df=68 P =0.772	

Table 3. Independent t-test to check the difference between the mean achievement motivation in pre- and post-test in students in two groups

Variable		Stage	Mean	The Standard Deviation	*P*-Value
Pre-Test	Achievement Motivation	The intervention	68.314	8.54	0.556
		Control	69.702	8.19	
Post-Test	Achievement Motivation	The intervention	89.738	9.82	0.000
		Control	70.210	8.39	

Table 4. The results of the covariance analysis of two intervention and control groups in the level of achievement motivation

Achievement Motivation	Sum of Squares	Degrees of Freedom	Mean Square	F Value	P value	Effect Rate	Statistical Power
Post-Test (Intervention Group)	38.52	1	52.16	20.17	<0.001	0.58	0.05
Post-Test (Control Group)	36.12	58	44.26	8.66	0.001	0.03	-
Group	9.204	1	9.480	28.55	<0.001	-	0.01
Error	13.60	4	60.39	-	-	-	-
Total	119.33	66	-		-		-

Table 5. One-factor variance analysis of students' achievement motivation assessment according to gender

Statistical Indexes / Gender	Number	Mean	The Standard Deviation	Standard Error	T Observed	*P* value
Female	34	74.09	6.58	1.49	3.96	<0.001
Male	36	70.46	5.23	1.87	-	-

the intervention's effect on post-test scores. The study aims to evaluate whether the CBL method can lead to significant improvements in achievement motivation after the intervention, compared to the control group.

Based on the results obtained from Levine's test for checking the homogeneity of variance between the intervention and control groups, the significance level was 0.327. Since this value is greater than the critical value at the 0.95 confidence level (0.05), the assumption of homogeneity of variance is confirmed (Table 4).

Findings of the covariance analysis in Table 4 show a significant difference between the achievement motivation of the intervention and control groups (P < 0.001) and F (20.17). Its square is equal to 0.58, that is, 28% of the achievement motivation is related to the implementation of training through CBL. In other words, it can be said that teaching through CBL has a significant effect on the motivation level of students' achievement (Table 4).

As shown in Table 5, after the intervention, there was a significant difference between the two groups in terms of achievement motivation scores (P < 0.001). The F-value from the analysis of covariance (ANCOVA) was 20.17, with a partial eta squared of 0.58, indicating that 28% of the variance in achievement motivation can be explained by the CBL method. These findings demonstrate that the CBL intervention had a significant effect on the achievement motivation of the students. Additionally, gender was identified as a significant variable influencing achievement motivation, with a P-value of 0.001 (Table 5).

Discussion

The objective of this research was to assess how Case-Based Learning (CBL) influences achievement motivation among medical students studying basic sciences at Iran University of Medical Sciences.

The findings indicated a significant and positive effect

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of the CBL intervention on students' motivation to excel in their studies.

A key aspect of medical education is the evolution of teaching methods, which is a topic under increasing consideration in universities worldwide. Previous research has shown that various instructional strategies, including active learning approaches like CBL, can significantly influence students' academic motivation. The importance of motivation in medical education cannot be overstated, as motivated students are more likely to engage with course material and perform better academically. This shift from teacher-centered to student-centered learning, with a focus on fostering deeper engagement through innovative teaching methods, is increasingly recognized as essential for improving learning outcomes (1).

The results of this study are in line with the findings of several other studies that have investigated the effectiveness of CBL in medical education. Specifically, the CBL method creates a meaningful connection between theoretical knowledge in basic sciences and its clinical applications. This helps medical students see the relevance of their coursework to their future clinical practices, which in turn enhances their motivation and interest in learning. According to Babaei's study at Gilan University, CBL successfully bridged the gap between theoretical education and its clinical application, fostering higher levels of student motivation and engagement (15). Similarly, Sanaa Eissa's research also demonstrated positive outcomes, including the enhancement of critical thinking, problem-solving, time management, and teamwork skills, which are vital for medical practice. These skills contribute to a better understanding of the relationship between basic sciences like biochemistry and clinical practice (23).

Moreover, CBL has been shown to support collaborative learning, improve knowledge retention, and foster critical thinking. These findings align with the work of Shahnam et al., who identified a positive relationship between academic motivation and self-directed learning. This suggests that incorporating CBL into medical education could help develop essential skills such as independent learning and critical analysis, which are fundamental for future medical practitioners (20).

The findings of this study also echo the work of Nouhi et al., who reported that problem-solving learning methods, such as CBL, encourage active participation and collaboration among students, leading to the development of critical thinking and independent learning (21). This is consistent with the increasing recognition of CBL as a powerful tool for improving student performance and engagement in medical education (22–27). In conclusion, the results of this study support the growing body of evidence suggesting that CBL is an effective teaching method for enhancing students' motivation and academic performance. The integration of CBL into basic science courses, especially biochemistry, can foster deeper learning and motivation, ultimately improving the educational experience and preparing students for future clinical challenges.

Strengths and weaknesses and limitations

One of the most important limitations of this study is the follow-up period, which was short. The strength of this study was the emphasis on important variables such as motivation for progress and new teaching methods. Given the quasi-experimental design of the study, certain limitations were present, including a small sample size and limited generalizability of the results. Therefore, extending the findings to other fields within the medical sciences should be approached with caution. It is recommended that future studies employ larger sample sizes and implement this intervention across other groups as well.

Conclusion

The main core of education is to create a suitable environment for students to interact and learn to grow and progress. In recent decades, educational systems have felt the need to improve teaching methods and employ new methods and active learning, and the use of these methods has become common in various fields of medical education. Since one of the effective factors on the student's achievement motivation is the effectiveness of teaching and learning in universities and higher education centers, in this field, the efficiency of educational methods is one of the important criteria of any educational system. Therefore, it is suggested that basic science courses, especially biochemistry, should be taught on a case-based basis (CBL) to increase the motivation of students to achieve.

Authors' Contributions

Conceptualization: A.B and Z.S
Data curation: M.N, A.ZH, A.N and M.B
Formal analysis: E.R , Z.N.KH and Z.M
Funding acquisition: A.B and Z.S
Methodology: A.B, Z.S M.N, A.ZH and A.N
Project administration: A.B and Z.S
Writing original draft – review & editing: All authors..

Ethical Considerations

The Iran University of Medical Sciences ethics committee approved the study (code IR.IUMS.FMD.REC. 1402.380).

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Conflict of Interests

The authors declare that they have no competing interests.

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Appendix. The intervention (CBL) was conducted over 8 sessions, fo-cusing on clinical biochemistry cases relevant to course objectives

Session	Topic	Scenario	Questions
1	Bioenergetics	Sara is an athlete. She trains for a 200-meter sprint race. However, she performs endurance 5000-meter runs once a week, and strength training 3 days a week. Once she increases the load of exercise, she feels soreness in her muscles.	What is the fuel of muscle cells? How long can the ATP that is already inside the cells provid the energy? Is ATP stored in the cell? If not, then how can a muscle cell manage to provide energ for continuous work? Compare the metabolism in the sprint race with the enduranc run? Aerobic or anaerobic? What do you think is the reason for sore muscles, and why?
2	Electron transport chain	A young woman presents to the emergency department due to a suicide attempt by ingestion of about 50 grams of bitter almonds with complaints of nausea and vomiting. Venous blood gas analysis reveals severe metabolic acidosis. The patient became comatose soon after admission but regained consciousness several hours after treatment.	What is in bitter almond that has caused the patient's symp toms? Considering Cyanide inhibits complex IV of the respirator chain, why has it caused the intoxication symptoms? Why is the patient comatose? What is the reason for acidosis?
3	Beta-oxidation defect	A seven-year-old boy presents to the emergency department with nausea, vomiting, lethargy, and weakness. His mother says that he had mild physical activity and refused to eat his dinner last night, went to bed, and the next morning woke up with the above symptoms. Lab evaluation showed lowered blood glucose and low ketone bodies in urine.	What is the main fuel for the body at the time of prolonge fasting or intense physical activity? What do you think is the reason for mental symptoms? Why has hypoglycemia occurred in this patient, although th glucose metabolism is normal? What is the expected level of ketones in the state of hypoglyce mia? Why are ketone levels low in this patient? What is your suggested treatment for this patient?
4	Carnitine shuttle defect	Two patients are presented here: both have symptoms of the defect in fatty acid oxidation. Apart from hypoketotic hypoglycemia, the first one shows high levels of carnitine, while the carnitine levels are low. The latter was treated with L-carnitine. Both responded well to medium-chain triglyceride (MCT) oil.	How is carnitine connected to fatty acid oxidation? Why only one patient benefited from carnitine supplementa tion? Which part of the carnitine shuttle can lead to high levels o carnitine? Which to low levels? Why has MCT oil been effective in treating the patients?
5	Lipid biosynthesis	A patient with type 2 diabetes has undergone liver function tests, and high levels of liver enzymes have been found together with high bilirubin. Further evaluation through ultrasound indicated grade 3 liver steatosis. The physician recommended controlling blood glucose. The patient asks about Firsocostat a drug he has heard about, which is in phase II clinical trial.	How are high blood glucose levels and high blood insulin con nected to lipid accumulation in the liver? What is the effect of insulin on lipids in adipose tissue? Wha is expected from thhormone-sensitive lipase in case of insuli resistance? What is expected for the free fatty acid levels an their fate? Firsocostat is an inhibitor of acetyl-CoA carboxylase. How ca it prevent lipid accumulation? What is the role of this enzym in lipid metabolism?
6	Cholesterol biosynthesis	A 62-year-old woman has been referred due to hypertension. In the initial evaluation, hypercholesterolemia is found. She states that her mother had coronary artery disease. She does not smoke or drink alcohol, and her blood glucose level is normal. She was recommended to follow a strict low-fat, low-carbohydrate diet containing lots of fruits and vegetables, and do regular physical activity. She returns 3 months later, and no improvement is noticed. Therefore, atorvastatin is prescribed for her. In the next visit, a significant reduction in cholesterol is noticed.	Why should the doctor be concerned about the blood glucos levels of the patient? How can vegetables help lower blood cholesterol levels? If statins target the metabolism of cholesterol, which enzyme i more suitable for inhibition? What other pathways can be considered for lowering bloo cholesterol if the patient did not respond to statins? Ezetimibe is a drug that inhibits cholesterol absorption. Wha is its target? How does inhibition of bile reabsorption help reduce bloo cholesterol levels?
7	Cofactors and trace elements	A 34-year-old woman presents to her physician with complaints of increasing fatigue, dizziness, and shortness of breath over the past few months. She had two pregnancies and regularly has heavy menstruation. Lab evaluations include red blood cell count, hemoglobin levels, serum iron levels, total iron binding capacity (TIBC), and ferritin levels. The physician's diagnosis is iron-deficiency anemia.	Why has iron deficiency caused these symptoms? How can heavy bleeding lead to iron deficiency? Why is red blood cell count and hemoglobin useful for the eval uation of iron deficiency? TIBC is related to which of the serum proteins? What do you expect for the TIBC and ferritin levels in this pa tient and why?
8	Cofactors and trace elements	A 45-year-old man presents to the clinic with progressive weakness and numbness in his legs and difficulty walking. Recently, he has noticed unexplained fatigue and difficulty concentrating. He also complains about easy bruising. He reports a history of bariatric surgery due to morbid obesity and, since then, takes daily iron and zinc supplements. The physician orders measurement of serum copper and ceruloplasmin.	What is the relationship between copper and the weakness an fatigue in this patient? What is the relationship with poor con centration? How can copper be related to the weakness of blood vessels? How can taking continuous high doses of iron and zinc contrib ute to copper deficiency? Why has the physician ordered ceruloplasmin measuremen along with copper levels?

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