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Review

How to Apply Case-Based Learning in Medical Education?

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ABSTRACT

Case-based learning is considered a form of active learning that prepares and qualifies students for their future professional field. It has many positive educational impacts, such as bridging theoretical or academic concepts to clinical practice, enhancing critical thinking, improving long-term knowledge retention and the persistence of educational attainment, and developing collaboration and communication skills. However, its implementation in medical education faces obstacles and challenges, including resource limitations, untrained tutors, complex group dynamics, and integration issues with other modules and courses. These challenges and obstacles stem from a lack of practical experience or a poor understanding of the nature of this learning method and the extent of its differences from problem-based learning. So, this study aims to present a review scope about successful implementation and management of case-based learning sessions in medical education prompting positive aspects and avoiding negative points. Moreover, the study focused on other application forms of case-based learning sessions that may be applied in medical education, such as virtual case-based learning or introducing role-play simulation in case-based learning sessions.

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¿Cómo aplicar el aprendizaje basado en casos en la educación médica?

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RESUMEN

El aprendizaje basado en casos se considera una forma de aprendizaje activo que prepara y capacita a los estudiantes para su futuro campo profesional. Tiene muchos impactos educativos positivos, como la conexión de conceptos teóricos o académicos con la práctica clínica, el fomento del pensamiento crítico, la mejora de la retención del conocimiento a largo plazo y la persistencia del logro educativo, así como el desarrollo de habilidades de colaboración y comunicación. Sin embargo, su implementación en la educación médica enfrenta obstáculos y desafíos, incluyendo limitaciones de recursos, tutores sin capacitación, dinámicas grupales complejas y problemas de integración con otros módulos y cursos. Estos desafíos y obstáculos se derivan de la falta de experiencia práctica o de una comprensión deficiente de la naturaleza de este método de aprendizaje y de la magnitud de sus diferencias con el aprendizaje basado en problemas. Por lo tanto, este estudio tiene como objetivo presentar una revisión sobre la implementación y gestión exitosas de sesiones de aprendizaje basado en casos en la educación médica, destacando los aspectos positivos y evitando los negativos. Además, el estudio se centró en otras formas de aplicación de las sesiones de aprendizaje basado en casos que pueden aplicarse en la educación médica, como el aprendizaje basado en casos virtuales o la introducción de la simulación de juegos de rol en las sesiones de aprendizaje basado en casos.

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1. INTRODUCTION

In recent years, the development of medical education has become an urgent necessity in the world, especially in developing countries. Some medical schools adopted the change in learning methods, while others developed the assessment methods. On the other hand, traditional medical schools in some developing countries adopted revolution in medical education via a complete change in the curriculum, learning, and assessment methods [1]. The curriculum of these medical schools is transformed into an integrated curriculum including horizontal and vertical integration using different modern learning methods such as problem-based learning (PBL), team-based learning (TBL), simulation-based learning (SBL), and case-based learning (CBL) [2].

However, success in adopting many learning methods does not always lead to the desired results, as there are a lot of challenges during the application. CBL is considered one of these learning methods that faces obstacles and challenges during the implementation, whether due to a deficiency of practical experience or understanding the nature of this learning method and the extent of its difference from PBL [3].

The use of CBL in medical education aims to use authentic clinical cases in teaching to prepare medical students for clinical practice, as well as link theory to practice. CBL is not a new learning method; it has been known since 1912, and its use has become widespread in recent years. It is considered a form of simulation-based learning that prepares and qualifies students for their future professional field. It may be used in many medical fields as structure and guidance learning method for undergraduate or postgraduate students [4].

The case-based learning method is considered an active learning strategy that focuses on solving a problem or studying a case using a discussion that achieves the knowledge and learning objectives that should be acquired by the learner during the session. It is one of the inquiry-based learning methods that promotes self-directed learning, clinical reasoning, and decision-making by providing repeated experiences, enabling students to engage with increasingly complex clinical cases. [5].

In addition, the case-based learning method outperforms traditional learning methods in promoting collaboration and communication. It is an interactive learning method encouraging the students to develop their interpersonal skills via articulating ideas, respecting diverse perspectives, and engaging constructively in collaborative activities in the group through intensive discussions [6].

CBL is a form of deep learning that facilitates knowledge from multiple disciplines and integration of existing knowledge with new knowledge. It is based on a clinical

case, or problem as well as the PBL method, so some cannot distinguish between case-based learning and problem-based learning, leading to the generation of some challenges during the application of any of them [7].

CBL is different from problem-based learning. The design of CBL depends on developing the student skills to diagnose and manage the clinical case focus on clinical-based knowledge, wherein learners participate and benefit from their baseline knowledge, besides asking questions related to the case. It promotes clinical knowledge and skills, improving teamwork and behavior during practice [8].

Moreover, CBL covers a lot of topics because of the stated learning objectives. The role of the teacher in case-based learning is more positive in comparison to the PBL method. The teacher provides the case, guides discussion, and corrects the answers, ensuring that measured outcomes and specific learning objectives are met [9].

On the other hand, the PBL method is designed to teach the student how to solve the problem using brainstorming, clinical reasoning, collaboration, and gathering the information that is researched during the case. The role of the learner is active participation via asking the questions and exploring the topic during the session, while the role of the teacher is facilitator and observer without interference, using restricted guidance as shown in Table 1 [10].

Table 1: Difference between Case-based learning and Problem-based learning

CBL (Case-based Learning)	PBL(Problem-based Learning)
Pr-reading material	Problem of the patient (Scenario)
Problem of the patient (clinical case, videotape)	Discussion (Brain storming)
Search for information sources	Self directed learning
Case discussion	Debriefing session
Active tutor (guided)	Passive tutor (facilitator)
Guided inquiry	Open inquiry
Clinical skills	Problem-solving skills

The PBL method focuses on the process wherein the process is the outcome, and the learning objectives are generated by the learners because PBL motivates the student to learn foundational knowledge during the research of the clinical problem, in contrast to CBL, wherein students have already acquired foundational knowledge, so CBL is considered more effective [11].

Briefly, PBL is a student-driven process wherein the role of the teacher is guide and facilitator, while CBL is a teacher-driven process wherein the teacher is the driver who guides and directs the learning much more in a large group, compared with PBL that is a small group discussion [12].

In another context, some think that CBL is a variant of PBL that reflects the educational objectives of a particular topic. Thus, some medical schools applied these two learning methods in their curriculum, wherein PBL was applied in preclinical years while CBL was applied in clerkship rotations [13].

However, the application of case-based learning in medical schools continues to face challenges, including large student groups, resource limitations, untrained tutors, difficult group dynamics, and low student participation, as well as integration with other modules and courses. These challenges were overcome in some medical schools by relying on well-trained tutors to administer the session in place of content experts, or by effective teamwork. Additionally, the assessment system for student participation and the debriefing format were used for more effective sessions [14].

2. THE EDUCATIONAL IMPACTS OF CASE-BASED LEARNING

From the above mentioned, the educational impacts of case-based learning may be summarized in definite points such as bridging theoretical or academic concepts to clinical practice, enhancing critical thinking, improving long-term knowledge retention and the persistence of educational attainment, and developing collaboration and communication skills. These educational impacts will reflect positively on the performance of medical graduates that improve their ability to face professional challenges as a team, maintaining the spirit of competency, giving them the opportunity to apply knowledge to realistic clinical situations using analytical skills [15].

In this context, some studies were conducted to measure the effectiveness of case-based learning by using the cognitive domain of Bloom's taxonomy. These studies showed that case-based learning results in a higher level of knowledge acquisition and application, the ability to analyze and evaluate, and creation [16].

However, some challenges may be summarized such as inability of the students to judge because of lack confidence (learner uncertainty), analysis of some cases is sometimes time consuming leading to out of the learning objectives (time-intensive), some cases may overwhelm students, because of the limited prior knowledge (cognitive overload),

and poor guidance because of non-skilled instructors (instructor challenges) [17].

Therefore, the educational impacts of case-based learning may be maximized if it is used in a suitable manner in health professions education. It may be used in preclinical or clinical phase, or in the programs of continuing professional development as part of continuous medical education. In addition, good dealing with the previous challenges mentioned and overcoming by the training program of tutors and well-designed scenarios (cases), providing the medical students with the experiences through repeated sessions that promote their ability to judge and time management [18].

In this context, many studies were conducted to determine the perception of the students about case-based learning and the extent of reflected benefits and outcomes. The study of Kaur and his colleagues [19], showed that most of students confirmed that case-based learning stimulates and motivates the desire to learn, develop clinical reasoning, understand the subject in a better way and build confidence. It is consistent with the results of the study of Thistlethwaite and his colleagues [20], and in agreement with Yang et a., 2024 [21], who indicated that case-based learning enhances critical thinking ability and promotes the development of personalized learning.

In the related context, Varma et al., 2025 [22] showed that case-based learning has been identified as a superior method of teaching as it significantly improves problem-solving, teamwork, and communication skills, and enhances clinical skills development and student satisfaction.

3. HOW TO IMPLEMENT A SUCCESFUL CASE-BASED LEARNING SESSION?

The starting point of a successful case-based learning session is a well-designed scenario (case) that contains essential characteristics to be more effective. This scenario should tell a brief, organized, compelling story focusing on an interesting medical problem requiring an action, relevant to one or more medical specialties (clinical relevance), which should have pedagogical utility and be presented in a sequential narrative style. It should also involve conflict (controversy) that provokes thought and forces decision-making [23].

Furthermore, cases should be authentic within real-world or contextual settings, allowing students to analyze data to draw a conclusion. Additionally, they should be open-ended, encouraging multiple choices that engage students and increase their interest and involvement in the discussion. The scenario content must be precise and relevant to the curriculum, connecting knowledge with real-life applications, and providing students with the opportunity to analyze, draw conclusions, and make decisions [24].

In the same context, the scenario should align with the instructional objectives, ensure the complexity of the case matches the level of learners, and be well-written using appropriate medical terminology so students can explore the dilemma, leading to the discovery of its solutions. Moreover, the designer of the scenario should avoid non-purposeful, non-useful, and non-scientific sentences that lead to boredom, missing the script's suspense [25].

The practical session is the next step in case-based learning, where tutors should facilitate discussions by posing open-ended questions focused on the patient’s problem (case study) and maintaining the discussion within the framework of the learning objectives. This involves investigating and analyzing events, motivating students to generate a cluster of questions based on background information that complements one another through collaborative teamwork. This process should lead to the evaluation of the case, encouraging judgments and proposed solutions [26].

Group dynamics are crucial to the success of case-based learning, but they require time to develop and the support of well-trained tutors who can accelerate this process. Initially, it should plan time for the group to orient and establish norms within the group at the beginning of the session. After that, group dynamics are gained through experience, enabling students to share ideas, findings, and listen to diverse opinions and perspectives, which motivates critical thinking [27].

A successful application of case-based learning means transforming how students think and debate, fostering the creation of the best pathways forward for case solutions while maintaining high engagement and promoting self-directed and lifelong learning. Finally, the group dynamic should be evaluated at the end of the session by the tutor and the peer evaluation through assessing individual contributions [28].

4. HOW TO MODERATE A CASE-BASED LEARNING SESSION?

Initially, introducing the case-based learning method to students before the start of the session is considered necessary preparation, showing how to deal with this innovative method, or an orientation lecture. The first step in a case-based learning session is identifying the key issues in the case by understanding what the problem involves, including the relevant anatomic structures and pathophysiological processes. It should also allow learners enough time to read and reflect on the case [29].

Secondly, it should prioritize problems or issues by answering what issues are most important that disturb the body's homeostasis in this case? Thirdly, summarize the most important issue or problem in the case as one sentence showing the relationship between different issues or problems [30].

Fourthly, suggest the probable differential diagnoses for the case, along with the possible diseases and underlying mechanisms. Fifthly, prioritize diagnoses based on exclusion and inclusion criteria that align with the case presentation. Lastly, outline the optimal management plan, such as investigations that confirm the diagnosis, the best treatment options and interventions, as well as patient health education [31].

The role of a tutor in a case-based learning session should be triggered by creating broad, open-ended questions depending on the level of knowledge of students, and then giving the learners a chance to discuss, and then narrowing the scope by posing questions about fundamental and core assumptions, giving the learners time for discussion and response [32]. A case-based learning session means learners talking, so there should be time for discussion with periods of silence when learners respond to questions, interpret data, and explore the rationale showing potential outcomes. It is noted that incorrect responses can give a chance to clarify misconceptions. At the end of the session, the tutor discloses the correct answers and provides a summary and take-home points [33].

5. VIRTUAL CASE-BASED LEARNING

On the other hand, the application and moderation forms of case-based learning sessions can have different aspects from one educational institution to another. Some medical schools use small group discussion as a model for case-based learning sessions, while others use a large cohort [34].

Moreover, others adopt simulation to implement case-based learning, such as peer role-play simulation, where a medical student practices his future role as a physician, including thought processes and reactions within the case story. Additionally, the use of virtual simulation (online vignettes) is another feature of the case-based learning sessions that may be applicable [35, 36].

According to Alizadeh et al., 2024 [37] virtual case-based learning sessions can be an effective method for enhancing learning motivation and have a higher significant impact on academic performance. On the other hand, Nicklen and his colleagues, [38] indicated that remote-online case-based learning via online platforms such as Zoom did not cover learning objectives in depth compared to face-to-face case-based learning. This study indicated that students were dissatisfied, and the cause may be due to technical difficulties faced during the online session.

On the contrary, Nasseri et al., 2024 [39] show that students expressed a preference for virtual interactive clinical case-based learning sessions because it is more effective for learning compared to in-person sessions. Another study was conducted using a case-based learning method combined with virtual reality simulation technology, which indicated improving students' performance, self- directed and comprehensive ability, confirming the effectiveness of this approach [40].

Furthermore, a study was conducted to evaluate the impact of interactive video-based case-based learning in clinical medical education, which showed that interactive video-based case-based learning is an innovative learning approach and complements traditional methods, wherein it improves academic outcomes, cognitive skills, particularly critical thinking, increases student satisfaction and engagement [41].

In addition, Lim and Veasuvalingam [42] conducted a study about the role of online case-based learning in fostering clinical reasoning skills through blended learning (integrating face-to-face and virtual case-based learning methods) that highlights how online case-based learning can develop clinical reasoning skills among medical students, encouraging educators to adopt a blended learning approach in the future. Moreover, students gained several benefits, such as improved question exploration and immediate feedback, although there were some challenges, like unrealistic case presentations and engagement issues.

Another prospective interventional study on using online case-based learning as a formative assessment tool indicated that this type of active learning helps students identify learning gaps, expect summative assessments, gain a better recognition of the clinical relevance of subjects, and guide their learning via receiving feedback. Moreover, it helps students to be self-directed learners [43]. In a different context, an interventional study was conducted to evaluate the impact of adding role play to case-based learning, which demonstrated that this combined approach improves the application of basic knowledge, bridges the gap between theory and practice, and encourages higher-order thinking skills, critical thinking, and develops teamwork skills among students [44].

6. CONCLUSIONS

The case-based learning method is one of the inquiry-based learning methods that promote self-directed learning,

clinical reasoning, and decision-making by providing repeated experiences, enabling students to focus on the complexity of clinical cases. Application of case-based learning in medical education has many challenges, such as time-consuming, cognitive overload, and non-skilled instructors. However, these challenges and obstacles may be overcome and implement a successful case-based learning session via well-designed scenarios (cases), well-trained tutors, and good preparation of students. In addition, other forms of case-based learning may apply, such as online case-based learning (virtual) and integrating role plays in case-based learning sessions.

7. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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