INCORPORATING CRITICAL THINKING SKILLS IN UNDERGRADUATE MEDICAL STUDENTS

Abstract

For medical students to analyse complicated clinical circumstances, make wise judgments, and deliver effective care to patients, critical thinking is an essential skill. However, fostering critical thinking abilities among undergraduate medical students remains a significant challenge. This narrative review explores various tools to enhance critical thinking in undergraduate medical curriculum. It discusses traditional and innovative approaches of teaching and assessment, their current status and challenges of implementation. The review also examines the effectiveness, advantages, and limitations of each approach, providing insights for educators and curriculum developers aiming to optimize critical thinking development in medical education.

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I. INTRODUCTION

Philosophical thinking is the source of critical thinking, often known as rational or logical cognition. Therefore, critical thinking can be considered a cognitive ability that is teachable and well learnt by the students. It is considered that critical thinkers solve problems more effectively, make better decisions, and therefore, are more skilled professionals. Here are a few of the crucial components:

- Analysis
- Evaluation
- Inference
- Problem-Solving
- Reflection

An even more expansive definition is provided by The Critical Thinking Community (2008). It has been defined as the fundamental cognitive ability that allows medical practitioners to assess evidence-based information, examine complex clinical situations, and make well-informed decisions. Critical thinking in medicine involves engaging in dynamic, multidisciplinary learning activities that support higher order thinking processes to construct comprehensive knowledge structures, drawing on the ideas of Rich Environments for Active Learning (REALs) (Dunlap et al, 1995). Furthermore, by exposing medical students to a variety of healthcare practices, dispelling myths, and promoting a thoughtful examination of evidence-based medical practices, knowledge of complementary and alternative psychotherapies (CAP) can extend their horizons and improve their critical thinking abilities (Adrián-Ventura et al, 2020). Through the integration of these many perspectives, medical students can get a overall understanding in the ever-evolving field of healthcare.

II. IMPORTANCE OF CRITICAL THINKING FOR MEDICAL STUDENTS

A fundamental component of medical education, critical thinking is necessary to help doctors develop their diagnostic and problem-solving abilities. Critical thinking abilities are becoming more and more important as healthcare systems keep changing. For medical students, critical thinking is essential because it is a basic ability for clinical competency and decision-making. The various studies mentioned below collectively highlight its impact on clinical reasoning, diagnostic accuracy, evidence-based practice, and overall clinical competence.

Table 1

Author (Year of study)	Subject of study	Key findings
Facione, P. A (1990)	Clinical Reasoning in Medical Education	The study emphasizes that critical thinking is integral to clinical reasoning
Ralston, S. (2006).	Impact of Critical Thinking on Diagnostic Accuracy	It found that excessive work hours have a negative impact on our analytical thought process, which is crucial for accurate diagnosis and effective patient care

Azer, S. A. (2013)	Promoting PBL to engage students	The findings suggest that PBL engages students with clinical scenarios that require analytical and reflective thinking.
Dawes, M. (2005)	Critical Thinking and Evidence-Based Approaches	It highlights the necessity of critical thinking for appraising research evidence and making informed clinical decisions, underscoring its importance in medical education.
Profetto-McGrath, J (2003)	Critical Thinking and development of clinical skills	It concludes that strong critical thinking skills are associated with higher clinical competence, which is crucial for patient care.
Victor-Chmil, J., & Larew, C. (2013)	Assessment of Critical Thinking in Medical Students	It highlights the importance of reliable assessment methods for critical thinking in healthcare education
Chan, Z. C. Y. (2013).	Critical Thinking in Clinical Education	It demonstrates that integrating critical thinking into clinical education enhances students' problem-solving abilities and clinical performance
Huhn, K. et al (2011)	Longitudinal Study on Critical Thinking Development	It provides evidence that critical thinking skills improve with targeted educational interventions, emphasizing their importance in medical curricula
Golafrooz et al (2006)	Assessment of critical thinking skill among senior student nurses	Fostering these skills in nursing students is crucial for fostering professional autonomy
Ellis et al (2017)	Using Simulation and Critical Thinking in Speech-Language Pathology: A University Case Study	Recognises the value of critical thinking abilities in clinical simulation experiences, demonstrating a wider understanding of its applicability across a range of healthcare specialties

Consequently, in the medical curriculum, developing critical thinking skills is essential for equipping aspiring healthcare workers to successfully navigate challenging clinical circumstances in addition to being advantageous for improving problem-solving capabilities. Therefore, it is important to include activities that encourage critical thinking into medical curriculum in order to guarantee that students have the cognitive and psychomotor abilities needed to make wise judgements in their professional lives.

III. OBJECTIVES OF THE RESEARCH ESSAY

- To review the various dimensions of critical thinking and its historical development
- To explore ways to seamlessly integrate critical thinking into the medical curriculum, including preclinical, paraclinical and clinical phases.
- To identify and describe specific teaching methodologies that enhance critical thinking skills in medical students.
- To study the existing assessment methods to evaluate this domain of critical thinking and recommend better methods if any
- To assess the role of modern educational technologies in enhancing critical thinking skills

IV. HISTORICAL PERSPECTIVE ON CRITICAL THINKING IN MEDICAL TRAINING

Critical thinking has evolved significantly over time, shaped by changes in educational theory, clinical practice, and societal needs. Here we explore and highlight the key milestones and the shift in pedagogical approaches from traditional rote learning to more dynamic, student-centered methodologies.

1. Evolution of Medical Education Curriculum

- **Early Medical Education: Apprenticeship Model:** In the early days of medical education, the apprenticeship model predominated. Aspiring physicians learned by working directly with experienced practitioners, acquiring skills through observation and hands-on practice. This model, while practical, focused heavily on rote memorization and the replication of established techniques rather than encouraging independent critical thinking (Cooke, Irby, & O'Brien, 2010).

- **19th Century: Emergence of Formal Medical Schools:** The 19th century saw the establishment of formal medical schools and a more structured approach to medical education. Pioneers like Abraham Flexner emphasized the importance of scientific rigor and laboratory-based learning. Flexner's 1910 report revolutionized American medical education, advocating for an educational model that integrated basic science with clinical practice (Flexner, 1910). Despite these advances, the emphasis remained largely on memorization and the mastery of factual knowledge.

- **Early 20th Century: Incorporation of Scientific Method:** With the rise of the scientific method in the early 20th century, medical education began to incorporate principles of hypothesis testing, experimentation, and evidence-based practice. This shift encouraged a more analytical approach to medicine, fostering the early stages of critical thinking. However, the pedagogical methods still leaned heavily towards didactic teaching and passive learning, where students were recipients of knowledge rather than active participants in their education (Ludmerer, 1985).

- **Mid-20th Century: Development of Problem-Based Learning (PBL):** Initiated by Barrows at McMaster University, PBL transformed medical education by making learning student-centric. Instead of passively absorbing information, students engaged

in collaborative problem-solving, working through clinical cases to develop their knowledge and critical thinking skills (Barrows & Tamblyn, 1980). This approach not only improved students' retention and understanding of medical concepts but also enhanced their ability to think critically and make informed clinical decisions (Hmelo-Silver, 2004).

- **Late 20th Century: Evidence-Based Medicine (EBM):** The late 20th century brought another paradigm shift with the advent of EBM. It emphasized the integration of clinical expertise with the best available research evidence and patient values (Sackett et al., 1996). This approach required physicians to critically evaluate and apply their findings to clinical practice, further embedding critical thinking into medical education. EBM promoted the incorporation of analytical skills by the systematic evaluation of literature and encouraging medical students and practitioners to question assumptions. (Guyatt et al., 2002).

- **21st Century: Technological Advancements and Simulation:** The 21st century has seen rapid advancements in technology, significantly impacting medical education. Simulation-based learning, utilizing high-fidelity mannequins and virtual reality, provides students with immersive, hands-on experiences in a controlled environment. These simulations enhance critical thinking by allowing students to practice and refine their clinical skills, make decisions in real-time, and reflect on their performance (Issenberg et al., 2005).

Furthermore, the widespread availability of online resources and digital tools has facilitated a more interactive and flexible learning experience. Online modules, virtual patients, and interactive case studies offer diverse opportunities for students to engage with content, collaborate with peers, and develop their critical thinking skills (Ellaway & Masters, 2008).

2. Shift in Pedagogical Approaches: From Teacher- centred to Learner-centred

The shift from traditional, teacher-centred approaches to learner-centred methodologies represents a fundamental change in medical education. Traditional methods, characterized by didactic lectures and passive learning, often limited opportunities. (Schön, 1987).

In contrast, learner-centred approaches, such as PBL, EBM, and simulation-based learning, emphasize active learning, collaboration, and reflection. With the help of these techniques, students are inspired to take charge of their education, practice critical thinking, and use their knowledge to address challenging clinical issues. (Spiro & DeSchryver, 2009).

- **Key Drivers of Pedagogical Shift:** Several factors have driven the shift towards learner-centred approaches in medical education:

  - **Changing Healthcare Environment:** The increasing complexity of healthcare and modern healthcare challenges demand that medical education produce adaptable, reflective practitioners capable of continuous learning and improvement (Frenk et al., 2010).

- **Educational Research:** Advances in educational research have provided insights into how students learn best. Constructivist theories, which emphasize the active construction of knowledge through experience and reflection, have informed the development of learner-centred approaches that foster deeper understanding and critical thinking (Bransford, Brown, & Cocking, 2000).

- **Technological Innovations:** Technological advancements have expanded the possibilities for interactive and personalized learning. Simulation, virtual reality, and online platforms provide innovative ways to engage students and enhance critical thinking (Cook et al., 2013).

- **Accreditation and Competency Standards:** Accreditation bodies and professional organizations increasingly emphasize and drive medical schools to adopt pedagogical approaches that develop these essential skills (Swing, 2010).

From the early apprenticeship model and the establishment of formal medical schools to the advent of PBL, EBM, and simulation-based learning, we have seen a gradual but significant shift towards approaches that prioritize critical thinking.

Learner-centred methodologies have emerged as the gold standard, fostering active engagement, collaboration, and reflection. These approaches better prepare medical students for the complexities of modern healthcare, ensuring that they not only acquire the necessary medical knowledge but also develop the critical thinking skills essential for effective clinical practice.

3. Role of Reasoning Skills in Learning Critical Thinking

Students must acquire the following reasoning abilities in order to foster critical thinking abilities:

a. Deductive Reasoning

- **Applying General Principles:** Deductive reasoning allows students to apply general medical principles to specific cases. For example, understanding the pathophysiology of a disease helps in predicting clinical manifestations and potential complications in individual patients (Kassirer, 2010).

- **Hypothesis Testing:** This skill involves forming hypotheses based on general knowledge and testing them through clinical evaluation and diagnostic testing. Deductive reasoning ensures a logical progression from general theories to specific conclusions (Groopman, 2007).

b. Inductive Reasoning

- **Generalizing from Specific Cases:** Using specific observations or situations to infer general conclusions is known as inductive reasoning. This is essential in medical education for building knowledge based on clinical experiences and case studies (Eva & Norman, 2005).

- **Developing Theories:** Medical students use inductive reasoning to develop theories about disease mechanisms, treatment responses, and patient behaviors based on observed patterns and evidence (Charlin et al., 2007).

c. Abductive Reasoning

- **Generating Hypotheses:** Abductive reasoning is the process of forming the best possible explanation for an observed phenomenon. In medical education, this skill is used to generate differential diagnoses and identify the most likely causes of a patient's symptoms (Josephson & Josephson, 1994).

- **Clinical Decision-Making:** This reasoning skill helps students prioritize diagnostic tests and treatments based on the most plausible explanations, improving clinical decision-making efficiency and accuracy (Elstein et al., 1978).

V. THEORETICAL FRAMEWORKS

The incorporation of critical thinking in the curriculum is supported by various theoretical frameworks that provide structured approaches to understanding and enhancing this complex cognitive process. This essay explores key theoretical frameworks that underpin critical thinking in medical education described as follows:

1. Bloom's Taxonomy

This is a model that classifies educational goals into hierarchical levels of cognitive complexity. This framework is widely used to structure learning abilities and assess analytical skills.

Bloom's Taxonomy guides curriculum development and assessment by promoting higher-order thinking skills. For instance, medical students are encouraged to move beyond mere memorization of facts (knowledge) to analysing patient data (analysis) and making clinical decisions (evaluation) (Adams, 2015).

2. Paul and Elder's Critical Thinking Model

This model is another influential framework that emphasizes the development of critical thinking through specific intellectual standards and elements of thought.

It also outlines elements of thought and is particularly relevant in medical education for fostering reflective practice and metacognition, allowing students to critically analyze their thought processes and improve clinical reasoning (Paul & Elder, 2013).

3. Reflective Judgment Model

This describes the stages of reasoning through complex problems. It outlines a developmental trajectory of critical thinking through the following stages:

- **Pre-reflective Thinking (Stages 1-3):** Individuals believe knowledge is certain and based on direct observation or authority.

- **Quasi-reflective Thinking (Stages 4-5):** Individuals recognize the uncertainty of knowledge but struggle to justify their reasoning.

- **Reflective Thinking (Stages 6-7):** Individuals understand that knowledge is constructed and justified through evidence and reasoned argument.

In medical education, the Reflective Judgment Model helps students progress through these stages, enhancing their ability to deal with ambiguous and complex clinical situations by promoting a sophisticated understanding of evidence and reasoning (King & Kitchener, 2004).

4. Socratic Method

The Socratic Method, rooted in the teaching style of the ancient Greek philosopher Socrates, involves probing the students with questions to stimulate their analytical thinking process and generate ideas in them. This dialectical method encourages students to engage deeply with content, question assumptions, and develop their reasoning skills.

In medical education, the Socratic Method is used in CBL and PBL environments. By posing thought-provoking questions, educators can guide students to critically evaluate clinical scenarios, consider multiple perspectives, and arrive at well-reasoned conclusions (Svinicki, 2010).

5. Ennis's Critical Thinking Framework

Robert Ennis's outlines several critical thinking dispositions which include:

- Open-mindedness.
- Scepticism.
- Intellectual humility.
- Fair-mindedness.
- Respect for evidence and reasoning.

Abilities include:

- Analysing arguments.
- Evaluating evidence.
- Making inferences.
- Explaining reasoning.
- Reflecting on one's thinking.

Ennis's framework emphasizes both the attitudinal and skill-based aspects of critical thinking, making it highly applicable in medical education, where students must balance scientific knowledge with compassionate patient care (Ennis, 1987).

6. Vygotsky's Sociocultural Theory

Learning happens when socially mediated processes are internalized, according to Vygotsky, and the Zone of Proximal Development (ZPD) is the boundary between what students can accomplish on their own and what they can accomplish with assistance.

In medical education, Vygotsky's theory emphasises the significance of integrative learning environments, mentorship, and the use of a foundation to foster critical thinking skills. Through interactions with peers and instructors, medical students can enhance their problem-solving abilities and clinical reasoning (Vygotsky, 1978).

7. Dual Process Theory

The Dual Process Theory, suggests that there are two systems of thinking: System 1 (fast, intuitive, and automatic) and System 2 (slow, deliberate, and analytical). In medical education, understanding the interplay between these two systems is crucial.

System 1 is often used in routine clinical tasks and situations requiring rapid decision-making. However, reliance on System 1 can lead to cognitive biases. System 2, which requires more cognitive effort, is essential for complex problem-solving and reflective practice. Educators can design curricula that train students to recognize when to engage System 2 thinking to avoid diagnostic errors and improve patient care (Kahneman, 2011).

8. Cognitive Load Theory

This centres on working memory capacity and how it affects learning. According to the idea, there are three types of load: germane load (effort needed to digest and grasp the material), extraneous burden (how information is presented), and intrinsic load (complexity of the content).

In medical education, managing cognitive load is essential for fostering critical thinking. Educators can optimize instructional design to reduce unnecessary load and enhance relevant load, allowing students to focus on understanding and applying complex medical knowledge. Techniques such as segmenting information, using visual aids, and incorporating spaced repetition can support this goal (Sweller, Ayres, & Kalyuga, 2011).

9. Cognitive Apprenticeship

This model integrates traditional apprenticeship methods with cognitive and metacognitive strategies.

In medical education, cognitive apprenticeship involves the students to observe, practice under supervision, and gradually take on more complex tasks as they gain proficiency. This approach helps develop critical thinking skills through authentic clinical experiences and guided practice (Collins, Brown, & Holum, 1991).

10. Experiential Learning Theory

According to this theory (Kolb's), learning is the process by which experience is transformed into knowledge.

In medical education, experiential learning is pivotal for developing critical thinking. Clinical rotations, simulations, and hands-on practice provide concrete experiences. Reflective observation allows students to analyse their actions and outcomes. Abstract conceptualization involves integrating new knowledge with existing frameworks, and active experimentation encourages applying this knowledge in new situations (Kolb, 1984).

The table below integrates the various theoretical frameworks with their key areas of focus, commonalities and differences:

Table 2

Framework	Key Focus	Commonalities	Differences
Bloom's Taxonomy	Hierarchical cognitive skills	Higher-order thinking	Structured levels of cognitive complexity
Paul and Elder's Critical Thinking Model	Intellectual standards and elements of thought	Higher-order thinking, Reflective practice and metacognition	Emphasis on intellectual standards
Reflective Judgment Model	Stages of reasoning development	Higher-order thinking, Reflective practice and metacognition	Developmental trajectory of reasoning
Socratic Method	Question-driven dialogue	Social and collaborative learning	Dialectical method of learning
Ennis's Critical Thinking Framework	Dispositions and abilities	Higher-order thinking, Reflective practice and metacognition	Emphasis on dispositions and abilities
Vygotsky's Sociocultural Theory	Social interaction and cultural context	Social and collaborative learning	Focus on social interaction and cultural context
Dual Process Theory	Intuitive (System 1) and analytical (System 2) thinking	Balancing intuitive and analytical thinking	Differentiates between two systems of thinking
Cognitive Load Theory	Managing working memory load	Balancing intuitive and analytical thinking	Focus on cognitive load management
Cognitive Apprenticeship	Cognitive and metacognitive strategies through modelling and guided practice	Reflective practice and metacognition, Social and collaborative learning	Integrates traditional apprenticeship methods
Experiential Learning Theory	Learning through experience	Reflective practice and metacognition	Emphasis on experience-based learning

VI. GAPS IN THE LITERATURE ON INCORPORATING CRITICAL THINKING SKILLS IN UNDERGRADUATE MEDICAL STUDENTS:

Critical thinking is a cornerstone of medical practice, essential for clinical reasoning, decision-making, and evidence-based practice. Despite its recognized importance, there are significant gaps in the literature regarding effective teaching and assessment methods for fostering critical thinking skills in undergraduate medical students. Here, we explore these gaps, highlighting areas where further research is needed to develop and refine educational strategies.

1. **Lack of Consensus on Definitions and Frameworks:** One of the primary gaps in the literature is the lack of consensus on what constitutes critical thinking in the context of medical education. Various definitions and theoretical frameworks exist, but there is no universally accepted model. This lack of standardization complicates the teaching-learning and assessment of critical thinking skills. While frameworks like Bloom's Taxonomy, Paul-Elder's Critical Thinking Model, and others provide a basis, the diversity of approaches indicates a need for a unified definition tailored to medical education (Facione, 1990; Paul & Elder, 2013).

2. **Insufficient Longitudinal Studies:** Most existing studies on critical thinking in medical education are cross-sectional, providing snapshots of students' abilities at specific points in time. There is a scarcity of longitudinal research that tracks the development of critical thinking skills throughout medical school and into residency. Longitudinal studies are essential to understand how critical thinking evolves and to find out the appropriate teaching strategies at different stages of medical education (Bordage, 2009).

3. **Variable Teaching Methods:** The literature reveals variety of teaching methods employed to develop critical thinking skills, including Problem-Based Learning (PBL), Team-Based Learning (TBL), simulation, and case-based discussions (Hmelo-Silver, 2004; Azer et al., 2013). However, comparative studies assessing the relative effectiveness of these methods are limited. Most studies focus on a single teaching method without comparing it to others, making it difficult to identify which is the best and under what circumstances.

4. **Assessment Challenges:** Assessing critical thinking skills is inherently challenging due to their intricate and multifaceted nature. Traditional assessment methods, such as multiple-choice questions (MCQs) and Objective Structured Clinical Examinations (OSCEs), may not adequately capture students' critical thinking abilities (Epstein, 2007). Newer assessment tools, such as concept maps, reflective journals, and portfolios, have been proposed but are not widely adopted or validated. There is a need for robust, validated assessment methods that can reliably measure critical thinking skills in medical students (Tiwari et al., 2006).

5. **Impact of Curriculum Design:** The integration of critical thinking into the medical curriculum varies significantly across institutions. Some curricula embed critical thinking skills into all aspects of training, while others address it in isolated modules. The impact of different curricular designs on the development of critical thinking skills has not been extensively studied. To determine best practices for curriculum design and to assess how

different curricular methods affect the development of critical thinking, research is required. (Cooke et al., 2010).

6. **Faculty Development and Training:** Effective teaching of critical thinking requires instructors who are themselves adept critical thinkers and skilled educators. However, there is limited research on faculty development programs aimed at enhancing educators' abilities to teach and assess critical thinking. Studies focusing on the impact of faculty training programs on teaching effectiveness and student outcomes are crucial for developing a competent teaching workforce (Steinert et al., 2006).

7. **Cultural and Contextual Factors:** The majority of research on critical thinking in medical education has been conducted in Western contexts, primarily in North America and Europe. There is a lack of studies examining how cultural and contextual factors influence the teaching and assessment of critical thinking in diverse educational settings. Understanding these factors is essential for developing globally relevant educational strategies (Patel et al., 2001).

8. **Interdisciplinary Approaches:** Critical thinking is not confined to medicine; it is a skill relevant across disciplines. However, there is limited research on interdisciplinary approaches to teaching and assessing critical thinking. Collaborations with other fields, such as nursing, engineering, and the humanities, could provide valuable insights and innovative strategies for medical education (Benner et al., 2010).

Addressing the gaps in the literature is crucial for advancing medical education. Future research should aim to establish a standardized definition of critical thinking in medicine, conduct longitudinal studies, compare the effectiveness of different teaching methods, develop robust assessment tools, and evaluate the impact of curriculum design. Additionally, studies should explore faculty development, cultural and contextual factors, and interdisciplinary approaches. By filling these gaps, educators can better prepare medical students to become proficient, reflective practitioners capable of navigating the complexities of modern healthcare.

VII. CURRENT STATE OF CRITICAL THINKING IN MEDICAL EDUCATION

1. **Teaching-Learning Methods for Enhancing Critical Thinking:** Incorporating critical thinking into the curriculum is essential for fostering effective thinkers among undergraduate medical students. While traditional approaches often focus on imparting analytical skills, it is imperative to also instil the necessary dispositions that underlie critical thinking. As highlighted in the synthesis by (Hendrix et al, 1999), teaching students to determine argument validity is insufficient without developing habits of mind such as open-mindedness, intellectual humility, and curiosity. Moreover, as (Junkin et al, 2020) emphasizes, incorporating the arts, storytelling, and real-world contexts into the curriculum can nurture students' abilities to reflect, communicate, and make informed decisions, thereby preparing them to navigate complex healthcare challenges with depth and acumen. It is important to incorporate teaching-learning methods which can explore the critical thinking capabilities of students. Educators should be aware of such methods and should be able to effectively implement these for successful incorporation of critical thinking in the curriculum.

Traditional lectures and practicals/tutorials do not suffice and therefore TL methods like PBL, CBL, simulation-based exercises, Socratic questioning, technology-based methods like gamification, interactive apps etc have been introduced in the recent years. The National Medical Commission has also stressed upon various newer methods of teaching-learning in the Competency Based Curriculum viz. Self-directed learning, Small group discussions.

Problem-based learning (PBL) and case studies have emerged as effective teaching strategies. By presenting students with realistic patient cases, PBL encourages active learning, self-directed inquiry, and problem-solving, which are essential skills for future healthcare practitioners. Case studies give in-depth examples of real-world medical scenarios, challenging them to analyse information, make diagnoses, and develop treatment plans. Research has shown that integrating these instructional methods into medical curricula can significantly improve students' critical thinking skills and clinical reasoning abilities (Peter Schwartz, 2013). However, in medical education, only a few methods are commonly incorporated due to several challenges and constraints:

- Curriculum Overload
- Resource Constraints
- Assessment Challenges
- Resistance to Change
- Lack of Faculty Training

2. **Assessment of Critical Thinking Skills in Medical Students:** Assessment is essential for evaluating their ability to analyse complex clinical scenarios, make evidence-based decisions, and solve problems effectively. Traditional multiple-choice exams may not adequately capture the depth of students' critical thinking abilities in real-world medical practice. Therefore, innovative assessment methods such as case-based scenarios, reflective writings, and standardized patient encounters have been proposed to better evaluate critical thinking skills in medical education. These methods challenge students to apply their knowledge in a clinical context, think critically about diagnostic and management strategies, and communicate effectively with patients. By incorporating diverse assessment tools, educators can more accurately measure the promotion of analytical skills in medical students, providing meaningful feedback to enhance their clinical reasoning abilities and get them ready for the complex challenges of modern healthcare practice (Robinson et al, 2019).

3. **Current Challenges in Teaching-Learning and Assessing:** These TL and assessment methods while highly beneficial, also presents several challenges and potential disadvantages. These disadvantages can impact both the educational process and the learners' experience.

- **Time Constraints**

➢ **Increased Time Requirements:** Teaching critical thinking skills often requires more time than traditional didactic teaching. Such TL methods involve in-depth discussions, group work, and reflective exercises, which can be time-consuming. This can be challenging within the already packed medical curriculum, where there is pressure to cover extensive content in a limited timeframe (Lai, 2011).

- **Balancing Depth and Breadth:** Focusing on critical thinking might lead to a deeper understanding of specific topics but can also result in less coverage of the broader curriculum. This trade-off can be problematic in medical education, where comprehensive knowledge across a wide range of subjects is essential (Norman, 2005).

- **Variability in Teaching and Learning Styles**

- **Inconsistent Implementation:** The impact of teaching critical thinking depends significantly on the skills and commitment of the educators. There can be considerable variability in how these skills are taught, leading to inconsistent learning experiences for students. Some educators might struggle with or resist adopting new teaching methods that promote critical thinking (Hitchcock, 2004).

- **Adaptation Challenges for Students:** Students accustomed to traditional learning methods, such as memorization and lectures, may find it difficult to cope up with the active and self-directed learning required for developing critical thinking skills. This transition can be stressful and may initially lead to decreased academic performance and increased anxiety (Papinczak, 2010).

- **Assessment Difficulties**

- **Challenges in Assessment:** Assessing critical thinking skills is inherently more complex than evaluating factual knowledge. Traditional exams and multiple-choice questions are often inadequate for measuring critical thinking abilities. Developing valid and reliable assessment tools that accurately capture students' critical thinking skills remains a significant challenge (Ku, 2009).

- **Subjectivity in Evaluation:** Critical thinking assessments can be subjective, relying heavily on the evaluator's judgment. This subjectivity can lead to inconsistencies and potential biases in grading, which may affect students' evaluations and outcomes (Ennis, 1993).

- **Resource Intensiveness**

- **Resource Requirements:** Implementing teaching strategies that promote critical thinking often requires significant resources, including trained faculty, small group facilitators, and adequate facilities for interactive learning. These resources may not be readily available in all institutions, particularly in resource-limited settings (Williams et al., 2001).

- **Increased Faculty Workload:** Educators may face an increased workload when designing, implementing, and evaluating critical thinking-oriented activities. This additional burden can lead to burnout and reduce the willingness of faculty to engage in these teaching methods (Steinert et al., 2006).

Time constraints, variability in teaching and learning styles, assessment difficulties, and resource intensiveness are significant disadvantages that need to be addressed.

VIII. ROLE OF EDUCATORS IN ENHANCING CRITICAL THINKING

1. **Student-Centred Versus Teacher-Centred Methods:** Such approaches represent a fundamental dichotomy in educational pedagogy, impacting the learning experiences of students significantly. Research has identified key distinctions between these approaches, with a focus on teaching style behaviours such as Personalizing Instruction as a defining element of learner-centred practices (Fumiko Yoshida et al, 2023). Additionally, teacher and student roles play vital roles in distinguishing between teacher-centred and student-centred learning environments (Lawrence Muganga et al, 2019). It is a matter of debate whether education should prioritize the transmission of knowledge through traditional, teacher-led methods or foster student agency and self-directed learning. While both approaches have their merits, the emphasis on student engagement, critical thinking, and metacognitive processes within student-centred approaches underscores their potential to nurture holistic learning outcomes and empower individuals in navigating complex educational landscapes.

2. **Faculty Development and Training:** The development and training of faculty members is essential for improving undergraduate medical students' critical thinking abilities. Educational institutions can establish a favourable atmosphere for students to acquire critical thinking by arming faculty members with the skills and techniques they need to foster it in the classroom. Faculty development programs can include workshops on effective teaching methodologies, incorporating active learning techniques, and fostering a culture of inquiry and reflection. Additionally, training faculty members to provide constructive feedback and facilitate discussions that challenge students' assumptions is important. Therefore, investing in faculty development and training is imperative for improving the overall quality of education in undergraduate medical programs (William Condon et al, 2016).

3. **Mentorship and Role Modelling:** Mentorship and role modelling play integral roles in shaping the professional development and success of individuals in various fields, particularly in the context of healthcare education. Through mentorship programs grounded in theories such as Jean Watson's Theory of Human Caring, educators can provide valuable support and guidance to students transitioning into clinical practice roles. Research has shown that mentorship programs can significantly enhance confidence levels among educators, contributing to their ability to effectively facilitate clinical learning experiences for students (Beaman et al, 2018). By modelling an ethic of care and providing personalized guidance, mentors can help contributing to a more inclusive and supportive learning environment (Ramos et al, 2019). Through intentional mentorship and role modelling, educators and mentors can positively impact the professional growth and success of diverse student populations, ultimately enhancing critical thinking skills and preparing them for future roles in healthcare practice.

IX. BARRIERS TO DEVELOPING CRITICAL THINKING

1. **Cognitive Biases and Heuristics:** Cognitive biases and heuristics have a crucial role in enhancing decision-making processes, including those of undergraduate medical students. These mental shortcuts enable quick judgments under uncertainty but can also lead to errors in reasoning and judgment. Students may exhibit confirmation bias, favouring information that aligns with their preconceived notions, while overlooking contradictory evidence. Additionally, availability heuristic could influence their perception, as readily available information may disproportionately impact their decision-making. Strategies such as promoting metacognition, encouraging active reflection on biases, and providing feedback on decision-making processes can help students (Charles R. Schwenk, 1985). Ultimately, students can develop a more rational approach to clinical decision-making and patient care (Henry Priest, 2019).

2. **Stress and Workload of Medical Students:** The stress and workload experienced by medical students can significantly impact their overall well-being and academic performance. The rigorous curriculum, demanding clinical rotations, and high-stakes examinations contribute to elevated stress levels among medical students. Studies have shown that medical students experience factors like long study hours, intense competition, and the emotional toll of dealing with patient care playing a significant role in their mental health. Moreover, the pressure to excel academically while managing personal responsibilities can further exacerbate stress levels. This chronic stress not only affects students' mental health but can also lead to physical symptoms such as fatigue, insomnia, and burnout (National Academies of Sciences, 2020), thereby, reducing their capacity to think analytically and critically. Addressing the stress and workload of medical students is crucial to promoting their overall well-being and ensuring they develop into competent and compassionate healthcare professionals.

3. **Resistance to Change in Traditional Teaching Methods:** Resistance to change by medical educators and learners is a significant barrier to incorporating critical thinking skills into medical education. This resistance stems from various factors, including entrenched educational practices, comfort with familiar methods, and perceived challenges of new approaches.

    - **Factors Contributing to Resistance**

    - **Entrenched Educational Practices:** Traditional medical education has long relied on lecture-based instruction and rote memorization. These methods are deeply ingrained in the culture of medical training, making it difficult to shift towards more dynamic and interactive approaches that foster critical thinking. Educators who have taught using these traditional methods for many years may be hesitant to adopt new strategies, fearing a loss of control or uncertainty in their effectiveness (O'Brien et al., 2007).

    - **Comfort with Familiar Methods:** Both educators and learners often exhibit comfort with familiar teaching and learning methods. Educators may feel confident and competent using established techniques, while students may prefer the predictability and clear structure of lectures and standardized testing. The transition which require

active engagement and critical thinking, can be perceived as disruptive and challenging (Ozuah, 2005).

- **Perceived Challenges of New Approaches:** Implementing new teaching strategies that promote critical thinking involves significant changes in curriculum design, assessment methods, and classroom dynamics. Educators may be concerned about the additional time and effort required to develop and facilitate these approaches. Additionally, there may be a lack of resources or institutional support for such initiatives. Learners, on the other hand, might fear that these methods are more demanding and could impact their performance and grades (Dolmans et al., 2005).

X. INTERPROFESSIONAL EDUCATION AND CRITICAL THINKING

Interprofessional education (IPE) plays a crucial role in fostering critical thinking skills in medical students by promoting collaborative learning, enhancing communication skills, and providing diverse perspectives on patient care. IPE involves students from different healthcare professions learning together with the objective of cultivating a collaborative practice-ready workforce capable of delivering high-quality patient care.

1. Enhancing Critical Thinking through Collaboration

- **Collaborative Learning Environment:** IPE creates a collaborative learning environment where medical students interact with peers from other health professions, such as nursing, pharmacy, and physical therapy. This interaction fosters critical thinking as students are exposed to different viewpoints and approaches to patient care. Working in teams, students must analyse complex clinical scenarios, discuss potential interventions, and justify their decisions, leading to deeper understanding and improved problem-solving skills (Thistlethwaite, 2012).

- **Communication and Teamwork:** Effective communication is a cornerstone of critical thinking and quality patient care. IPE emphasizes the development of communication skills through teamwork exercises and simulations. Medical students learn to articulate their reasoning, listen to others, and integrate diverse insights into their decision-making process. This practice prepares them for real-world clinical settings where interprofessional collaboration is essential (Reeves et al., 2013).

2. Diverse Perspectives and Comprehensive Care

- **Exposure to Different Perspectives:** In IPE settings, medical students gain exposure to the knowledge and expertise of other healthcare professionals. This exposure helps them appreciate the value of different disciplinary perspectives and encourages them to consider various factors in patient care. By understanding how different health professionals contribute to patient outcomes, students develop a more comprehensive approach to problem-solving (Hall & Weaver, 2001).

- **Complex Problem-Solving:** IPE often involves case-based learning and simulation exercises that mimic real-life clinical situations requiring multifaceted solutions. These scenarios challenge students to apply critical thinking by analysing patient

information, synthesizing knowledge from multiple disciplines, and collaboratively developing and evaluating treatment plans. This process enhances their ability to think critically and make informed decisions in complex and uncertain situations (Hammick et al., 2007).

3. Building Competence and Confidence

- **Reflective Practice:** Reflective practice is integral to IPE, encouraging students to reflect on their experiences, decisions, and interactions with other professionals. This reflection helps them identify areas for improvement, understand their own thought processes, and develop greater self-awareness. Reflective practice promotes continuous learning and critical thinking, enabling students to adapt and improve their clinical reasoning skills over time (Zwarenstein et al., 2009).

- **Preparing for Real-World Practice:** By participating in IPE, medical students are better prepared for the collaborative nature of modern healthcare. They develop the competence and confidence to engage in interprofessional teamwork, communicate effectively, and make well-reasoned decisions. These skills are crucial for navigating the complexities of patient care and for improving health outcomes (Barr et al., 2005). By fostering a culture of teamwork and communication, IPE prepares medical students to meet the challenges of contemporary healthcare environments.

XI. THE ROLE OF ETHICS IN CRITICAL THINKING

Ethics plays a fundamental role, as it challenges them to navigate complex moral dilemmas, enhances their decision-making abilities, and fosters a sense of professional responsibility. By integrating ethics into medical education, students learn to critically evaluate their actions and the consequences of those actions in a healthcare context.

1. Navigating Complex Moral Dilemmas

- **Exposure to Ethical Issues:** Medical education that includes a robust ethics curriculum exposes students to a variety of moral dilemmas they will encounter in their professional practice. These dilemmas often lack clear-cut solutions, requiring students to weigh different values and principles. This exposure promotes critical thinking as students must analyse, compare, and justify their ethical decisions (Eckles et al., 2005).

- **Case-Based Learning:** Utilizing case-based learning in ethics education allows students to engage with real-world scenarios that require ethical analysis. Through discussions and debates, students explore multiple viewpoints and consider the implications of different actions. This process encourages them to think critically about the ethical dimensions of medical practice and to develop well-reasoned arguments (Smith et al., 2004).

2. Enhancing Decision-Making Abilities

- **Structured Ethical Frameworks:** Teaching structured ethical frameworks, such as principlism (which includes principles like autonomy, beneficence, non-maleficence, and justice), provides students with tools to systematically approach ethical dilemmas. y applying these frameworks, students learn to organize their thoughts and consider all relevant factors, enhancing their critical thinking and decision-making skills (Beauchamp & Childress, 2013).

- **Reflective Practice:** Reflective practice is an integral part of ethics education. Encouraging students to reflect on their ethical decisions and the reasoning behind them helps develop self-awareness and critical thinking. Reflective exercises, such as writing essays or journals, allow students to critically evaluate their own beliefs and the impact of their decisions on patients and society (Branch, 2010).

3. Fostering Professional Responsibility

- **Understanding Professional Ethics:** A strong foundation in medical ethics instills a sense of professional responsibility in students. They learn the importance of ethical conduct and the expectations of their profession. Understanding these ethical standards requires critical thinking to apply them appropriately in various situations, balancing professional obligations with patient care (American Medical Association, 2001).

- **Ethical Leadership:** Ethics education also prepares students for leadership roles where they must advocate for ethical practices within healthcare settings. Developing the ability to think critically about ethical issues enables future physicians to lead by example, promote ethical standards, and address unethical behaviors in their practice (Shapiro & Stefkovich, 2011).

Through exposure to ethical issues, case-based learning, structured ethical frameworks, reflective practice, and an emphasis on professional responsibility, students enhance their ability to navigate complex moral dilemmas and make informed, ethical decisions. These skills are essential for their development as competent and conscientious healthcare professionals.

XII. THE INFLUENCE OF PERSONAL ATTRIBUTES ON CRITICAL THINKING

Personal attributes play a significant role in shaping these skills. Here we explore how various personal attributes of medical students, such as personality traits, cognitive styles, emotional intelligence, motivation, and prior experiences, influence their levels of critical thinking.

1. **Personality Traits:** Inherent qualities of people called personality traits affect a person's behaviour, nature and mindset. The Five-Factor Model offers a helpful framework for comprehending how personality affects critical thinking.

- **Openness to Experience:** This is marked by curiosity, imagination, and a willingness to interact with new ideas. Students with this trait are more likely to seek out diverse perspectives and challenge existing beliefs, which fosters critical thinking. Research has shown that openness to experience is positively correlated with critical thinking skills (Kaufman et al., 2010).

- **Conscientiousness:** Conscientious individuals are organized, diligent, and goal-oriented. These qualities can enhance critical thinking by promoting thoroughness and attention to detail. Conscientious students are likely to systematically analyze information and consider various outcomes before making decisions.

- **Extraversion and Agreeableness:** While extraversion and agreeableness are not directly linked to critical thinking, they can influence collaborative learning environments. Extraverted students may engage more actively in discussions, while agreeable students may be more open to others' viewpoints, both of which can enhance critical thinking through social interaction.

- **Neuroticism:** High levels of neuroticism, characterized by emotional instability and anxiety, can hinder critical thinking. Anxiety may impair cognitive function and decision-making processes, leading to difficulty in analyzing information objectively (Moutafi et al., 2006)

2. **Cognitive Styles:** Cognitive styles refer to the preferred ways individuals process information and solve problems. Two primary cognitive styles that impact critical thinking are analytic and intuitive thinking.

    - **Analytic Thinking:** Analytic thinkers approach problems methodically, breaking them down into smaller components and examining each part systematically. This cognitive style aligns closely with critical thinking, as it involves careful analysis and logical reasoning. Medical students with a strong analytic thinking style are likely to excel in tasks requiring detailed examination and evidence-based decision-making.

    - **Intuitive Thinking:** Intuitive thinkers rely on gut feelings and immediate perceptions rather than systematic analysis. While intuition can be valuable in certain situations, over-reliance on it may undermine critical thinking. Balancing intuitive insights with analytic rigor is crucial for medical students to develop well-rounded critical thinking skills.

3. **Emotional Intelligence:** Emotional intelligence is the capacity to recognize, understand, and control one's own feelings as well as those of others (EI). High EI can enhance critical thinking in several ways:

    - **Self-Regulation:** Students with high EI can manage stress and remain calm under pressure, allowing them to think more clearly and critically. Self-regulation helps prevent emotional responses from clouding judgment and decision-making.

- **Empathy:** Understanding others' emotions can improve interpersonal communication and collaboration, which are essential for critical discussions and problem-solving in medical education.

- **Motivation:** EI includes intrinsic motivation, which drives students to pursue excellence and engage deeply with their studies. Students who are motivated are more likely to persist in challenging tasks and apply critical thinking to overcome obstacles.

4. **Motivation:** Motivation, both intrinsic and extrinsic, significantly influences critical thinking. Intrinsic motivation, which comes from within and is driven by personal interest and satisfaction, fosters a deeper engagement with learning materials and encourages students to explore topics thoroughly. Extrinsic motivation, driven by external rewards such as grades or recognition, can also promote critical thinking, but it may not lead to the same level of sustained engagement.

    - **Intrinsic Motivation:** Intrinsically motivated students are more likely to engage in self-directed learning, seek out additional resources, and critically evaluate information. They tend to be more curious and persistent, traits that are conducive to developing strong critical thinking skills (Deci & Ryan, 2000).

    - **Extrinsic Motivation:** While extrinsic motivation can drive performance, it may sometimes lead to surface-level learning if students are focused solely on achieving external rewards. However, when combined with intrinsic motivation, it can provide a powerful impetus for sustained critical thinking and academic success.

5. **Prior Experiences:** The experiences students bring to their medical education can shape their critical thinking abilities. These experiences include prior academic background, work experiences, and life challenges.

    - **Academic Background:** Students with a strong foundation in sciences and humanities often possess well-developed analytical and critical thinking skills. Exposure to diverse academic disciplines can enhance their ability to integrate and synthesize information from various sources.

    - **Work Experiences:** Practical experiences, such as internships, research projects, or clinical work, provide opportunities for students to apply critical thinking in real-world contexts. These experiences help students develop problem-solving skills and the ability to make informed decisions under uncertainty.

    - **Life Challenges:** Overcoming personal and professional challenges can build resilience and adaptive thinking. Students who have faced and navigated significant challenges may develop stronger critical thinking skills as they learn to evaluate situations, consider alternatives, and make decisions.

XIII. RECOMMENDATIONS FOR ENHANCING CRITICAL THINKING IN MEDICAL EDUCATION

1. Integrative Curriculum Design

- **Problem-Based Learning (PBL):** PBL is a student-centered methodology in which learners collaborate in small groups to find solutions to challenging, real-world issues. This method promotes knowledge application, critical thinking, and active learning. Research has indicated that PBL can strengthen knowledge retention and critical thinking abilities. (Hmelo-Silver, 2004).

- **Case-Based Learning (CBL):** Similar to PBL, CBL uses clinical cases to stimulate critical thinking. By analyzing and discussing real patient cases, students learn to apply theoretical knowledge to practical scenarios. (Thistlethwaite et al., 2012).

- **Interprofessional Education (IPE):** IPE involves learning along with students from other healthcare disciplines. This integrative approach helps students understand different perspectives and enhances their ability to work in teams and communicate effectively. (Reeves et al., 2013).

2. Innovative Teaching Methods

- **Flipped Classroom:** By bringing activities, such as those that promote critical thinking, into the classroom and presenting instructional content online outside of it, the flipped classroom model subverts conventional teaching techniques. This model promotes active learning and allows more time for in-depth discussion and problem-solving during class (Bishop & Verleger, 2013).

- **Simulation-Based Learning:** Through simulation, students can hone their clinical judgment and decision-making abilities in a safe, regulated setting. Complex clinical scenarios can be replicated via high-fidelity simulations, giving students the chance to hone and expand their critical thinking abilities. (McGaghie et al., 2010).

- **Reflective Practice:** Encouraging students to engage in reflective practice helps them to critically evaluate their own experiences and learning processes. Reflective writing assignments and discussion groups can foster self-awareness and critical thinking (Sandars, 2009).

- **Newer Tools for Engagement**

  - **Crosswords, Quizzes, and Riddles:** These tools can make learning more engaging and fun, encouraging students to think critically and creatively as they solve problems. Quizzes and riddles provide immediate feedback, helping students to quickly identify and address gaps in their knowledge and reasoning.

  - **Essays:** Writing essays requires students to organize their thoughts, make coherent arguments, and reflect deeply on the material. This process enhances critical thinking and the ability to communicate complex ideas effectively.

- **Multi-Media Resources:** Videos, podcasts, and interactive simulations can provide diverse ways to engage with content, catering to different learning styles and promoting critical thinking through varied perspectives.

- **Gamification:** Incorporating game-like elements into learning (e.g., leaderboards, badges) can motivate students and make the learning process more interactive and engaging.

- **Online Discussion Platforms:** Tools like discussion boards and social media can facilitate rich, ongoing dialogues about course material, allowing students to practice critical thinking in a collaborative environment.

3. Assessment of Critical Thinking

- **Performance-Based Assessment:** Objective Structured Clinical Examinations (OSCEs) and other performance-based assessments can be used to evaluate students' critical thinking skills in realistic clinical scenarios. These assessments provide a more accurate measure of students' ability to apply knowledge and think critically (Harden et al., 1975).

- **Portfolios:** Portfolios allow students to compile evidence of their learning and critical thinking over time. This can include reflective essays, case analyses, and feedback from peers and mentors. Portfolios provide a holistic view of students' development and can be used for formative and summative assessment (Driessen et al., 2007).

- **Standardized Critical Thinking Tests:** Tools like the California Critical Thinking Skills Test (CCTST) and the Health Sciences Reasoning Test (HSRT) can be used to assess critical thinking skills quantitatively. These tests can provide valuable data on students' progress and the effectiveness of the curriculum (Facione & Facione, 1994).

4. Faculty Development

- **Training Programs:** Providing faculty with training in critical thinking pedagogy and assessment is essential. Workshops, seminars, and continuing education courses can help educators develop the skills needed to teach and evaluate critical thinking effectively (Steinert et al., 2006).

- **Peer Collaboration:** Encouraging faculty to collaborate and share best practices can enhance the overall quality of teaching. Faculty learning communities and peer mentoring programs can provide support and foster innovation in teaching methods (Cox, 2004).

5. Technology Integration

- **E-Learning Platforms:** E-learning platforms can provide interactive, multimedia-rich content that engages students and promotes critical thinking. Online discussion forums, virtual patient simulations, and adaptive learning technologies can

supplement traditional teaching methods and provide additional opportunities for critical thinking (Ellaway & Masters, 2008).

- **Artificial Intelligence (AI):** AI can be used to generate adaptive learning environments that respond to individual learner's needs. AI-driven simulations and diagnostic tools can provide personalized feedback (Shah et al., 2019).

6. Creating a Supportive Learning Environment

- **Encouraging Curiosity and Questioning:** Fostering a culture of curiosity and questioning can promote critical thinking. Encouraging students to ask questions, challenge assumptions, and explore alternative perspectives helps create an environment where critical thinking can flourish (Paul & Elder, 2007).

- **Promoting Diversity and Inclusion:** Diverse learning environments expose students to a variety of perspectives and experiences, which can enhance critical thinking. Promoting inclusivity and valuing diverse viewpoints can help students develop a more nuanced understanding of complex issues (Gurin et al., 2002).

- **Providing Constructive Feedback:** Regular, constructive feedback is essential for developing critical thinking skills. Feedback should be specific, timely, and focused on the process of thinking as well as the final outcome. This helps students understand their strengths and weaknesses and provides scope for improvement (Hattie & Timperley, 2007).

The future of critical thinking in medical education lies in innovative curriculum design, effective teaching methods, robust assessment strategies, faculty development, technology integration, and a supportive learning environment. By adopting these recommendations, medical schools can better prepare students to navigate the complexities of modern healthcare and make sound, evidence-based decisions. As medical knowledge continues to evolve, the students who are critical thinkers will always have an edge as future healthcare professionals.

XIV. CASE STUDIES OF SUCCESSFUL PROGRAMS

Table 3

Institution	Country	Key Themes	References
All India Institute of Medical Sciences (AIIMS), New Delhi	India	- Problem-Based Learning (PBL) - Case-Based Learning (CBL) - Research and clinical rotations - Workshops and seminars on critical thinking	Pathak, 2013; Sharma et al, 2011
Christian Medical College (CMC), Vellore	India	-Simulation-based learning - Reflective practice - Journal clubs	Thomas et al, 2006; Jacob et al, 2005

Manipal Academy of Higher Education (MAHE)	India	- Problem-Based Learning (PBL) - Technology-enhanced learning - Research and innovation	Rao & Rao, 2007; Supe et al, 2006
Harvard Medical School, USA	USA	- Competency-based curriculum (Pathways) - Self-directed learning - Reflective practice and continuous assessment - Extensive research opportunities	Tosteson et al, 1994; Muller et al, 2008
University of Oxford, Medical Sciences Division, UK	UK	- Problem-Based Learning (PBL) - Case-Based Learning (CBL) - Extensive clinical training - Personalized instruction and feedback - Emphasis on research	Smith 2010; Field 2010
Karolinska Institute, Sweden	Sweden	- Integrated curriculum - Interprofessional education (IPE) - Simulation-based learning	Lindgren et al, 2005
University of Toronto, Faculty of Medicine, Canada	Canada	- Problem-Based Learning (PBL) - Case-Based Learning (CBL) - Extensive clinical training - Reflective practice and continuous assessment - Strong research focus and innovation	Bolander et al, 2014

The above table show institutions in India and abroad which have successfully implemented programs to incorporate critical thinking skills amongst medical students. These institutions exemplify the integration of critical thinking into medical education through innovative curricula, experiential learning, and a strong emphasis on research and reflective practice. By fostering an environment that encourages inquiry, collaboration, and continuous learning, these medical schools prepare their students to navigate the complexities of modern healthcare and make informed, evidence-based decisions in their future careers.

XV. REFLECTIONS ON MY OWN EXPERIENCE

Incorporating critical thinking skills in medical undergraduate students has always been a rewarding challenge. Over the years, I've found that traditional methods often need a creative boost to fully engage students. One unique approach I've adopted involves using limericks and riddles as educational tools. Here's a reflection on my personal experience:

1. **Limericks in Medical Education:** Limericks, with their catchy rhythm and rhyme, provide a memorable way to teach and reinforce medical concepts. They are particularly useful for summarizing information and prompting students to think critically about key points.

   For instance, I created a limerick to help students remember the differential diagnoses for chest pain:

   A patient with pain in the chest,
   Could be suffering from many a pest.
   Is it heart, is it lung?
   Check if they're highly strung,
   Or perhaps it's just heartburn at best.

2. **Riddles to Stimulate Critical Thinking:** Riddles serve as an excellent tool to challenge students' diagnostic reasoning and problem-solving skills. Presenting a clinical scenario as a riddle encourages students to think deeply and discuss various possibilities before arriving at a conclusion.

   Here's a riddle I used in a clinical reasoning class:

   I live in the marrow,
   Blood is not my home…..
   Huge in size, but porous inside;
   My presence makes people lose their chrome!

   This riddle, which describes a megaloblast, sparked a lively discussion about the properties and morphology of a megaloblast in megaloblastic anemia, leading to a deeper understanding of the subject.

3. **Impact on Students:** Using limericks and riddles in my teaching has had several positive effects on students:

   - **Enhanced Engagement:** Students find the lessons more enjoyable and engaging, which increases their motivation to learn. The playful nature of limericks and riddles breaks the monotony of traditional lectures and captures their attention.

   - **Improved Retention:** The rhythmic and often humorous nature of limericks makes the information more memorable. Similarly, the process of solving riddles helps students retain complex concepts by linking them to a fun and challenging activity.

- **Development of Critical Thinking:** Both limericks and riddles require students to think beyond rote memorization. They must analyse the clues, consider various possibilities, and apply their knowledge creatively, which enhances their critical thinking skills.

Incorporating limericks and riddles into medical education has proven that these creative tools not only make learning more enjoyable but also deepen students' understanding of medical concepts, improve their engagement and enhances retention. As an educator, seeing students engage with and enjoy the material in this way is incredibly rewarding.

XVI. CONCLUSION

1. Summary of Key Findings and Insights

In summarizing the key findings and insights of enhancing critical thinking in undergraduate medical students, it becomes evident that a multifaceted approach is essential. Research has shown that engaging in reflective practices, such as journaling and peer discussions, enables students to analyse their thought processes and enhances their analytical thinking in clinical scenarios (Marc Stickdorn et al, 2018). These findings underscore the importance of structuring medical education curricula to prioritize critical thinking skills, as it is a fundamental competency for future healthcare professionals. By integrating diverse instructional methods and promoting reflective practices, educators can effectively cultivate the critical thinking abilities of aspiring medical practitioners.

2. Final Thoughts and Recommendations for Future Research

Drawing from the literature on sustainability consciousness and leadership theories (Maree L. Stansfield, 2020), it is evident that fostering a sustainability-focused worldview among students could significantly impact their ability to engage critically with complex healthcare challenges. As such, future research endeavours should consider incorporating elements of trait leadership theory and behavioural theories of leadership in educational interventions aimed at promoting critical thinking skills in medical undergraduates. Moreover, exploring the intersection of authenticity and transparency in leadership development within the medical education context could offer valuable insights into cultivating a culture of critical inquiry and ethical decision-making among students (M. Ehret, 2018). By delving deeper into these areas and aligning educational practices with sustainability principles, future research can pave the way for cultivating a cohort of medical professionals equipped with the critical thinking skills necessary to navigate contemporary healthcare complexities.

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