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USING AN EXPERIENTIAL LEARNING MODEL TO TEACH CLINICAL REASONING THEORY AND COGNITIVE BIAS: AN EVALUATION OF A FIRST-YEAR MEDICAL STUDENT CURRICULUM

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ABSTRACT

Background: The majority of medical students who start clerkships don't fully grasp the fundamentals of clinical reasoning. It is unclear if first-year medical students benefit from learning about cognitive biases and theories of clinical reasoning.

Objective: The purpose of this study was to assess the benefits of providing first-year medical students with specific instruction in cognitive bias and clinical reasoning theory.

Methodology: We used the experiential education method to teach clinical thinking to first-year medical learners at Women Medical College. Additionally, we discussed cognitive prejudices, script theory, and dual process theory. The investigation was conducted in 2021, namely from March to December. Due to the COVID-19 pandemic, lessons were shifted to a format for distance learning in May 2021. The program included a number of written tests on clinical reasoning along with support for discussions in smaller groups. Via written self-evaluations participants were compelled to consider their observations, draw conclusions about their clinical reasoning skills, and plan for potential future clinical reasoning encounters. We evaluated the curriculum's value using a combination of approaches, looking at staff evaluations, student self-evaluation inquiries, and a confidential end-of-curriculum inquiry that gathered feedback from learners.

Results: Out of the 317 exams that 105 participants took in total, 253 (79%) had a comprehensive problem representation, and 198 (62%) had a problem representation that was deemed concise. In their clinical reasoning, the learners most frequently mentioned anchoring bias, availability bias, and premature closure as cognitive biases. Students saw four main themes as important consequences of the CREs: Synthesis of medical knowledge;(2) improved capacity for making differential

diagnoses;(3) growth in clinical reasoning self-efficacy; and (4) increased consciousness of one's own cognitive biases.
Conclusion: We discovered that first-year medical students benefit greatly from explicit instruction of ‘clinical reasoning theory and cognitive biases through an experiential learning’ paradigm. This allows them to gain important ‘knowledge, skills, and self-efficacy associated with clinical reasoning’.

Keywords: Curriculum, Script Theory, Dual Process Theory, Clinical Reasoning Examination, Cognitive Bias.

Introduction

A crucial part of medical professionals' and learners' competency as professionals is clinical thinking, which is the mental processes used by clinicians for diagnosing and treating patients [1]. Most diagnostics mistakes made in clinical practice are the result of cognitive mistakes, particularly those related to typical cognitive prejudices ‘in medicine’ “e.g., anchoring prejudice, availability bias, premature closure” [2–8]. A vast ‘majority of medical learners attending medicine internships have a minimal or inadequate comprehension of clinical thinking ideas, according to a national study of medicine clerkship directors in the USA’[9]. A systematic course ‘in clinical thinking should be imparted throughout the medical education continuum’, which includes the pre-internship years, according to the majority of interviewees. Additionally, the ‘National Academies of Sciences’ have advocated for the development of clear, theory-based clinical reasoning in curriculum in undergraduates and postgraduate medical colleges in order to reduce the problems caused by diagnosing mistakes made during clinical practice [10,11].

Yet considering their fairly limited practical expertise and scarcity of practical expertise, it is still unclear if clinical thinking ‘theories and cognitive biases can be taught to pre-internship medical students’ in an efficient manner [12–15]. Students with practical training have been the primary focus of the medical curriculum, which is founded on concepts ‘of clinical reasoning and cognitive biases’ [13, 14, 16, 24]. ‘Dual process theory and script theory have’ been the main focuses of teaching clinical reasoning theories, and several studies have shown that these approaches increase senior medical learner and trainees' ability to diagnose [25–31]. Dual process theory is a problem-solving abilities model that proposes two ways of thinking: System 1, which is more analytical and intentional, and System 2, which is spontaneous and automatic and leverages heuristics and pattern recognition [32, 33].

Script theory explains how information about illnesses, ailments or pathologies is reorganized into ‘illness programs, which are cognitive representations of disease states that incorporate the pathophysiological insults, clinical’ implications, and predisposing circumstances [34–38]. There is no research on the application of a practical ‘reasoning curriculum’ that teaches first-year medical students about cognitive biases, script theory, and dual process theory. Here, we outline the development and execution of a clinical reasoning program that specifically covers these ideas and prevalent cognitive biases that have an impact on diagnostic reasoning during the first year of medical college.

The development and assessment of the clinical reasoning curriculum were guided by Kolb's experiential learning model. According to Kolb, the process of acquiring and converting experiences leads to the formation of knowledge, or learning.[39] understanding, in which students combine what they've observed with what they already know to draw conclusion; and (4) active exploration, when students put their newly developed understanding of concepts to the exam.

According to Kolb's model, learning occurs in four stages: (1) concrete experience, during which students participate in an activity; (2) observation as reflection, during which students watch and consider the experience; (3) conceptualization of abstraction, during which students combine what they have seen with past knowledge to generate results; and (4) engaged experimentation, during which students put their newly acquired understanding of concepts to the test. Through the use of three written examples and the accompanying small-group and individual discussions, we were able to provide tangible experiences. We included chances in the educational program for learners to develop plans and experiment using new methods and behaviours that they could apply to future scenarios, gain knowledge from their own experiences, and comprehend the method of clinical reasoning.

The goal of the present investigation was to assess how well 'first-year medical students' clinical reasoning abilities and awareness of their cognitive biases were developed by this theory-informed clinical reasoning curriculum'. Here, we also go over how our experiential curriculum was created and put into practice to educate 'first-year medical students about clinical reasoning theories', ideas, and cognitive biases.

Materials and methods

Initially, the curriculum (Table-1) consisted of two one-hour educational classes on 'diagnostic clinical thinking, covering topics such as dual process theory, illness scripts, availability bias, confirmation bias, base-rate neglect, anchoring bias, diagnostic momentum, implicit bias, representativeness bias, and premature closure'. Students were asked to 'create illness scripts as part of a lecture assignment'. Students were able to identify 'cognitive biases in their clinical decision-making' through interactive discussion of cases and utilize particular clinical reasoning techniques such as diagnostic frameworks, asking the question "why," worst- case medicine, and diagnostics validation.

The next session of the learners' first year of medical college began with the delivery of these lectures in the third week of March 2020. In addition to having a minimum 3 'years of expertise co-leading clinical reasoning classes and workshops for medical learners, residents, and junior faculty members at Women Medical and Dental College, the lecturer has undergone faculty development coursework in practical reasoning' teaching. Then, a medical librarian and a clinician-educators trained in evidence-based medicine courses presented a workshop on how to frame the historical context and frontline issues of a clinical situation.

Following these initial courses, students were given a written case-based assignment to complete as a practice for creating problem representations, 'creating illness scripts, defending their diagnostic conclusions, identifying background and foreground questions raised by the case, and outlining search tactics for the most effective evidence to answer these' questions.

Throughout the academic year, two 'full-day clinical reasoning examinations' (CREs) were conducted every two months in the months April, June, August 2020. Learners were provided with Part I of a written clinical case for each CRE. As with a typical hospital admitting note, Part 1 had a 'History & Physical Examination' (H&P) note that comprised case details from the principal concern to diagnosing results from tests (eliminating the evaluation and plan parts). Using a "whole-case" approach, the case material that was made available to each student was standardized, reducing the need for students to extract the history given their inexperience in doing so. The scenarios incorporated material 'from the organ systems that the students had previously learned about, but were more complicated compared to those employed in other case-based instruction for small groups' "the first CRE involved the heart and lungs, the following one added digestive and kidney procedures, and the final one added hematology/oncology and hormonal circumstances". The organ system unit chiefs examined the cases among themselves.

For a period of two hours, each student reviewed Part 1 of the story and answered questions from the modified IDEA Assessment Tool: 'Create a problem list; create a problem representation; write an illness script for each of the three likely causes', write an explanation of your leading hypothesis, write about any reservations you may have about it, write about alternative hypotheses, write about any additional information you feel is necessary or the need for additional diagnostic workup and write an explanation of your background question for diagnostic reasoning along with a resource to help you find the answer.

Participants got Part 2 of the scenario, which contained additional diagnostic data, after completing their Part 1 responses. They had three hours to evaluate, work together, explore resources, and turn in answers to the following tasks: (1) ‘Provide an updated problem representation, leading diagnosis, and justification’ (2) ‘Provide a systematic approach for the primary clinical problem’ and (3) Create a foreground question and resource to address it. The responses were sent in digital form.
A teacher moderator ‘led a 90-minute small group session’ with 10–12 participants at the end of each Clinical Reasoning Exercise (CRE). The first CRE had in-person sessions; the second, because of COVID-19, had online sessions; and the third, large-group virtual sessions. For a little time after the CRE, students may examine sample answers; however, they must not duplicate or distribute them in order to preserve the curriculum's integrity. After seeing sample responses, students had two weeks to ‘complete a self-assessment questionnaire’. They noted information gaps, cognitive biases, semantic qualifiers, superfluous language, missing parts, useful tactics and resources, and possible areas for future development. The final CRE self-assessment examined how the semester's changes in clinical reasoning, learning techniques, and cognitive biases were applied.
To faculty evaluators assessed ‘each student's written assignment’ for completeness, conciseness, and use of semantic qualifiers. They also ‘evaluated the self-assessment questionnaires’ to check if students accurately recognized missing components, excess verbiage, confusion in identifying semantic qualifiers, and correctly identified cognitive biases. Faculty independently reviewed 20% of assignments ‘to reach a consensus on evaluation and feedback’ before dividing the rest. Feedback was provided to students, and the ‘CREs were graded as Pass/Fail based on’ satisfactory completion of all parts.
Following each Clinical Reasoning Exercise (CRE), ten to twelve participants participated in a ‘90-minute small group session supervised by a teacher moderator. There were in-person sessions for the first CRE, online sessions for the second’ due to COVID-19, and large-group virtual sessions for the third. Students are allowed to review example answers for a short period of time following the CRE, but in order to maintain the integrity of the curriculum, they cannot copy or disseminate them.
Students ‘were given two weeks to finish a self-assessment questionnaire’ after viewing sample answers. They identified gaps in knowledge, cognitive biases, semantic qualifiers, redundant language, missing pieces, practical strategies and tools, and potential directions for further research and development. The application of the learning strategies, cognitive biases, and clinical reasoning modifications from the semester was evaluated in the final CRE self-assessment. Learner input was gathered through the administration of a confidential survey. Students answered open-ended queries about the importance of CREs, learning about cognitive biases and clinical reasoning, when to teach these topics, difficulties addressing CRE cases with colleagues, modifications for Part 2 due to the online format, experiences with various session formats, and ideas for enhancement. They also ‘rated the CREs on a scale from 0 to 3’.
This study comprised all Women Medical and Dental College first-year medical students (N = 105) enrolled in the 2020–2021 academic year. ‘To assess medical students' clinical reasoning performance, we evaluated written CRE submissions, self-assessment questionnaires, and faculty’ assessments for completeness, conciseness, use of semantic qualifiers, and any confusion about them. For cognitive biases, we checked if students identified or described biases accurately in their self-assessments, noting any misunderstandings. To assess reflections on clinical reasoning and learning strategies, we reviewed self-assessments for the use of strategies/resources and plans for future improvement. For ‘students' perspectives on the curriculum, we analysed responses to an anonymous questionnaire’ on the value of CREs, learning experiences with cognitive biases and clinical reasoning, optimal timing for teaching these concepts, issues with peer discussions, adjustments for virtual formats, preferred discussion formats, and suggestions for curriculum improvement.
Shortly after every CRE, electronic questionnaires for student self-assessment were distributed. ‘After each CRE, students' written assignments and self-assessments were arranged and gathered by a curriculum coordinator’, and faculty evaluation surveys were distributed electronically about two weeks later. Before any data analysis could begin, all of the data were de-identified. A research

assistant took away each student's name and randomly assigned them a unique identification number, ranging from 1 to 105.

‘Descriptive statistics were calculated for quantitative data on medical students' clinical reasoning, cognitive biases, learning strategies, and curriculum impact’. No statistical tests were used for comparisons between CREs due to the context-specific nature of clinical reasoning performance.

Manifest content analysis was used ‘for student responses to open-ended questions’ about ‘cognitive biases, strategies, and reflections’ on clinical reasoning. Content analysis involved three ‘phases: familiarization with the data, categorization’ (coding and organizing data into categories), and reporting findings. Four investigators ‘initially met to familiarize’ themselves with the data. They conducted categorization in pairs and then as a group to resolve disagreements by consensus. Curriculum leaders paired with non-involved investigators. This iterative process continued until consistent coding was achieved, after which the remaining data was categorized by the pairs.

Table 1 : Curriculum Timeline

Year 2020	March	April	May	June	July	August
‘Foundational Curriculum’	‘Cardiology Unit’	‘Pulmonary Unit’	‘Gastro Intestinal Unit / Kidney Unit’	‘Hematology/ Oncology Unit’	‘Endocrinology Unit’	‘Reproduction Unit’
‘Clinical Reasoning Curriculum’	‘Introductive Lectures’	‘Practice Assignment’	‘CRE 1’	‘CRE 2’	‘CRE 3’	

‘Abbreviation CRE, Clinical Reasoning Examination’

Results

The 105 participants finished 317 CREs in total, of which 253 (79%) had a comprehensive problem representation and 198 (62%) had a problem representation that was deemed concise. Of the 211 (91%) problem representations examined in the first two CREs, 194 had linguistic qualifiers. In terms of linguistic qualifiers, just one out of every six students' self-assessment responses showed perplexity. 260 out of 317 students (81%) who self-assessed ‘their clinical reasoning skills during the CREs were able to name or characterize a cognitive bias’. ‘Premature closure, availability bias, and anchoring bias were the most prevalent cognitive biases in all three’ CREs.

The propensity to "lock onto" prominent details from a ‘patient's initial presentation’ at an early stage in the process of diagnosis and to fail to alter the first impression as more information becomes available is known as anchoring bias [49]. The case's salient characteristics allowed learners to quickly arrive at a certain diagnostic opinion.

The inclination to assess something as more plausible if it is immediately remembered (a recent illness, for example) is known as availability bias [40]. The majority of students pointed to the lecture material and concurrent organ system courses as sources of availability bias.

The one and only most prevalent cognitive bias in diagnostic testing is premature closure, which is the propensity to cease exploring alternative options after receiving a diagnosis mistakes [2]. We determined ‘premature closure in statements that did not include another cognitive bias reported "upstream" to premature closure’ “e.g., anchoring bias that led to premature closure” since it is frequently the "final common pathway" for cognitive biases leading to diagnostic ’errors.

Students also recognized and/or explained confirmation bias and ‘representativeness bias’. The propensity to be drawn is known as representativeness bias toward classical illness presentations [40]. The propensity to seek out supporting evidence for a diagnosis rather than contradicting data to challenge it is known as confirmation bias [40]. In each CRE, we found multiple students indicating a "test taking" bias, which we characterized as any impact on reasoning brought on by individual responses, activities, and techniques throughout the test. Students seldom ever named cognitive biases, on the whole. In all CREs, we only discovered four instances when ‘the student self-assessment revealed uncertainty in their attempt to name and/or characterize a cognitive bias’. In each CRE, almost 25% of students were unable to name or explain any cognitive bias that affected their reasoning.

More often ‘than other clinical reasoning techniques like diagnostic verification, students reported using sickness scripts and diagnostic frameworks. Students regularly worked with peers and examined additional materials (such as lecture notes and internet resources) throughout each CRE. Students frequently stated that they planned to extend their diagnostic thinking in future CREs. Student self-assessments included ‘methods for reading the case materials, such as underlining, highlighting, and annotating’; nevertheless, ‘we did not consider any of these to be techniques for clinical reasoning’. In our research, methods that were too nebulous to be classified—such as narrowing down or methodically going over case material without saying how, or staying away from cognitive biases in general ‘were also not classified as descriptions of strategies for clinical’ reasoning.

Seventy-two (72%) of the learner who answered the anonymous survey expressed their opinions about the course material. The majority of respondents gave the CRE learning experience a great (70%, 54/76) or moderate (26%, 19/76) rating for value. Out of 76 responders, only two thought the learning experience was insignificant or useless. Students discovered that the CRE program provided ways to use previously learned material from previous ‘units of the first-year curriculum and to incorporate medical knowledge from several different units of organ system.

In response to an open-ended question about their experience learning ‘about cognitive biases and concepts related to clinical reasoning throughout the year’, the majority of students felt that they had either improved their diagnostic abilities or clinical reasoning (29%, 22/76) or were better able to identify and confront their own biases (36%, 27/76). Students felt that it was beneficial to become more conscious ‘of their own cognitive biases’, especially in a low-stakes setting where mistakes and comments were encouraged for personal growth. Responding to a suggestion for recommendations for enhancing the course of study, free text comments grouped into several different types: wouldn't alter anything (43 percent, 33/76); increase the number of CREs (24%, 18/76); enhance discussions in groups (13%, 10/76); shorten CRE days (11%, 8/76); enhance the caliber of the CRE case material (9%, 7/76); do away with grading (7%, 5/76); emphasize and develop reasoning skills in the organ units (3%, 2/76); better prepare ‘students for the first CRE (4%, 3/76); and enhance feedback from students’ (3%, 2/76).

Discussion

We developed and implemented a ‘theory-informed clinical reasoning curriculum for first-year medical students’ using Kolb's experiential learning approach. The conceptual framework of medical ‘reasoning and cognitive biases were’ presented to learners, along with expertise in clinical reasoning. They were also encouraged to reflect, conceptualize, and explore iteratively with ‘clinical reasoning concepts’, techniques, and biases in thinking.

By use of a sequence of education and a CRE, every learner advanced through Kolb's initial learning phase in diagnostic clinical reasoning. Learners engaged with the material in smaller groups with instructors as well as both alone and together with their classmates. In their clinical reasoning, the majority of learners showed that they could build a ‘complete problem representation, incorporate semantic qualifiers, and recognize or identify cognitive biases’. According to the learners, the material was suitably included into the a first-year curriculum and could have been easily switched to a simulation as needed.

Using self-evaluations learners in Kolb's second experiential learning stage pondered on the CRE. When describing their diagnosing clinical thinking process, learners most commonly mentioned premature closure, availability bias, and anchoring bias. More frequently than other clinical reasoning techniques (such the meta-cognitive techniques of questioning "why?" or performing "worst-case scenario medicine"), students reported employing disease scripts and diagnostic frameworks. Students also thought that using online resources or lecture materials, as well as working with colleagues, were beneficial.

Students understood the diagnostic clinical reasoning process and could articulate tactics for refining their approaches to clinical reasoning in Kolb's third stage of experiential education. Furthermore, learners believed that this program improved how well they can synthesize medical knowledge, improved their capacity to make multiple diagnoses, increased their confidence in their competence to use clinical reasoning, and increased the understanding of their own biases in thinking.

In successive CREs, learners had the chance to test out novel tactics and behaviours in ‘Kolb's fourth stage of experiential education’. In their future interactions, students most commonly stated that they intended to "broaden their diagnostic thinking." Future research could examine the ways in which medical learners try to extend their ‘diagnostic thinking and conduct comparative studies of various methods or approaches that result in enhanced clinical reasoning’ ability.

As far as we are aware, our program is the first that offers ‘first-year medical students’ with a thorough explanation of how to incorporate cognitive bias awareness and clinical reasoning theories into their education. Two research investigations that targeted ‘first-year medical students were discovered during a systematic assessment of pre-clinical education programs that teach disease’ scripts [41]. Participants were required to compose illness scripts and reflect on them ‘for the diseases they were learning about in problem-based learning and lectures’, according to Hennrikus et al. [42].

A virtual clinic exercise designed to teach first-year medical students the sickness scripts of several viral infections was created by Jackson et al. [43]. The fundamental ideas of ‘clinical reasoning, cognitive biases, and methods for avoiding’ them were not, however, covered by either. We discovered that outstanding performance in key components of diagnostic clinical reasoning was achieved through the ‘explicit teaching of clinical reasoning theories and cognitive biases combined with experiential learning cycles including difficult written cases’: 82% discovered or stated cognitive biases, and 80% showed complete problem representations. The capacity to develop a succinct ‘problem representation’ (62%), which should be the focus of future research and interventions to enhance the diagnostic clinical reasoning of first-year medical learners, received the lowest score. There is little data to support the efficacy of educational initiatives that aim to increase students' understanding of cognitive biases and reasoning [44].

Debiasing-training programs, however, have been demonstrated in experimental investigations in the psychological sciences to improve decision making over the long term, even in graduate learners [45,46]. A series of steps lead to cognitive debiasing: precontemplation, awareness and the capacity to identify bias, decision to change, and implementation of tactics to carry out and sustain the transformation[47]. One element that could account for the challenges in reducing cognitive biases is ignorance. Educating medical learners about cognitive biases in their first year of school could have a number of benefits: it increases the amount of time they have to develop their attitudes, knowledge, and skills related to cognitive biases; it gives them time to concentrate on these ‘skills and perspectives before the competing demands and cognitive load of internships; it gives them the chance to see how relevant cognitive biases are in subsequent material and clinical encounters; and it’ gives them the chance to practice using an approach to learning that regularly involves reflection, conception

Additionally, our study revealed that students valued the chance ‘to integrate their medical knowledge and provide differential diagnoses’, which helped them feel more confident in their ability to use clinical reasoning. Students felt that by engaging in ‘clinical reasoning exercises and acknowledging their own cognitive biases, they were better able to deal with cognitive biases, develop their diagnostic clinical reasoning abilities, and prevent premature closure’. A crucial, ‘domain-specific phenomena that could account for part of the difference in medical students' perceptions of their readiness for professional activities during internships’ is self-efficacy [48]. In order to help medical students develop ‘self-efficacy in clinical reasoning and facilitate their transition to internships’, it may be beneficial to introduce clinical reasoning ideas during their first year of study.

Additionally, students realized—without being asked—how crucial interpersonal relationships and possible "group biases" are to their ability to acquire and use clinical reasoning skills. Learners were able to name group bias such as social isolation, polarization in groups, and groupthink. Although there have been very few empirical research on the subject, patient safety has paid considerable attention to 'these systematic biases in group decision-making'[41]. The function and impact 'of group biases in clinical reasoning and medical education' require more investigation.

Conclusion

As far as we are aware, this is a new study that outlines and assesses a clinical reasoning program that teaches first-year medical students about cognitive biases, script theory, and dual process theory. It has been shown that first-year medical students benefit greatly from the opportunity to acquire knowledge, skills, and self-efficacy related to clinical reasoning when clinical reasoning theory and cognitive biases are taught through an experiential learning methodology.

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