

COGNITIVE DIAGNOSTIC MODELING IN HEALTHCARE PROFESSIONS EDUCATION: A RAPID SCOPING REVIEW PROTOCOL

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ABSTRACT: Background: The rapid increase in the supply of health professions schools requires improvements in assessment methodologies/strategies to ensure the achievement of sufficient professional competence in health, health and well-being of the professional himself, and patient safety. It is necessary to determine which learners have or have not achieved sufficiency in a specific health profession. Objective: The main objective of this article is to present the protocol of a rapid scoping review to map the literature on the use of Cognitive Diagnostic Modeling (CDM) in assessment in health professions education. Methods: This rapid scoping review protocol is registered in the Open Science Framework (OSF) and followed the updated Joanna Brigg Institute (JBI) manual for scoping reviews, the Arksey and O'Malley framework, and adhered to the structured approach to the Reporting In healthcare education of Evidence Synthesis (STORIES) and Best Evidence Medical Education (BEME) guidelines. A systematic and comprehensive search of MEDLINE/PubMed, Embase, Scopus, Web of Science, ERIC, LILACS, MedEdPublish, and gray literature will be conducted without restrictions on date, language, and study design. This review will include studies on the assessment of undergraduate, postgraduate, and continuing education of physicians and other health

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professionals. Study selection and data extraction will be performed by two independent authors and synthesized using several strategies to ensure representation of the state of the art on the use of CMD in the assessment of health professional education. Results: This review should map the applications of CMD in health professional education, including for admissions, progress testing, assessment, and clinical reasoning. Conclusion: The findings of this rapid scoping review protocol will contribute to ensuring relevance, understanding, and identification of gaps in the use of CMD in the assessment of health professional education. In addition, they can help academic, administrative, and research staff in health education in the development of new studies on this topic.

KEYWORDS: Educational Measurement; Medical education; Professional Competence.

MODELAGEM DIAGNÓSTICA COGNITIVA NA EDUCAÇÃO DE PROFISSIONAIS DE SAÚDE: UM PROTOCOLO DE REVISÃO DE ESCOPO RÁPIDA

RESUMO: Introdução: O rápido aumento da oferta de escolas profissionais de saúde impõe melhorias nas metodologias/estratégias de avaliação para garantir a obtenção de suficiente competência profissional em saúde, saúde e bem-estar do próprio profissional e segurança do paciente. É preciso determinar qual educando atingiu ou não a suficiência em uma profissão de saúde específica. Objetivo: O objetivo principal deste artigo é apresentar o protocolo de uma revisão de escopo rápida para mapear a literatura sobre o uso da Modelagem de Diagnóstico Cognitivo (CDM) na avaliação na educação de profissões de saúde. Métodos: Este protocolo de revisão de escopo rápida está registrado no Open Science Framework (OSF) e seguiu o manual atualizado do Joanna Brigg Institute (JBI) para revisões de escopo, a estrutura de Arksey e O'Malley e aderiu à abordagem estruturada para as diretrizes Reporting In healthcare education of Evidence Synthesis (STORIES) e Best Evidence Medical Education (BEME). Uma busca sistemática e abrangente no MEDLINE/PubMed, Embase, Scopus, Web of Science, ERIC, LILACS, MedEdPublish e na literatura cinzenta será conduzida sem restrições de data, idioma e desenho de estudo. Esta revisão incluirá estudos sobre avaliação de graduação, pós-graduação e educação continuada de médicos e demais profissionais de saúde. A seleção de estudos e a extração de dados serão realizadas por dois autores independentes e sintetizadas em várias estratégias para garantir a representação do estado da arte sobre o uso de CMD na avaliação da educação profissional de saúde. Resultados: Esta revisão deve mapear as aplicações de CMD na educação profissional de saúde, incluindo para admissões, teste de progresso, avaliação e raciocínio clínico. Conclusão: As descobertas deste protocolo de revisão de escopo rápida contribuirão para garantir a relevância, a compreensão e a identificação de lacunas no uso de CDM na avaliação da educação profissional de saúde. Além disso, eles podem ajudar a equipe acadêmica, administrativa e de pesquisa na educação em saúde no desenvolvimento de novos estudos acerca dessa temática.

PALAVRAS-CHAVE: Medição educacional; Educação médica; Competência profissional.

MODELADO DIAGNÓSTICO COGNITIVO EN LA EDUCACIÓN DE PROFESIONES DE LA SALUD: UN PROTOCOLO DE REVISIÓN RÁPIDA DEL ALCANCE

RESUMEN: Antecedentes: El rápido aumento de la oferta de escuelas de profesiones de la salud requiere mejoras en las metodologías/estrategias de evaluación para asegurar la consecución de la competencia profesional suficiente en salud, salud y bienestar del propio profesional, y seguridad del paciente. Es necesario determinar qué aprendices han alcanzado o no la suficiencia en una profesión de la salud específica. Objetivo: El objetivo principal de este artículo es presentar el protocolo de una revisión rápida de alcance para mapear la literatura sobre el uso del Modelado Diagnóstico Cognitivo (CDM) en la evaluación en la educación de las profesiones de la salud. Métodos: Este protocolo de revisión rápida de alcance está registrado en el Open Science Framework (OSF) y siguió el manual actualizado del Joanna Brigg Institute (JBI) para revisiones de alcance, el marco Arksey y O'Malley, y se adhirió al enfoque estructurado de las pautas Reporting In healthcare education of Evidence Synthesis (STORIES) y Best Evidence Medical Education (BEME). Se realizará una búsqueda sistemática y exhaustiva en MEDLINE/PubMed, Embase, Scopus, Web of Science, ERIC, LILACS, MedEdPublish y literatura gris sin restricciones de fecha, idioma y diseño del estudio. Esta revisión incluirá estudios sobre la evaluación de la educación de pregrado, posgrado y continua de médicos y otros profesionales de la salud. La selección de estudios y la extracción de datos serán realizadas por dos autores independientes y sintetizados utilizando varias estrategias para asegurar la representación del estado del arte en el uso de CMD en la evaluación de la educación de los profesionales de la salud. Resultados: Esta revisión debe mapear las aplicaciones de CMD en la educación de los profesionales de la salud, incluyendo admisiones, pruebas de progreso, evaluación y razonamiento clínico. Conclusión: Los hallazgos de este protocolo de revisión rápida de alcance contribuirán a asegurar la relevancia, comprensión e identificación de brechas en el uso de CMD en la evaluación de la educación de los profesionales de la salud. Además, pueden ayudar al personal académico, administrativo y de investigación en educación para la salud en el desarrollo de nuevos estudios sobre este tema.

PALABRAS CLAVE: Medición Educativa; Educación médica; Competencia profesional.

1. INTRODUCTION

The growing supply of health professional schools and the pressing global problems and proposed solutions require governments, universities, and educators to strive for academic, professional, and social excellence (HARVARD UNIVERSITY, 2024). Educators must therefore improve assessment methodologies/strategies to ensure the achievement of sufficient competence of health professionals, the health and well-being of the professional themselves, patient safety, and the optimal use of the health system. It must be determined whether or not students have achieved sufficiency in attributes that go beyond memorization and mastery of material, including adaptive

problem solving, empathetic and compassionate professionalism, and ethics in a specific health profession (SCHAUBER; HECHT; NOUNS, 2018; SCHREURS *et al.*, 2020).

There has been increasing criticism against classical test theory, generalizability theory, and item response theory that has grown in recent decades, especially in their application to health professional education. Many authors have called for a paradigmatic shift in the psychometric measurement of health assessment. This change occurred mainly after the pandemic, when the entire education model had to be restructured and readapted for remote teaching, which demonstrated several weaknesses in the teaching models used (CAETANO *et al.*, 2023). Some authors have demonstrated how cognitive diagnostic modeling differs from older psychometric paradigms by classifying candidates according to their mastery or non-mastery of a large number of specified latent categorical attributes. They have also shown that the ultimate goal of cognitive diagnostic modeling is to classify candidates according to the presence or absence of attributes in a dichotomous model or the degree of presence of attributes in a polytomous model (MAUÉS *et al.*, 2023).

There has been no systematic review of the literature on the use of Cognitive Diagnostic Modeling (CDM) in assessment in health professions education. The heterogeneity of statistical measurement models applied in health education assessments makes such a review a difficult task, a fact already analyzed by research that sought to assess meaningful learning in the health area (COLLARES, 2022). This difficulty is compounded by the diverse ways in which health education assessment has been understood and implemented around the world.

2. RATIONALE

This review protocol is the first step in a scoping review process. It differs from systematic reviews in that it provides a more time-efficient alternative, which is essential for rapidly changing fields such as health education (TRICCO *et al.*, 2015; MARSHALL *et al.*, 2019; GARRITTY *et al.*, 2021). Furthermore, although rapid reviews in education are new, their importance in the field is growing (WOLLSCHIED; TRIPNEY, 2021).

Within the family of overview reviews—i.e., scoping reviews, mapping reviews, and evidence and gap maps— (CAMPBELL *et al.*, 2021) a rapid scoping review is most appropriate. This is because we have an experienced team who are fully aware of what the timelines (i.e., 2–4 weeks) will mean for the review findings. This choice was

motivated by the need to provide a timely and concise synthesis of this evolving field to meet the urgent demands of policymakers, health professionals, researchers, and the community at large. Given the dynamic nature of health professional education, a rapid scoping review ensures that our findings are quickly available for informed decision-making and user accessibility (MOYA *et al.*, 2023; VERAS *et al.*, 2024).

3. OBJECTIVE

The primary objective of this article is to present the protocol of a rapid scoping review to map the literature on the use of Cognitive Diagnostic Modeling (CDM) evaluating its current applications in health education, particularly in areas such as formative assessment, progress testing and its role in the development of clinical reasoning. This will allow us to evaluate the use of CDM in health education, including gaps and directions for future research.

4. METHODS

4.1 Design

A scoping review protocol is the first stage of the scoping review process and will follow JBI Scoping Review Methodology Group's best practice guidance and reporting items for the development of scoping review protocols (PETERS *et al.*, 2022). The reports will follow the STORIES statement (STRUCTURED approach to the Reporting In health-care education of Evidence Synthesis) (GORDON; GIBBS, 2014), BEME guidance (HAMMICK; DORNAN; STEINERT, 2010) and the PRISMA-ScR reporting standards (MARSHALL *et al.*, 2019), drawing on support from Peters *et al.* (2020, 2022) to offset the absence of specialized reporting standards for scoping reviews in health professions education.

4.2 Eligibility Criteria

The eligibility criteria will follow the Population, Concept, and Context framework for scoping reviews (PETERS *et al.*, 2022). To align with rapid scoping review purpose – to map, summarize and identify gaps of a range of evidence in order to convey the breadth and depth of a field (LEVA; O'BRIEN, 2010) –, we have defined

broad inclusion criteria (MUNN *et al.*, 2018) that can adequately inform readers and reviewers (PETERS *et al.*, 2020).

4.3 Population

The population must be clearly defined in scoping reviews (PETERS *et al.*, 2020). The population for this rapid scoping review are undergraduate, graduate, and continuing medical and healthcare education. The main qualifying criterion (LUNNY *et al.*, 2021; PETERS *et al.*, 2022) is that these healthcare professions stakeholders have to be involved in any assessments or tests of their development of knowledge, skills, and attitudes.

4.4 Concept

In a rapid scoping review, concepts are the key points to investigate (LUNNY *et al.*, 2021; PETERS *et al.*, 2022); in this study, we will explore the uses of Cognitive Diagnostic Modeling (CDM) on assessment in healthcare professions education including gaps and directions for future healthcare professions' research.

4.5 Context

The last element, context, is connected to the location and/or field of the concept and/or participants of the review (PETERS *et al.*, 2022). We will focus on CDM in the context of healthcare professions assessment. CDM, also known as Diagnostic classification models are a psychometric paradigm for designing and scoring tests with the goal of providing a profile of examinee skill mastery rather than just an overall test score, in order to support their further development – that is, with the goal of informing action. Cognitive diagnostic models allow the evaluation of test taker performance relative to a potentially large number of skill domains. Instead of assuming that we are measuring a single well-defined unidimensional factor, CDM instead tries to assign examinees into more qualitative groups by determining whether they are categorized along a number of axes. What this means is that the final “score” we hope to obtain on each examinee is not a single number, but a profile of which axes they have and which they do not. The axes could be a number of different psychoeducational constructs, but are often used to represent cognitive skills examinees have learned or developed. Because we are trying to diagnose strengths versus weaknesses, it is called a cognitive diagnostic model (VON DAVIE; LEE, 2019; WILLIAMSON. 2023).

CDMs can be applied in the development of new tests for diagnostic purposes, aiming to gather fine-grained information about the strengths and weaknesses of the test takers, in order to inform and to support action towards their further development. CDMs may also be used to extract diagnostic information from existing assessments (not necessarily designed to be cognitive diagnostic assessments at all), a process called “retrofitting”. Investigation of the structure of educational constructs can take place within both “true” CDM studies and retrofitting studies. Something that does not appear to have developed over recent years is widespread use of CDMs in assessment practice. To our knowledge, CDMs have far more been applied in methodological research than in actual diagnostic assessment. Further, despite the serious objections to retrofitting (described as the- measure-of-last-resort); see also Bradshaw *et al.* (2014), Rupp and Templin (2008) examples of retrofitting out numbered “true” CDM applications four to one.

Williamson (2023) notes that besides CDM assessments and retrofitting studies, cognitive diagnostic modeling can be integrated into a number of products or technologies in digital learning settings: 1. Cognitive diagnostic computerized adaptive testing; 2. Longitudinal models for learning, e.g., to track learning over a course; 3. Recommendation systems for adaptive learning.

4.6 Study Design

This rapid scoping review will include primary and reviews studies of qualitative, quantitative, mixed methods, theoretical and opinion approaches on assessment of undergraduate, graduate, and continuing medical and health professions’ education. This suit scoping reviews as they have a broad nature that allows sources’ diversity (HAMMICK; DORNAN; STEINERT, 2010).

4.7 Information Sources

A systematic and comprehensive search across MEDLINE/PubMed, Embase, Scopus, Web of Science, ERIC, LILACS, MedEdPublish and the grey literature will be conducted without date, language and study design restrictions. These databases were selected for their comprehensive and interdisciplinary coverage of healthcare professions education research, fitting well for capturing relevant CDM studies.

4.8 Search strategy

The research team included a librarian expert in reviews to perform preliminary searches, capture new keywords, and to develop customized search strategies for each database, as to optimize precision and appropriateness (KHANGURA, 2012; PETERS *et al.*, 2020). The search incorporated a range of essential keywords to cover two major groups of meanings: 1) Cognitive diagnostic modeling and its synonymous, and 2) healthcare professional education and some major health professions. The identified articles were imported to Rayyan, an online software for managing reviews.

Appendix A presents the research carried out and the number of studies retrieved from the databases.

5. STUDY SELECTION

The scoping review will include undergraduate, graduate, and continuing medical education, published in any language, date, and study design/type on the use of CMD in assessment of healthcare professional education. The study selection will have two stages. In the first stage, two reviewers will use Rayyan to first run a pilot study selection of 30 retrieved publications. They will review these publications' titles and abstracts independently and classify the studies as included, maybe or excluded, in accordance with the eligibility criteria. This step will ensure calibration on the use of the inclusion criteria and on its improvement (HARTLING, 2017). Once disagreements and screen selection are overcome, the same two research team members will screen all titles and abstracts independently (HARTLING, 2017; LUNNY *et al.*, 2021). If the two reviewers disagree, a third reviewer will resolve the discrepancy (LUNNY *et al.*, 2021; SRIHARAN *et al.*, 2020). Only the studies that meet or potentially meet the inclusion criteria will be considered for the next phase.

The second stage will include screening full texts using the inclusion and exclusion eligibility criteria. The same two reviewers will screen these texts independently.

Any conflict arising between the reviewers was resolved through discussion with a third reviewer until a final consensus decision was reached. The reviewers will document the rapid scoping review's search, screening, and retrieval processes with the PRISMA-ScR flow diagram (TRICCO *et al.*, 2015).

6. DATA EXTRACTION

Data extraction will be conducted by a single reviewer, with a second reviewer performing accuracy checks on a random sample of at least 10% of the extractions. The rapid scoping review will use a predefined extraction (Table 1), which may suffer changes during calibration stage. Full data extraction, using the agreed-upon table, will include two independent reviewers who will organize the information (TRICCO *et al.*, 2015; HARTLING, 2017) and the third reviewer will help resolve disagreements if necessary (LUNNY *et al.*, 2021).

Table 1: Proposed Data Extraction Table*

Component	Description
Citation	Source's citation data according to APA 7 guidelines
Country	Source's country (where it was implemented)
Geographical location	Source's specific city(ies) or town(s) and campus
Year of Publication	Source's specific publication year
Type of document	Source could be a (1) blog, (2) book, (3) book section, (4) conference paper, (5) conference proceedings, (6) journal article, (7) magazine article, (8) newspaper article, (9) thesis, and (10) webpage
Participants	Source could include: (1) faculty, (2) students, (3) teaching assistants, (4) academic support staff, and (5) educational developers
Purpose(s)	Source's purpose(s) as indicated by the author(s). This section could also include the research objectives, if included by the authors.
Research question(s)	Source's research question(s) as indicated by the author(s).
Intervention/Implementation (if applicable)	Source's intervention details.
Data collection	Source's information on how the data was collected. Other details concerning data collection, such as variables and instruments can also be included.
Results	Source's findings
Limitations(s)	Source's limitations, as communicated by the author(s)
Conclusion(s)	Source's conclusions, as outlined by the author(s)
Other data extraction elements	Source's information: to be added as the reading of full-text included studies advances.

* Adapted from Dobbins,²⁶ Khangura *et al.*,²³ Lunny *et al.*,¹⁸ and Tricco *et al.*⁶

7. DATA ANALYSIS

This rapid scoping review will follow the STORIES statement (Structured approach to the Reporting In health-care education of Evidence Synthesis) (GORDON; GIBBS; STORIES, 2014), BEME guidance (HAMMICK; DORNAN; STEINERT, 2010) and the PRISMA-ScR reporting standards (TRICCO *et al.*, 2015), drawing on support from Peters *et al.* (2020, 2022) to offset the absence of specialized reporting standards for scoping reviews in health professions education. The included studies will undergo a narrative synthesis and descriptive statistics approaches to categorize and summarize the extracted data. The research team will develop descriptive thematic summaries (LUNNY *et al.*, 2021; WOLLSCHIED; TRIPNEY, 2021). This time will also develop recommendations for future research in this area.

8. PRELIMINARY RESULTS

The initial literature search identified 781 publications that met the search criteria (Appendix A). These were exported to Rayyan. Two reviewers independently evaluated the titles and abstracts of the studies for relevance. After removing 315 duplicate articles, 466 articles were screened to assess whether they met the inclusion criteria. Of these, 450 articles were considered ineligible and excluded, leaving 16 articles for full-text screening.

9. FUTURE DIRECTIONS

These preliminary findings of this review protocol endorse the need to carry out the full rapid scoping review, especially because there must be more studies to be found in the gray literature. They also suggest that future directions for Cognitive Diagnostic Modelling in healthcare professions education include developing new algorithms and models, improving usability and accuracy, and extending applications to various assessment types and conditions.

By identifying gaps in the current use of CDM, this review will provide educators and policymakers with insights into how diagnostic models can be better integrated into health education, ultimately leading to more targeted interventions and improved student outcomes. It will also serve as a guide for the development of new studies on the use of this model.

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AUTHORS CONTRIBUTIONS

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