Metacognitive judgments in medical education

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Abstract

Metacognition contributes to medical education from different aspects: improve academic performance, contributes to decision making, facilitates the development of clinical skills, helps combat overconfidence and reduces diagnostic errors. This is why it becomes a necessary skill to develop in the training of the student medicine for which strategies such as metacognitive scaffolds are included, deliberate consideration of alternatives, and the reproduction of optimal actions. To understand these contributions for learning medicine, a bibliographic review article was developed, through a process that included searching databases through descriptors in Spanish and English, the selection of articles that will include the relationship of metacognition and the learning of medicine, to arrive at the construction of a text that would account for an understanding of the subject. The above allowed, not just delve into metacognition as a higher order skill in learning, but also guide a discussion that highlights a line of work called metacognitive judgments, which is characterized by focusing on the precision between performance claims on a task and actual performance.

Keywords: metacognition, learning, medicine, judgment (MESH)

Juicios metacognitivos en la educación médica

Resumen

En la educación médica, la metacognición inicide en diferentes aspectos: mejora el rendimiento académico, contribuye a la toma de decisiones, facilita el desarrollo de habilidades clínicas, permite combatir el exceso de confianza y disminuye errores diagnósticos. Por ello, se constituye en una habilidad necesaria en la formación del médico. En este sentido, el uso de estrategias que promuevan el desarrollo de juicios metacognitivos, es clave en los procesos de enseñanza y aprendizaje. Para profundizar en los aportes de los juicios metacognitivos en el campo de la educación médica, se construye el siguiente artículo producto de una revisión bibliográfica. En él se logra pasar de una dimensión macro de la metacognición (conocimiento o regulación), a una dimensión micro referida a los juicios metacognitivos, evidenciado cómo estos aportan al razonamiento clínico, a la toma de decisiones, a la disminución del error médico y a la seguridad del paciente. El artículo muestra una línea de trabajo denominada *juicios metacognitivos*, caracterizada por centrarse en la precisión entre las afirmaciones de desempeño en una tarea y el rendimiento real.

Introduction

Learning medicine involves the analysis of elements such as the acquisition, transfer and retention of knowledge (1–3). In the same way, the understanding of deeper elements such as the development of the individual capacity for self-organization and action. This, without a doubt, makes it easier for the student, in addition to making adjustments when addressing unknown situations and understanding their limits and biases (4), to recognize that everyday problems are more challenging and that therefore, they require effective actions and make pertinent decisions to fix them. Ultimately, it requires the activation of skills and personal resources essential in the analysis of a situation, the active reflection of the competences and the knowledge of how knowledge is built, also known as metacognition (4).

Metacognition is one of the higher order skills, defined as the knowledge of one's own thoughts and the different factors that can influence them (5). In the field of learning, it is recognized for its contributions in the awareness of the study process, the monitoring of the effectiveness in the development of the task and the adaptation to the demands of the activity (6). From the clinical field, it is a strategy that physicians can use to reflect on the thought process in the immediate context of the clinical decision (7). In other words, it contributes to the process of clinical reasoning and decision-making.

Now, in the field of medical education, metacognition

is incorporated through different ways, among them: monitoring in decision-making and reduction of retrospective biases (8); as a method to promote the storage, retrieval, transfer, and application of basic sciences (9); finally, as a strategy to improve decision-making that lead to success in the development of the task (10). At present, new lines of research and theories in the field of metacognition locate their conceptualizations and methodological proposals in the so-called metacognitive judgments, referring to estimates of successes and failures according to a task and a proposed objective (11). The reviewed literature shows that judgments can be classified as judgments of difficulty, learning judgments, confidence judgments, feelings of knowing judgments and performance judgments (11).

In this sense, this article aims, through a systematic review, to theoretically locate the advances in metacognition. The above with a special emphasis on the research line of metacognitive judgments applied to the learning of medicine. This through a process of consulting scientific articles located in different databases and an analysis of the contributions of the authors.

Methodology

It was used, for the search of the documents, as databases: Web of Science, Science Direct, Scopus and as search engines: Eric and Pubmed. The descriptors in English and Spanish, respectively, were the following: metacognition, learning, metacognition judgment, metacognition, learning, and medicine. The result of this process yielded a total of 532 articles of which, after applying the selection criteria: published in the last five years (2015 to date); exposing an explicit relationship between metacognition and learning medicine, 37 documents were chosen (Table 1).

Table 1. Research articles on metacognition

Database	Number of scientific articles identified	Number of selected scientific articles
Web of Science	38	12
Scopus	66	10
Science Direct	237	1
PubMed	114	7
Eric	77	7
Total	532	37

The process previously described allowed us to continue with the second action: an analysis and discussion of articles that addressed metacognition, metacognitive judgments, and learning medicine.

Discussion

Initially, the discussion describes the contributions of metacognition to the learning of medicine. Later, the metacognitive judgments will be deepened; Emerging line of research that works on the precision in the affirmations of successes and mistakes in relation to the performance of a task.

Metacognition

Metacognition is associated with better results in academic performance, cynical success, and lifelong learning (12–15). It is important to clarify that only in the study developed by Baothman et al (6), they show that metacognition and self-regulation do not correlate with better test results. This difference between authors depends, significantly, on the type of variables measured and the type of standardized tests that measure student performance during the development of a task.

The bibliographic search shows a trend in the development of research that seeks to correlate the different components of metacognition (metacognitive knowledge and metacognitive regulation) with performance on standardized tests. In this sense, the study by Khalil et al (13) correlate the inventory of learning strategies with academic success; study that demonstrates a relationship between self-regulation (time management, self-assessment and study aid) and student academic performance. Likewise, Lafleur et al (16) work on the correlation between metacognition and objective structured clinical examinations (OSCE); This study highlights the change in time management for the development of this type of evaluation.

With the different tests, relationships and analyzes, it is shown that metacognition contributes to clinical reasoning and decision-making (17). In a special way, it allows working on cognitive biases, defined as deviations from rationality, since metacognition facilitates critical self-reflection by separating the immediate context at the time the decision is made with the purpose of analyzing the thought process used (7,17,18).

Research in this field shows that medical students have significant difficulties in applying conceptual knowledge to clinical cases and that they lack metacognitive awareness (17). This implies an invitation to work on metacognition in the medicine classroom in order to ensure that students develop the ability to prepare prior

to the development of the task, adjust their behaviors according to performance during the task and carry out a self-reflection through the evaluation of their own results (15). From the previous authors, it can be seen that there is a need for an approach to metacognition in the training of the physician; in addition to assuming that this constitutes a skill that favors the learning of clinical reasoning, decision-making and the analysis of the best alternatives.

Metacognitive judgments

The bibliographic review reaffirms the emergence of new lines of research, including metacognitive judgments (MJ), assumed as those statements about the successes and mistakes in the development of a task. The MJ can occur according to the moment in which the development of an activity was evaluated (11). In this sense, we can find judgments of difficulty, learning, confidence and performance; all of them, possible to be evaluated before (prospective trials), during (concurrent trials) or after (retrospective trials) (11,21, 22) the development of the task.

It is important to note that, on the subject of calibration, absolute precision measures emerge, which is an exact match between the judgment issued and performance, the relative precision that shows correct or incorrect confidence judgments (20). On the other hand, there are measures such as: sensitivity and specificity (21). The first, understood as the ability to discriminate between correct and incorrect answers (22) and is calculated as the proportion of affirmative judgments when the item is answered correctly; with it, it is also possible to measure the feeling of knowledge, the precision of performance and the ease of processing (20). The second measure called specificity, indicates the proportion of negative judgments, when the item is answered correctly (21); Through this measure, the feeling of not knowing and the difficulty of processing can be calculated (20).

The previous elements allow the development of different investigations that show that metacognitive judgments are: a) predictors of better performance, reaffirming in turn, b) they depend on previous knowledge (the more prior knowledge one has of the task, the greater precision), c) contribute to problem solving (23). Likewise, the precision of metacognitive judgments in the first years of medicine is better in smaller tasks (24). Now, from the training of future professionals in the field of health, it is identified that they contribute to the decrease of excess confidence regarding the task, improve the diagnostic process and improve decision-making; all essential for patient safety (24,25); The student, when conducting a learning process analysis, identifies at the same time which signs and symptoms have been overlooked in the assessment process, as well as which other assessments are required to make a better decision. Relevant reasons that indicate the necessary incorporation of metacognitive judgments in the training of the doctor.

Trust judgments

Confidence judgments are defined as the estimate of a person who makes a decision about the possibility of being correct (26). They correspond to one of the metacognitive judgments that are measured before, during and after a task. According to the review carried out, it is one of the most highly evaluated judgments in medical students and even in the clinical field, perhaps, due to its relationship with the fact that overconfidence is one of the factors that could influence with greater weight than medical error in diagnosis occurs (27). The researchers reported a tendency to overestimate the real performance of the students. In this sense, Callender et al (28) and Fritzsche et al (29) identify that medical students who perform less well on the task are overconfident. Likewise, De Bruin et al (30) show that university students have an excess of confidence in the results of the exams; situation that leads to problems of self-regulation and academic performance.

The reported works show that the precision of metacognitive judgments and the reduction of excess confidence can be improved through training processes in metacognitive judgments (31); and, for this, metacognitive scaffolding may be one of the most relevant strategies in the field of teaching metacognition and incorporating judgments in the classroom.

When describing the metacognitive scaffolding (articulated to Vigotskian theory (35)), reference is made to the scaffold metaphor, in which temporary support is provided to the student in complex tasks, which would not have been successful in their execution, without the teacher's guide. In the field of medicine, it occurs in a particular way when the student begins to make decisions as a result of clinical reasoning. When applying this strategy, it must be taken into account that it is a sequential process that gradually increases complexity that goes from global skills to local skills (8).

Learning judgments and feelings of knowing

Finally, there are the learning judgments and the feeling-of-knowing judgments. In this case, two investigations were identified. First, the work of Avhusttiuk et al (32)

who address the judgment of feeling of knowing in university students; Their study shows three important aspects: first, that judgment occurs more frequently in prospective trials; second, that they depend on the type of task and third, that they occur in younger students with lower academic performance. On the other hand, it was possible to identify the study by Andreas et al (33), the authors, when evaluating the precision of the learning judgments, show that working on them in the classroom facilitates their precision.

With all that has been exposed so far, it can be said that, incorporating metacognitive judgments in the classroom, will surely allow the teacher to sustain the teaching processes more than in content, in higher-order thought processes, and the students, to go from learning superficial to deep learning.

Conclusions

After reviewing the previous articles, the following conclusions can be reached:

1. It is important to teach and learn the theoretical and methodological development of metacognition, based on the understanding of micro elements, that is, the incorporation of studies on how judgments of a different metacognitive nature contribute to the improvement of the precision of the performance of students in the face of a specific task by enriching clinical reasoning and decision making processes.

2. There is clarity that by incorporating in the clinical field the processes of assessment, clinical reasoning and decision-making in a more detailed way about a task, it leads to the reduction of biases and medical errors.

3. Confidence judgments, the most studied in medicine, show that there is often an excess of confidence that can lead to poor academic performance. Working on them, in the classroom, surely makes possible a more conscious and analytical learning, essential aspects in the appropriation of the knowledge and the processes that the professional in this field must carry out and necessary, in addition, to reduce the gap between the judgments made and actual performance.

It is recommended, then, that the teacher's programming aimed at the development of communicative interactions with their students be permeated with metacognitive scenarios, in which reflection on their own judgments and processes is an explicit, conscious and intentional activity, to promote the development of deep learning in students.

References

1. Zare S, Hemmatjo R, Allahyari T, Hajaghazadeh M, Hajivandi A, Aghabeigi M, et al. Comparison of the effect of typical firefighting activities, live fire drills and rescue operations at height on firefighters' physiological responses and cognitive function. Ergonomics. 2018;61(10):1334-44.

2. Arcoraci V, Squadrito F, Altavilla D, Bitto A, Minutoli L, Penna O, et al. Medical simulation in pharmacology learning and retention: A comparison study with traditional teaching in undergraduate medical students. Pharmacol Res Perspect [Internet]2019 [cited Jun, 2019];7(1). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6327107/

3. Alluri RK, Tsing P, Lee E, Napolitano J. A randomized controlled trial of high-fidelity simulation versus lecture-based education in preclinical medical students. Med Teach. 2016;38(4):404-9.

4. Hasske E, Beil M, Keller K. Competency-based Education and Training of medical staff. A Programm of the Medical Academy Waldbreitbach: Concept – Implementation – Materials. GMS J Med Educ [Internet]2017 [cited Apr 27,2020];34(4). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5654121/

5. Poorman SG, Mastorovich ML. Using Metacognitive Wrappers to Help Students Enhance Their Prioritization and Test-Taking Skills. Nurse Educ. 2016;41(6):282-5.

6. Baothman A, AlJefri H, Agha S, Khan MA. Study Habits of Health Science Students at King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia. SAGE Open. 2018;8(2):2158244018778092.

7. Chew KS, Durning SJ, van Merriënboer JJ. Teaching metacognition in clinical decision-making using a novel mnemonic checklist: an exploratory study. Singapore. Med J. 2016;57(12):694-700.

8. Medina MS, Castleberry AN, Persky AM. Strategies for Improving Learner Metacognition in Health

Professional Education. Am J Pharm Educ [Internet]. mayo de 2017 [cited Aug 18, 2019];81(4). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5468716/

9. Hennrikus EF, Skolka MP, Hennrikus N. Applying Metacognition Through Patient Encounters and Illness Scripts to Create a Conceptual Framework for Basic Science Integration, Storage, and Retrieval. J Med Educ Curric Dev [Internet] 2018 [cited Dec16,2020];5. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5967154/

10. Ali S, Yasmeen R. Practice to preach self-regulation: Use of metacognitive strategies by medical teachers in their learning practices. Pak J Med Sci. 2019;35(6):1642-6.

11. Valenzuela A. ¿Qué hay de nuevo en la metacognición? Revisión del concepto, sus componentes y términos afines. Educ Pesqui Sao Paulo. 2019;15(187571).

12. Hong WH, Vadivelu J, Daniel EGS, Sim JH. Thinking about thinking: changes in first-year medical students' metacognition and its relation to performance. Med Educ Online [Internet]2015 [cited Dec 14,2020];20. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4551498/

13. Khalil MK, Williams SE, Gregory Hawkins H. Learning and study strategies correlate with medical students' performance in anatomical sciences. Anat Sci Educ. 2018;11(3):236-42.

14. Cho KK, Marjadi B, Langendyk V, Hu W. Medical student changes in self-regulated learning during the transition to the clinical environment. BMC Med Educ. 2017;17(1):59.

15. Siqueira MAM, Gonçalves JP, Mendonça VS, Kobayasi R, Arantes-Costa FM, Tempski PZ, et al. Relationship between metacognitive awareness and motivation to learn in medical students. BMC Med Educ [Internet] 2020 [cited Dec 15,2020];20. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7602298/

16. Lafleur A, Laflamme J, Leppink J, Côté L. Task Demands in OSCEs Influence Learning Strategies. Teach Learn Med. 2017;29(3):286-95.

17. Kiesewetter J, Ebersbach R, Tsalas N, Holzer M, Schmidmaier R, Fischer MR. Knowledge is not enough to solve the problems - The role of diagnostic knowledge in clinical reasoning activities. BMC Med Educ. 2016;16(1):303.

18. Chew KS, van Merrienboer JJG, Durning SJ. Perception of the usability and implementation of a metacognitive mnemonic to check cognitive errors in clinical setting. BMC Med Educ [Internet] 2019 [cited Feb 10,2019];19. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6327396/

19. Craig K, Hale D, Grainger C, Stewart ME. Evaluating metacognitive self-reports: systematic reviews of the value of self-report in metacognitive research. Metacognition Learn. 2020;15(2):155-213.

20. Gutiérrez AP, Schraw G, Kuch F, Richmond AS. A two-process model of metacognitive monitoring: Evidence for general accuracy and error factors. Learn Instr. 2016;44:1-10.

21. Händel M, de Bruin ABH, Dresel M. Individual differences in local and global metacognitive judgments. Metacognition Learn. 2020.

22. Mazancieux A, Dinze C, Souchay C, Moulin CJA. Metacognitive domain specificity in feeling-of-knowing but not retrospective confidence. Neurosci Conscious [Internet]. 24 de febrero de 2020 [cited Dec 14, 2020];2020(1). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7043299/

23. Mihalca L, Mengelkamp C, Schnotz W. Accuracy of metacognitive judgments as a moderator of learner control effectiveness in problem-solving tasks. Metacognition Learn. 1 2017;12(3):357-79.

24. Cleary TJ, Konopasky A, La Rochelle JS, Neubauer BE, Durning SJ, Artino AR. First-year medical students' calibration bias and accuracy across clinical reasoning activities. Adv Health Sci Educ. 2019;24(4):767-81.

25. Garcia-Retamero R, Cokely E, Hoffrage U. Visual Aids Improve Diagnostic Inferences and Metacognitive Judgment Calibration. Front Psychol. 2015;6:932.

26. Lebreton M, Bacily K, Palminteri S, Engelmann

JB. Contextual influence on confidence judgments in human reinforcement learning. PLoS Comput Biol [Internet]. 8 de abril de 2019 [cited Dec15, 2020];15(4). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6472836/

27. Braun LT, Zwaan L, Kiesewetter J, Fischer MR, Schmidmaier R. Diagnostic errors by medical students: results of a prospective qualitative study. BMC Med Educ [Internet] 2017 [cited Feb 13, 2019];17. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5679151/

28. Callender AA, Franco-Watkins AM, Roberts AS. Improving metacognition in the classroom through instruction, training, and feedback. Metacognition Learn. 2016;11(2):215-35.

29. Fritzsche ES, Händel M, Kröner S. What do second-order judgments tell us about low-performing students' metacognitive awareness? Metacognition Learn. 2018;13(2):159-77.

30. de Bruin ABH, Kok EM, Lobbestael J, de Grip A. The impact of an online tool for monitoring and regulating learning at university: overconfidence, learning strategy, and personality. Metacognition Learn. 2017;12(1):21-43.

31. Melgar MF, Elisondo R, Melgar MF, Elisondo R. Metacognición y buenas prácticas en la universidad. ¿Qué aspectos valoran los estudiantes? Innov Educ México DF. 2017;17(74):17-38.

32. Avhustiuk MM, Pasichnyk ID, Kalamazh RV. The Illusion of Knowing in Metacognitive Monitoring: Effects of the Type of Information and of Personal, Cognitive, Metacognitive, and Individual Psychological Characteristics. Eur J Psychol.2018;14(2):317-41.

33. Andreas J, Veit K, Fredik J. What moderates the accuracy of ease of learning judgments? Metacognition Learn. 2017; 12 (3) 1 - 19