



# Colombian Journal of Anesthesiology

*Revista Colombiana de Anestesiología*

www.revcolanest.com.co

OPEN

Wolters Kluwer

ESSAY

## Relationship among mental models, theories of change, and metacognition: structured clinical simulation

### *Relación entre modelos mentales, teorías del cambio y metacognición: Simulación clínica estructurada*

Diego Andrés Díaz-Guio<sup>a,b</sup>, Francisco Javier Ruiz-Ortega<sup>b</sup>

<sup>a</sup> Centro de Simulación Clínica Vital Care, Armenia, Colombia

<sup>b</sup> Universidad de Caldas, Manizales, Colombia.

**Keywords:** Simulation Training, Models, Psychological, Metacognition, Models, Educational, Formative Feedback

**Palabras clave:** Entrenamiento Simulado, Modelos Psicológicos, Metacognición, Modelos Educativos, Retroalimentación Formativa

#### Abstract

Learning is a change in the way of thinking that lasts over time and allows for solving problems; on the other hand, education based on structured clinical simulation is a pedagogic mediation between the classroom and clinical practice, which allows experience, reflection, monitoring, control, and restructuring of thought, which can contribute to deep and lasting learning. It is desirable that students, both undergraduate and graduate, are given the opportunity to be trained under structured simulation.

#### Resumen

El aprendizaje es el cambio en el pensamiento que perdura en el tiempo y permite la solución de problemas; por su parte, la educación basada en simulación clínica estructurada es una mediación pedagógica entre el aula de clase y la práctica clínica, que permite experiencia, reflexión, monitoreo, control y reestructuración del pensamiento, lo que puede aportar en aprendizajes profundos y duraderos. Es deseable que los estudiantes, tanto en pregrado como en posgrado, tengan la oportunidad de ser formados con simulación estructurada.

#### Introduction

Research in education aims to find the best ways for the teacher to teach and the student to learn. The teacher must know the scientific concepts of his or her disciplinary field in depth, and understand how the student learns, as well as integrate metacognitive developments, multiple languages, the evolutionary perspective of learning, affectivity, emotions, and reflection as fundamental elements in his or her teaching-learning processes<sup>1</sup>.

In this reflection, which is based on doctoral experience and training in educational sciences, we intend to expose the relationship generated during clinical simulation between 3 highly relevant theoretical constructs: multidimensional mental models (MMs), theories of change, and metacognitive processes. This is because we consider that the training of the health sciences teacher who makes use of clinical simulation, improves by including the conceptual review of educational theories, which provide an epistemic support to this mediation between the classroom and clinical practice.

How to cite this article: Díaz-Guio DA, Ruiz-Ortega FJ. Relationship among mental models, theories of change, and metacognition: structured clinical simulation. Colombian Journal of Anesthesiology. 2019;47:113-116.

Read the Spanish version of this article at: <http://links.lww.com/RCA/A860>.

Copyright © 2019 Sociedad Colombiana de Anestesiología y Reanimación (S.C.A.R.E.). Published by Wolters Kluwer. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Correspondence: Centro de Simulación Clínica Vital Care, Calle 16N No. 14-50, Armenia, Colombia. E-mail: [andres.diaz@vitalcare.co](mailto:andres.diaz@vitalcare.co)

Colombian Journal of Anesthesiology (2019) 47:2

<http://dx.doi.org/10.1097/CJ9.0000000000000107>

## Teaching and learning

In relation to teaching, Shulman<sup>1</sup> ratifies at least 7 knowledge items necessary for a teacher: pedagogical, curricular, disciplinary, didactic knowledge of the content, of how students learn, of the educational system, and of the purposes of education itself. This means that the teacher, in addition to the knowledge of his profession, must know pedagogy, general, and specific didactics, and therefore, it would not be justifiable for a professional to teach without having previous training for it. Teaching based on simulation follows the same logic, and yet, teacher training in this area is heterogeneous.<sup>2,3</sup>

Learning is a concept that has changed according to the prevailing paradigm: in *behaviorism* it was assumed as the permanent change in behaviors; *cognitivism* considered it an enduring change in the mental scheme, which leads to a change in behavior; and *constructivism* assumed that the student should be the architect of his or her learning and that these are constructed through social interaction. Knowledge is not susceptible of being transmitted from one mind to another in a passive manner, but must be constructed in a social manner. These theories have been adapted and adopted by the health sciences.<sup>4</sup>

Accordingly, improving teaching and learning processes requires incorporating at least 3 components: the MMs of subjects with an evolutionary perspective of learning, metacognition as an objective of intentional and conscious teaching and learning,<sup>5,6</sup> and the use of strategies based on experiential learning. We shall refer to these elements in the following paragraphs.

## Multidimensional mental models

Our brain makes representations of the world, as scale models, to understand it, explain it and predict it. In the theory of representations, 3 levels are described: *images*, *propositions*, and *mental models*.<sup>7</sup> MMs are internal representations of external realities, and they are complex, dynamic, and modifiable cognitive constructs. In their structure, at least 4 dimensions are recognized: ontological, epistemological, motivational, and cognitive-linguistic.<sup>5,6</sup> The ontological dimension refers to the vital and developmental process of the individual; the epistemological dimension refers to scientific knowledge, the knowledge built, which can be declared and demonstrated; the cognitive-linguistic dimension represents the use of language, the way of expressing, learning, thinking, arguing, and interacting with others; and the motivational dimension refers to the intention to do; to the underlying force that can lead to carrying out a task (Fig. 1).

In didactics, MMs have been used to explain them, make them aware, work on them, and restructure them.<sup>8</sup> Recently, a concept that has been under scrutiny for decades has gained strength: *interdisciplinary education*<sup>9</sup> as a felt need. This perspective allows the formation of high-

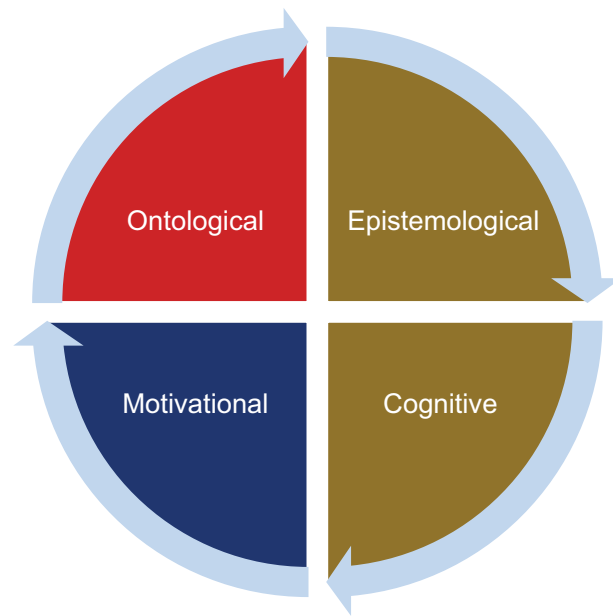


Figure 1. Dimensions of an MM. MM=mental model. Source: Authors, from Tamayo<sup>5</sup> and Vosniadou.<sup>6</sup>

performance multidisciplinary teams, which may come to share their MM<sup>10</sup>; being aware of these MM and reconfiguring them through their inspection can enhance team learning, efficiency, and safety for patients.

## Theory of change and learning

Learning implies a change from an initial model to a new MM; it requires intention, action, reflection, and maintenance. At this point, the *theory of defrosting*, which has been used in simulation, despite being rational and task-oriented, does not consider feelings and experiences. A more accepted theoretical model is the *spiral theory*<sup>11</sup> which consists of 5 levels: precontemplation, contemplation, preparation, action, and maintenance. Change requires time, and this time is variable, dependent on the individual and his motivation.

Instead, the *theory of conceptual change*<sup>6</sup> states that knowledge is generated in specific domains, it starts with naïve theories and becomes more complex as thought evolves until it is plausible from the perspective of scientific knowledge. This change is usually slow and gradual, except if the individual is able to intentionally direct his or her learning, that is, can use metacognitive strategies.

## Metacognition

Thinking about thought includes 3 domains: *metacognitive knowledge*, *metacognitive strategies*, and *metacognitive experience*.<sup>12</sup> We will deal with strategies (*knowing how*), which include: planning, which refers to thinking about the steps to resolve a situation, and monitoring and control,

referring to reflection, within the process, on how the strategy is working, to proceed to regulate it and, if necessary, to reformulate it.<sup>13</sup> The metacognitive activity is fundamental in the processes of change and restructuring of the MM. Incorporating it in an intentional way allows the student to know the objective of the tasks proposed by the teacher, to be aware of his own difficulties, and to evaluate the efficiency of his actions, thus improving his learning.

### Education based on clinical simulation

Simulation is defined as the use of special devices in specific places, by people trained in special techniques, in order to imitate real contexts and thus, allow learning.<sup>14</sup>

Education based on clinical simulation attempts to represent reality without placing the patient at risk; it is continuously being developed, working on the constructs of learning theories, didactics, cognitive psychology, industrial engineering, technologies, human resources,<sup>15</sup> and patient safety.<sup>16</sup> An integral way of doing it, in our view, is *structured clinical simulation* as an emerging concept (Fig. 2), a construct that includes clear learning objectives, representations that are congruent with reality, structured reflection (*debriefing*), and evaluation.

We recommend that learning objectives include disciplinary skills, non-technical skills (asking for help, leadership, role-taking, closed-loop communication, resource mobilization, situational awareness, etc.).<sup>17</sup> and metacognitive strategies. These objectives should be shared with the students before starting the simulation

exercise, when the teacher provides guidance on what will be done during the session, in order to establish an atmosphere of trust and psychological assurance.<sup>18</sup>

There must be verisimilitude in the scenario that is simulated with respect to the facts of real life where the subjects unfold physically, conceptually, and psychologically.<sup>19</sup> In *debriefing*, the student should be allowed to express the emotions generated during the simulation, and it is recommended to reconstruct the situation from the perspective of those who experienced it, and identify the MM's, so that the teacher can *diagnose* and propose a possible treatment for what was found. Here, critical insight on what students think is fundamental. It is important to understand that the change in the MM will not be immediate, and that the student should be motivated in the areas of theory of change and metacognitive strategies.

It is desirable for a team to achieve high levels of development, and therefore, to be trained in the use of summative assessment (declarative knowledge), task accomplishment, application of scales validated for Non-Technical skills (NTS) (procedural knowledge) and application of formative evaluation, which is possible through a good *debriefing*.<sup>20</sup>

### Conclusion

Actions follow complex cognitive constructs called MMs, which have several underlying dimensions and can be consciously identified during *debriefing* by the teacher and the student.

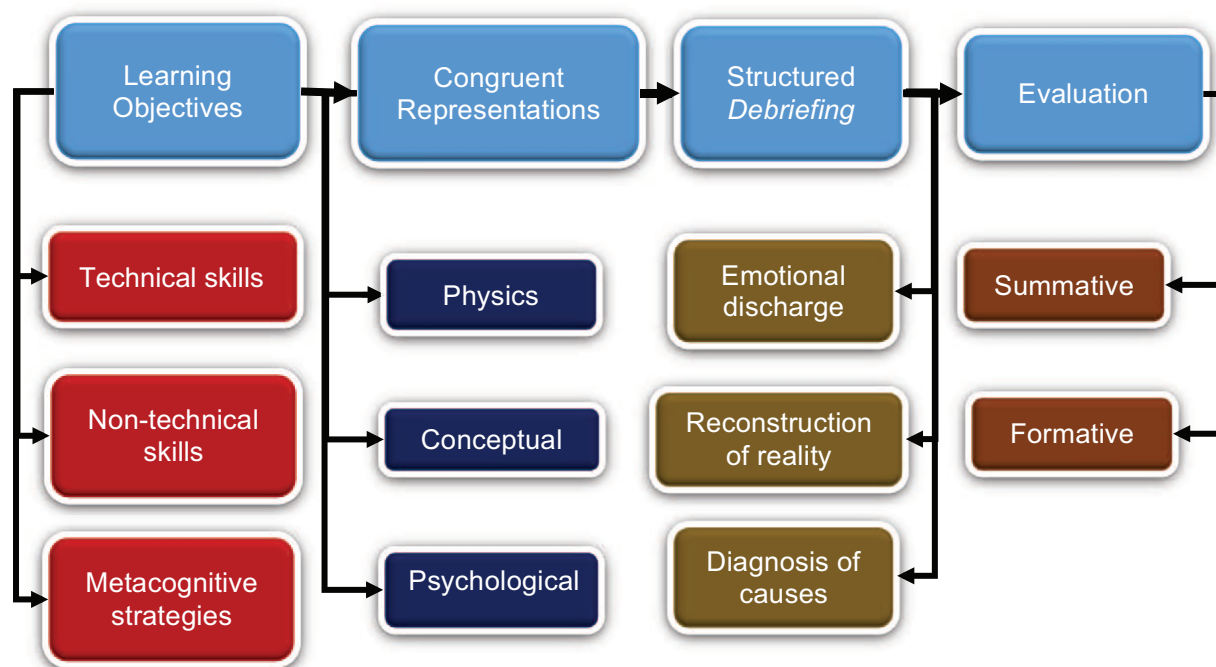


Figure 2. Structured clinical simulation.  
Source: Authors.

Deep learning implies a change of the MM; in this sense, structured clinical simulation generates highly realistic experiences, allows metacognitive activity during practice and *debriefing*, as it is a space for conscious reflection on what is felt, known and done, and where possible change scenarios are proposed when restructuring the MM of the individual and the team, something that would contribute to better future performances.

### Financing

The authors declare that they have not received funding for the production of this manuscript.

### Conflict of interest

The authors declare that they have no conflict of interest.

### References

- Shulman L. Knowledge and teaching: foundations of the new reform. *Harv Educ Rev* 1987;57:1–23.
- Opazo Morales EI, Rojo E, Maestre JM. Training instructors in clinical simulation models: The role of a fellowship program. *Educ Medica* 2017;18:22–29.
- Ahmed R, Frey J, Hughes PG, et al. Simulation fellowship programs in graduate medical education. *Acad Med* 2017;92:1214.
- Torre DM, Daley BJ, Sebastian JL, et al. Overview of current learning theories for medical educators. *Am J Med* 2006;119:903–907.
- Tamayo O. Evolución Conceptual desde una Perspectiva Multidimensional. Aplicación al concepto de respiración Barcelona: Universidad Autónoma de Barcelona; 2001.
- Vosniadou S. Capturing and modeling the process of conceptual change. *Learn Instr* 1994;4:45–69.
- Johnson-Laird P. *Mental models*. Cambridge: Harvard University Press; 1983.
- Rudolph JW, Simon R, Raemer DB, et al. Debriefing as formative assessment: closing performance gaps in medical education. *Acad Emerg Med* 2008;15:1010–1016.
- Dow A, Thibault G. Interprofessional education—a foundation for a new approach to health care. *N Engl J Med* 2017;377:803–804.
- Gardner AK, Scott DJ, AbdelFattah KR. Do great teams think alike? An examination of team mental models and their impact on team performance. *Surgery* 2017;161:1203–1208.
- Prochaska JO, Di Clemente CC. Transtheoretical therapy: toward a more integrative model of change. *Psychotherapy* 1982;19:276–288.
- Flavell JH. Metacognition and cognitive monitoring: a new area of cognitive-developmental inquiry. *Am Psychol* 1979;34:906–911.
- Brown A, Weinert F, Kluwe R. Metacognition, executive control, self-regulation and other mysterious mechanisms. Metacognition, motivation and understanding Hillsdale, NJ: Erlbaum; 1987;65–116.
- Issenberg SB, McGaghie WC, Petrusa ER, et al. BEME: features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. *Med Teach* 2005;27:10–28.
- Flin R, O'Connor P, Crichton M. *Safety at the sharp end: a guide to non-technical skills*. Aldershot: Ashgate Publishing; 2008.
- Díaz Guio DA, Del Moral I, Maestre JM. Do we want intensivists to be competent or excellent? Clinical simulation-based mastery learning. *Acta Colomb Cuid Intensivo* 2015;15:187–195.
- Petrosoniak A, Hicks CM. Beyond crisis resource management: new frontiers in human factors training for acute care medicine. *Curr Opin Anaesthesiol* 2013;26:699–706.
- Kolbe M, Grande B, Spahn DR. Briefing and debriefing during simulation-based training and beyond: content, structure, attitude and setting. *Best Pract Res Clin Anaesthesiol* 2015;29:87–96.
- Dieckmann P, Gaba D, Rall M. Deepening the theoretical foundations of patient simulation as social practice. *Simul Healthc* 2007;2:183–193.
- Cheng A, Grant V, Huffman J, et al. Coaching the debriefer. *Simul Healthc* 2017;12:319–325.