

Keynote Paper: **The Role of e-Learning for the Future Health Care: A Reflection**

Dr. Fernando Fernández-González

QmB Innovation Manager

Former Head - Clinical Neurophysiology, Hospital Central de Asturias, SPAIN

fgfernando@msn.com

Dr. Palmira López-Fresno

Senior Expert in International Cooperation for Development - European Union, United Nations

correo@palmiralopezfresno.com

ABSTRACT

Fifteen years ago, during the 15th ICIT in Montreal, Canada, we presented our experience on a new organization of the functional structure of hospital disciplines. We titled our contribution "From a Vertical hospital to a Horizontal one". Perhaps, the hospital and the health care of the future is no longer a hospital, and Medicine will return to be a familiar and domiciliary one, but highly technified. It is very possible that we will be able to read the data about patient's process in our own hand, when we visit him or her at the hospital "capsule" at his or her own home. But this change of paradigm requires tools that allow "learning to learn", to learn how to manage this new type of health care. A technological aid process where declarative (explicit) knowledge is strengthened with non-declarative (implicit) processes. Therefore, a type of learning that strengthens critical thinking, so that professional knowledge is strengthened with good bedside manners. This is a reflexive paper on e-Learning and the Health Care of the future.

Keywords: Critical learning; critical thinking; e-learning; explicit knowledge, health care; meta-cognition; meta-thinking.

1. Scientific knowledge and good bedside manners

Those of us who have consumed part of our lives dedicated to health care, old doctors like me, have a bedside manner that is usually humanistic and based on a conscious empathy, a respectful assertiveness and a responsible criterion of vulnerability. But we have experienced a great technological revolution since the mid-fifties of the last century, in such a way that medical practice has come to depend on the criteria of the profit industry, from anticonceptive pills to new biotechnology genetic therapies, from radiology to magnetic resonance imaging, etcetera. In this same sense, we used to search and consult scientific papers published using the so-called Index Medicus. It consisted of a voluminous updatable book, bigger than DIN A4 format, where the published scientific articles were included every six months or once a year. Today, we generally use the MEDLINE biology and medicine database, accessible in real time, and we also receive alerts periodically on specific topics previously selected. Continuing medical education has been an essential vector in medical practice, and it is even more so in the current times. In medicine, knowledge is fully changed every 5 years. For this reason, at the beginning of this 21st century, a greater awareness towards the unavoidable and ineluctable teaching and ethical learning is taking place.

The old doctors, like me, found that young medical doctors spend little time talking with patients and family members. But also, these young doctors do not undress, inspect, feel, percuss, auscultate, touch sweaty or dry, serous or scaly skin. They do not look at the appearance of feces or urine, the presence or not of sediments, the colour from the eyes, the fragility of the nails, or the shape of the fingers. They have lost propaedeutic practice, and mostly base their decisions on new technologies. They avoid establishing the essential previous hypothesis and the application of later scientific thinking. They depend on technology, in such a way that without it they remain blocked, or they are hesitant when they have to discern the ambiguity before a false negative or positive result. For these reasons, my intervention today will be a reflexion on e-learning and future of medical practice, and I will try to deal with a perspective about thinking, observing, learning, knowing and acting.

The exercise of medicine, and the accumulated experience based on the narrative of patients, teach us that medical practice requires both scientific knowledge and good bedside manners, given that knowledge

alone is not enough to practice the good and proper medicine each individual patient requires. Doctors need both knowledge and good manners to practice a good and appropriate medicine. I believe that good bedside manners are the essence of the art of medicine.

The consummate physician has a bedside manner that is humane and compassionate, empathetic, and supportive. Patients want time, conversation and physical contact with doctors. For this medical time to be efficient, doctors must consider patients' vulnerability in a responsible way, and must also exercise a respectful assertiveness and manage empathy in a conscious way (Timimi, 2012).

2. The eight senses and long-term memory

To learn these three behavioural vectors, a holistic approach is required. That is, there is critical thinking, and in turn critical learning. And the basis of learning lies in the active process of long-term memory.

When we ask people in the street how many senses we have, in the Western world they will say five. If we ask a doctor, like me, he or she will tell you that there are eight senses, extending to a ninth, and that these senses incorporate sensations and interact with each other at all times, in every millisecond of our life. These eight senses are: Gustatory system, Olfactory system, Auditory system, Visual system, Tactile system, Vestibular system, Interoceptive system, Proprioceptive system. These eight senses collect information constantly, process it and generate pieces of memory. But there is also a ninth sense: the brain cartographic GPS. Each piece of sensory memory is temporally stored with its longitude and latitude and forms a true space-time cartography for our long-term memory.

The winners of the 2014 Nobel Prize, Professor O'Keefe and the marriage of teachers May and Edward Moser discovered that there is an internal GPS in our brain, which makes up a cartography for our mental frames:

- The Place cells are located at the Hippocampus. These cells are activated when a person is located at a specific spatial point.
- The Hexagonal Grid cells are located at Entorhinal cortex. Six of these cells are arranged as a hexagon and activated when a person is located at a specific space-time point.

This cerebral cartography along with the set of pieces of sensory memory, make up a mental frame. Our mind is made up of millions of mental frames. At every moment, we are comparing our recent experience with stored mental frames. Frames are mental structures, shaped from our childhood, that give way to how we see the world, but with GPS and cartographic references. A kind of Google earth with videos located in time and space. But instead of images or videos, it is about mental frames. As a result, they set the background of the objectives we seek, the plans we make, the way we act and what counts as a good or bad result of our actions.

Constantly around us, simple or complex stimuli are happening. These stimuli impact with greater or lesser intensity and duration on our senses (Figure 1). This impact, within a certain context and location, make up a set of information that remains for a few milliseconds, but not more than 1 second. This type of temporary memory is called sensory memory. This sensory memory is interpreted as a perception of the "contextual stimulus". That is, a perception in a specific context. When attention is paid explicitly or implicitly to this sensory memory. The so-called short-term memory, or working memory, is generated. This working memory usually lasts for 10 to 15 seconds. The working memory is either lost or, on the contrary, consolidated by means of repetition or remembrance. This type of working memory can be considered significant or not significant, but it can be stored and consolidated in an implicit way. So, it is not necessary that it always be stored explicitly or voluntarily. Naturally, the capacity of the working memory is slightly variable, so there are people with greater or lesser capacity. A recent study (Amici et al., 2018) has shown that the word order of languages predicts native speakers' working memory. Thus, the native speakers' Japanese or Chinese have a better working memory than the Anglo-Saxon speakers.

When the short-memory is consolidated, long-term memory is generated within a specific context. This type of long-term memory can last hours, days, months or years, in the form of mental frames. In such a way that a word, sound, event, or circumstance, evokes a frame, or set of frames in the mode of a thought. There are two major types of long-term memory: declarative or explicit (we can explain what we remember) and not declarative or implicit (we cannot explain how to do something or understand it). The

first is composed of subcomponents that can be considered episodic and semantic, although both tend to be overlapping. The long-term non-declarative memory is composed of subcomponents such as procedural, emotional conditioning, priming effect and conditioned effect. So, mental frames are made up of both types of long-term memory, with a greater preponderance of one or the other according to the context and the needs of its remembrance and use, either for an execution or to conform an idea or a discursive thought.

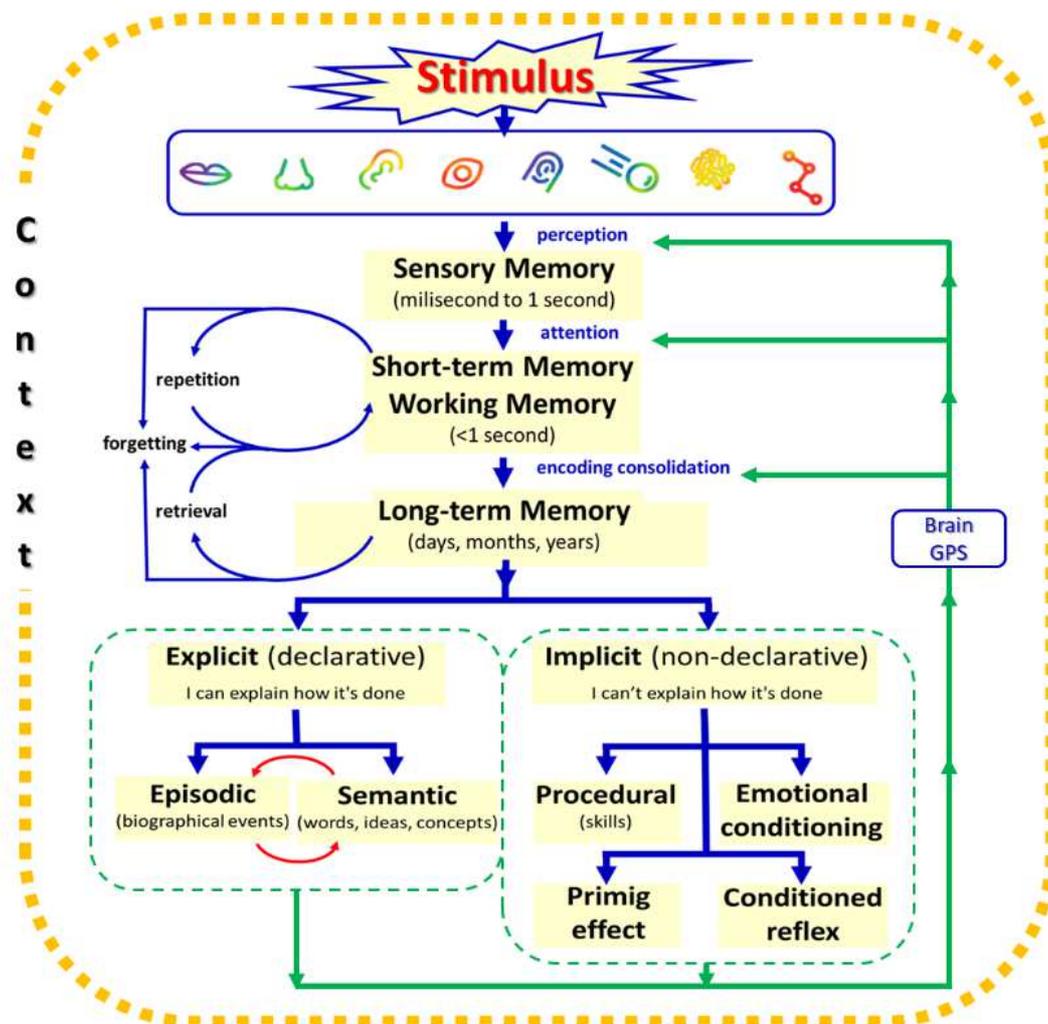


Figure-1. Basis of learning

NOTES on Figure-1:

- **Procedural memory.** It is a type of implicit memory (unconscious memory) and long-term memory which aids the performance of particular types of tasks without conscious awareness of previous experiences.
- **Priming.** It is a technique whereby exposure to one stimulus influences a response to a subsequent stimulus, without conscious guidance or intention. For example, the word NURSE is recognized more quickly following the word DOCTOR than following the word BREAD. Priming can be perceptual, semantic, or conceptual.
- **Conditioned reflex or classical conditioning.** It refers to a learning procedure in which a biologically potent stimulus (e.g. food) is paired with a previously neutral stimulus (e.g. a bell). It also refers to the learning process that results from this pairing, through which the neutral stimulus comes to elicit a response (e.g. salivation) that is usually similar to the one elicited by the potent stimulus.
- **Emotional conditioning:** It is an "emotional response" that results from classical conditioning, usually from the association of a relatively neutral stimulus with a painful or fear-inducing unconditional stimulus. As a result, the formerly neutral stimulus elicits fear. For example, if seeing a dog (a neutral stimulus) is paired with the pain of being bitten by the dog (unconditioned stimulus), seeing a dog may become a conditioned stimulus that elicits fear (conditioned response).

3. “By learning you will teach; by teaching you will learn” (Latin proverb)

Learning is a complex process of continuous reengineering of the explicit and implicit components of the memory, that make up the spatio-temporal mental frames. Changing our mental frames is changing the objectives we seek, the plans we make, the way we act and what counts as a good or bad result of our actions. Any word, sound, image, gesture, posture, smell, turbulence in the plane, a gut wrenching... evoke explicit and/or implicit contextual mental frames. Mental frames that, as experiences, we can extrapolate to other real or virtual contexts, to make decisions and exercise our adaptive capacity to the context of each living situation.

Two important pieces in the exercise of our adaptive capacities are empathy and assertiveness. Empathy is the ability to be aware of the feelings and emotions of other people. Empathy is not the same as sympathy, which is feeling for someone. We need empathy to understand patients, but to be efficient we need to learn to manage empathy without sympathy. This management of empathy is carried out through the implementation of assertive behaviours. Assertiveness is the ability to express one's feelings and assert one's rights while respecting the feelings and rights of others. Assertive communication is appropriately direct, open and honest, and clarifies one's needs to the other person. But in addition, to carry out an assertive communication we need a specific and appropriate narrative for each particular case. Doctors need and want time to cope with patient's process. The clinical process of any patient is characterized by its volatility, uncertainty, complexity and ambiguity. Therefore, doctors need critical thinking to practice their medical practice.

4. Meta-cognition or Critical Thinking

Thinking is a complex and voluntary cognitive process to manage our long-term memory when we are awake. Thinking is related to coping and resolution of the uncertainty and ambiguity of our experiences. Dreaming is a complex and involuntary cognitive process to manage our memory when we are sleep. There are two types of dreams: logic and oneiric. The former consolidates our memory; the latter reduce the emotional components of our experiences and reorganize dissimilarities. Thinking and dreaming make up our thoughts, our mental settings, our mental frames, the background to take decisions.

Previously, we have described how we, humans, memorize events in declarative (explicit) or non-declarative (implicit) mode. Now, we will see how humans remember explicitly or implicitly those memorized events. This mental action or process of remembering, by which a person acquires knowledge and understanding through thought, experience and senses is called cognition. Referring to humans, cognition is synonymous of thinking, and critical thinking is a form of meta-cognition involving the analysis of one's own process of reasoning, assumptions, and bias, so as to identify flaws and improve one's thinking by applying critical standards. As such, critical thinking (meta-cognition) is the process of analysing and assessing thinking with a view to improving it, and it is often referred to simply as “thinking about thinking.” Likewise, meta-cognition involves the capacity to distinguish between effective and ineffective processes of inference, valid and invalid data sources, and requires the formation of beliefs based upon sound reasoning. To carry out this process, we need pre-acquired mental references. Therefore, the active or reiterated repetition of an event, or thinking actively and repeatedly about this event, allows us to consolidate the memory of the explicit and implicit types, as well as the interrelations between them, since all the events (reading, hearing, driving, coitus, caring, etc.), involve explicit and implicit components. And this consolidation is essential, so that it becomes conscious as learning (Connor et al., 2019).

Since cognition is not only thinking, but also involves other complex mental processes, which are not necessarily conscious, we will talk about Meta-cognition in a broad sense, and Meta-thinking as a synonym and component of the process we have called critical thinking. When “we think about what we think” (meta-thinking), we mentally represent a thought, not just a fact the thought may be about. It is obvious that if we have an explicit and implicit memory, there are two different ways of thinking about a thought:

- *Implicit meta-thinking.* If we specify a thought in terms of its content and determine the content in terms of what it is (its true conditions), then it is an implicit meta-thinking. This type of implicit meta-thinking has both implicit memory scraps (70%) and scraps of semantic memory (30%). It is

implicit because although the mental identity of thought is recognized (of which we are marginally conscious), the structure of that thought is neither centred nor even can be explained in detail. But it is also semantic, because the scraps of semantic memory specify the content of the thought, appealing to how it is contained in the frames of the mental world itself. Not all thoughts are explainable. Thinking imaginatively, or daydreaming, could be said to be an example of Implicit Meta-thinking. I can explain what I'm thinking about, but I cannot explain all the thoughts. The idea is there, but there is an unexplainable mental barrier. However, one can persevere on that implicit meta-thinking until it explodes, like a Eureka, or the start of a semantic process. We could say that implicit meta-thinking is the background of creativity.

- *Explicit meta-thinking.* We think explicitly and semantically when we represent a thought in terms of thought (if it focuses on that type of mental relationship) but specifies its content semantically. For example, when I think of my decision to play music to drown out the surrounding noises, it represents a mental relationship and specifies its content semantically, in terms of a state of affairs in the world (playing music to stifle noises). That is, a person can explain what he or she is doing mentally and his or her thoughts are explicable.

Let's take an example of explicit meta-thinking. I am at home and the noises and discussions of the neighbours flood everything, so I cannot concentrate. I think of the need to ask Alexa to put my favourite Jazz radio station, so that the perception of all the surrounding noises is appeased. When I am thinking in this way, I have a desire in the form of thought. At that moment I will make a decision, for which I generate a mental relationship and also specify its semantic and episodic content, in terms of a state of affairs with the surrounding world (listening to music to drown noises). But, at the same time, I think about what my friend advised me ("you do not have to worry about children, they will grow"). When this happens, I think about the thought that expresses and how to specify the content for decision making in an episodic and semantic way. That is, there is a process of mental analysis of the type: "thought about thinking during the process of thinking about a thought", where both the identity and the content of the objective thought are expressed explicitly as thoughts. In this sense, we metathink explicitly when we represent thoughts whose mental identity is fully represented as thoughts, as mental structures that represent, and their contents are specified in terms of other thoughts or rare linked to other thoughts in various patterns. (Bogdan, 2000)

In the same way, and with similar characteristics, that there is a critical thinking, there is a critical learning. In this way, the internalization process of mental frames, shaped explicitly or implicitly, within a specific sociocultural context, is not the mere transfer of an external activity to a pre-existing "internal plane of consciousness". On the contrary, it is the active process in the one that forms this plane or mental frame. A person learns implicitly and explicitly. A person can learn without knowing how he or she is learning, or without knowing how he or she has learned. In the same way that one drives a bicycle but cannot explain semantically how to ride a bike and tell a friend "look, it's done like that". Now, you can also teach "learning to learn".

For the interest of our reflexion on e-learning is necessary to rationalize that very rarely we can have the possibility of finding ourselves in "pure" situations of explicit or implicit meta-thinking. Usually, the context in which we are and we find ourselves influences the exercise of thinking and the flow of thoughts.

5. e-Learning

E-Learning is teaching and learning conducted via electronic media and information and communication technologies (ICT). It uses various forms of educational technology to create a virtual learning environment, by providing equivalent technology enhanced access to classes, content, homework, tests, assessment and grades (Railean, Elçi and Çelic, 2015). The concept of e-Learning is not new, but gained increased relevance in the last decade and a half, as a response to the need to enhance professional competencies to face the challenges posed by an increasing globalized world and VUCA environment, supported by huge technology development and change in habits of life. The unstoppable technological development means that every month there is not only a technological improvement of the available tools, but there is a technological novelty. Today, presumably there are already new developments. We can specify 12 technology tools in e-learning applied to health care:

- *Mood Identity of the student (Facial recognition)*. The current technological advances allow not only to identify a person, through this or her portrait, but his/her mood, changes in his/her heart and respiratory rate, in her/her pupils, tremulation in his/her language, intonation, as well as the speed and acceleration in the keystroke when typing, errors, pauses, etc. And this is available now on our smartphone (Sandanayake, Madurapperuma and Dias, 2011; Kulkarni, Reddy and Hariharan, 2009).
- *Blockchain applied to e-Learning*. This technology ensures that transactions are carried out in a decentralized manner without the need for a reliable central authority. As public keys are used, it is not necessary to reveal someone's identity. Transactions are simultaneously secure and trustworthy due to the use of cryptographic principles. This is very useful for using clinical records as a learning database without remorbing privacy and the Data Protection Act (Hölbl et al., 2018).
- *Mixed Reality and 3D content*. The possibility of creating an environment of scenes or objects of real appearance, generally generated by computer technology, which creates in the user the sensation of being immersed in it. This environment is contemplated by the user through an appropriate device, more or less complex, that can stimulate the 8 senses, where the interaction with the environment, as well as the perception of different stimuli, intensify the sensation of reality (Francesconi et al., 2015; Condino et al., 2018).
- *Chatbot as virtual assistant*. The term chatbot is used to refer to virtual assistants in general, or specifically to those that are accessed by online chat. But its application is wider. A virtual assistant helps users of computer systems, automating and performing tasks with "the minimum man-machine interaction". The interaction between a virtual assistant and a person must be natural; a person communicates using the voice and the virtual assistant processes, interprets and responds in the same way (Palanica et al., 2019; Pereira and Díaz, 2019).
- *Content Curation in the selection of information*. It is the process of sorting through the vast amounts of content on the web and presenting it in a meaningful and organized way, around a specific theme. The work involves sifting, sorting. Content curation is about selecting the best quality digital content for your intended audience; organizing and displaying it on a curation tool your users can access; adding value to the curated content through selecting, arranging and providing insights; and publishing information. (Krumholz, Terry and Waldstreicher, 2016).
- *Micro-Learning in learning pills*. The term microlearning is a perspective or learning modality consisting of the fragmentation of didactic contents, by means of which certain competences are acquired. Learning is generated in small steps, which, when interconnected, form a broader and deeper knowledge in the long term. It is characterized for being a form of learning realized in a short time, that can be carried out in any moment and place. The didactic microcontents can be explicit or implicit from the perspective of the observer or student, but when the microcontents are agglutinated in the student's mind, they form an explicit and interrelated whole (Simons et al., 2015).
- *Video-Learning as a complement to e-Learning*. It is a video specifically prepared with docent objectives, that presents educational material for a topic that must be learned. The format of this video can vary, from a mere teacher, to a set of scenes, etc., and in turn can interrelate or establish links with other applications and with the observer (Choules, 2007).
- *Mobile Learning*. As its name suggests it refers to learning using mobile phones, PDAs, tablets, Pocket PCs, iPods and any device that has some form of wireless connectivity (Sarrab, Elgamel and Aldabbas, 2012).
- *Gamification (Narrative Medicine-Art)*. Learning through the game is used in Narrative Medicine. Specifically, the Columbia University of NY uses it. Through pictorial works of art, medical students detect the uncertainty and ambiguity those works hide (Murphy, Franz and Schlaerth, 2018; Wazny, 2018).
- *Big Data to customize the training*. Gartner (2018) defines big data as "high-volume, high-velocity, and high-variety information that demands cost-effective, innovative forms of information processing for enhanced insight and decision making". Each patient, each process in healthcare, generates thousands and thousands of data, which extrapolated to the social network can entail millions of millions of data. In turn, interactions, congruences, correlations, etc., are available to solve doubts and ambiguities to the student, observer or researcher (White, 2014).
- *Social crowd learning to share knowledge*. The concept of crowd learning is defined as learning among crowds. It is a learning situation in which two or more people learn something or gain a greater understanding of a specific topic, solving a problem or a set of problems in a collaborative work (Upadhyay, Valera and Gómez-Rodríguez, 2017).

- *Crowd learning machine.* The application of Artificial Intelligence to human machine interaction is already a reality in progress in surgical and medical practice, both for the help in neuroimaging recognition and in the decision making in the operating room (Battogtokh, Mojirsheibani and Malley, 2017).

6. Conclusion: The Reflexive Opinion

“By learning you will teach; by teaching you will learn”

Latin proverb

The impact of the technological revolution on medicine and social changes has, in the opinion of the old doctors, generated a welfare drift, in which the bedside manners have deteriorated. Patients ask for more personalized attention and sufficient time of relationship with doctors. However, new technologies allow more effective attention and intervention. Numerous studies of the RAND corporation establish that physicians consolidate their decision-making about the ambiguity of medical advances through face-to-face meetings in small work groups or informally. Since two decades ago, the medical databases allow access to searches very quickly and form a substantial basis for learning, updating and improving the resolution of doubts. On the other hand, the new information and communication technologies, specifically the Artificial Intelligence applied to the manipulation of data and information, have taken an unprecedented leap for medical practice, from surgical robots to probabilistic prediagnosis. This impact has induced a metalearning, that is, learning to learn. This meta-learning is intimately linked with the essential practice of critical thinking. Critical thinking, or meta-thinking, consists of the practice of thinking about thinking of a frame of thoughts.

The implementation of the possibilities of e-learning are intimately linked with critical thinking. However, as a tool for learning, it suffers from being based on basic coaching of how one learns. This is, in too many occasions its use confuses complicated with complex. In our opinion, and it is our reflection, new technologies aimed at e-learning in medicine should be based on meta-cognition. In other words, if our long-term memory is consolidated, incorporating explicit but also implicit components, the latter must be incorporated into the training options of e-learning. When we are in a decision environment for health care, the events that occur do not behave in a linear way. The event has a large number of "noise" components, in principle not informative, but in reality, they are behaving like afferences stored as implicit memory, together with purely declarative components and mediates to discern if you have the necessary knowledge. Therefore, we consider, for example, that e-learning based on learning pills or microlearning, must be accompanied by both non-declarative pills for the observer, and by declarative pills. Structured in such a way that in the end the student or observer has the necessary implicit and explicit resources, so that he or she, by himself or herself, accedes to exercise meta-thinking both implicit and explicit.

The great rationalist philosopher Immanuel Kant (1724-1804) affirmed: "the vast ocean is not absolutely large, but the effort made by the faculties of subjects confronted with the vast ocean, meanwhile, is absolutely large". That is to say, the great thing of the ocean is the opinion of the observer, it is not the ocean. In this sense, we therefore postulate that for e-learning in healthcare applications should consider aspects of Narrative Medicine, so that, for example, the use of paint, and the analysis of works of internationally recognized painters, with all their ambiguity and uncertainty that all work entails, as part of the material. Not only Velazquez paintings about "the bearded woman" or court jesters, but also Goya about "the disasters of war". Also, include films of equal recognized prestige, or not, or documentaries about social situations, politics, technological advances, etc. All these possibilities must be incorporated into the bigdata for medical e-learning. Similarly, if the observer is identified and characterized his or her mood, heart rate or breathing, speed and acceleration to interrelate with virtual reality, through a metacognitive process can evaluate and make the appropriate situation to every situation. Hence, video-learning should enable this implicit and explicit meta-thinking. For example, a person with Parkinson's has a specific gait, but this is when he or she is already quite ill. However, if that patient is included in the video-learning in a complex context, that of real life, in a home with paintings, tables, toilets, etc., or walking down the street, asking for a coffee, eating in a restaurant, etc., the capabilities of e-learning will be closer to the sick individual and not to the disease. Doctors, health care professional, should be taught with multiple multicultural examples, not how to face death, but how to deal with third parties, how to approach them towards family members, children, etc. E-learning can easily provide this complex and multiple behavioural situations before which a doctor will ever find himself or herself in the exercise of his or her professional life. Therefore, e-learning cannot only help us "teach to teach", "learn to learn", also to develop implicit and explicit meta-thinking capabilities.

References

- Federica Amici, F., Sánchez-Amaro, A., Sebastián-Enesco, Cacchione, R., Allritz, M., Salazar-Bonet, J. and Rossano, F. (2019). The word order of languages predicts native speakers' working memory. [online]. Available at: <https://www.nature.com/articles/s41598-018-37654-9>. [Accessed 2 March, 2019].
- Battogtokh B., Mojirsheibani, M. and Malley, J. D. (2017). *The optimal crowd learning machine. BioData Mining*. [online]. Available at: 10:16-28 DOI: 10.1186/s13040-017-0135-7 https://www.researchgate.net/publication/317093624_The_optimal_crowd_learning_machine [Accessed 5 April, 2019].
- Bogdan, R. J. (2000). Minding minds: evolving a reflexive mind by interpreting others. Chapter 4, *The Reflexive Mind*. Massachusetts: MIT. A Bradford book.
- Choules A. P. (2007). The use of e-learning in medical education: a review of the current situation. *Postgraduate Medical Journal*, 83, pp. 212–216.
- Condino, S., Turini, G., Parchi, P. D., Vigliani, R.M., Piolanti, N., Gesi, M., and Ferrari, F. (2018). How to Build a Patient-Specific Hybrid Simulator for Orthopaedic Open Surgery: Benefits and Limits of Mixed-Reality Using the Microsoft HoloLens. *Journal of Healthcare Engg.*, pp. 1-12.
- Connor, C. M., Day, S. L., Zargar, E., Wood, T.S., Taylor, K.S., Jones, M. R. and Hwang, J. K. (2019). Building Word Knowledge, Learning Strategies, and Meta-cognition with the Word-Knowledge E-Book". *Computers & Education*, 128, pp. 284-311.
- Francesconi, M., Freschi, C., Sinceri, S., Carbone, M., Cappelli, C., Morelli, L., Ferrari, V. and Ferrari, M. (2015). New training methods based on mixed reality for interventional ultrasound: Design and validation. *Conference Proceedings IEEE Engineering in Medicine and Biology Society*.
- Gartner (2018). *IT glossary*. [online]. Available at: <https://www.gartner.com/it-glossary/> [Accessed 5 April, 2019].
- Glazer J., Kremer, I. and Perry, M. (2018). *Crowd Learning without Herding: A Mechanism Design Approach*. CRETA [online]. Available at: warwick.ac.uk/fac/soc/economics/research/centres/creta/papers [Accessed 20 March, 2019].
- Hölbl, M., Kompara, M., Kamišalić, A. and Zlatolas, L. N. (2018). A Systematic Review of the Use of Blockchain in Healthcare. *Symmetry*, 10, pp. 470-492.
- Krumholz, H. M., Terry, S. F. and Waldstreicher, M. A. J. (2016). Data Acquisition, Curation and Use for a Continuously Learning Health System. *JAMA* [online, published September 26]. Available at: doi:10.1001/jama.2016.12537 <http://jama.jamanetwork.com/>
- Kulkarni, S. S., Reddy, N. P. and Hariharan, S. I. (2009). Facial expression (mood) recognition from facial images using committee neural networks. *BioMedical Engineering OnLine*, 8, pp. 16-28.
- Murphy J. W., Franz, B. A and Schlaerth, C. (2018). The Role of Reflection in Narrative Medicine. *Journal of Medical Education and Curricular Development*, 5(1).
- Palanica, A., Flaschner, P., Thommandram, A., Li, M. and Fossat, Y. (2019). Physicians' Perceptions of Chatbots in Health Care: Cross-Sectional Web-Based Survey. *Journal of Medical Internet Research*, 21, pp.1-10.
- Pereira, J. and Díaz, Ó. (2019). Using Health Chatbots for Behavior Change: A Mapping Study. *Journal of Medical Systems*, 43, pp. 135-140.
- Railean, E., Elçi, A., Çelic, D. (2015). Metasystems Learning Design Approach for STEM Teaching, Learning and Assessment. In E. Ostler, ed. *STEM Education: An Overview of Contemporary Research, Trends and Perspectives*. Elhron Nebraska, IA: Cycloid Publications, pp. 52-81.
- Sandanayake, T. C., Madurapperuma, A. P. and Dias, D. (2011). Affective E Learning Model for Recognising Learner Emotions. *International Journal of Information and Education Technology*, 1, pp. 315-320.
- Sarrab M., Elgamel, L. and Aldabbas, H. (2012). Mobile Learning (M-Learning) and Educational Environments. *International Journal of Parallel Emergent and Distributed Systems*, 3(4), pp. 31-38.
- Simons L. P., Foerster, F., Bruck, P. A., Motiwalla, L. and Jonker C. M. (2015). Microlearning mApp raises health competence: hybrid service design. *Health Technology (Berl)*, 5, pp. 35-43.
- Timimi, F. K. (2012). Medicine, morality and health care social media. *BMC Medicine*, 10, pp. 83-86.
- Upadhyay U., Valera, I. and Gómez-Rodríguez, M. (2017). Uncovering the Dynamics of Crowdfunding and the Value of Knowledge. *WSDM*, February 06-10, Cambridge, United Kingdom.
- Wazny, K. (2018). Applications of crowdsourcing in health: an overview. *Journal of Global Health*, 8(1), p. 20.
- White, S. E. (2014). A review of big data in health care: challenges and opportunities. *Open Access Bioinformatics*, 6, pp.14-18.

Authors' Backgrounds



Dr. Fernando Fernández-González is Medical Doctor specialized in Neurophysiology and Neurology, with more than 46 years of experience in delivering health care to patients and in health care management. He also received specific training in Biological Engineering.

He was Head of Clinical Neurophysiology in the Hospital Central de Asturias (1993-2019) and previously in the Hospital Valle del Nalón. From 1982-1992 he worked with the Spanish Health Minister, as assessor for New Health Care Technologies, being Director responsible of assessment and implementation of new medical devices, at the National Health Authority. He was also Advisor of the NATO for healthcare technologies.



Dr. Palmira López-Fresno works as Senior Expert in International Cooperation for Development. She has more than 20 years of international experience in management and assessment, with extensive knowledge of the economic and social reality of Latin America, Europe and Asia-Pacific. She developed her activity in more than 50 countries in all continents, in different projects and top management positions, covering areas of assessment (Chief Examiner APBEST, Lead Assessor EFQM, Assessor of the Spanish Quality Award), quality management (Quality Director, Vice-president for Corporate Quality, consultant and auditor) and business management (Project Director; Production Director; Executive Director, President).

Author of several books on leadership abilities and service quality. International speaker, trainer and consultant. Distinguished member of Spanish Association for Quality (AEC), Senior member of ASQ, member of BAM and other management organizations.

Former President of the Service Quality Committee (AEC) - 2001 to 2014. Former Vice President of AEC, 2008 to 2014.