DIFFERENT LEARNING STYLES AND THE 4 MAT IN SCIENCE

Adolfo E. Obaya-Valdivia[1], Dulce Parrales-Vargas[2], Carlos Montaño Osorio[1]

[1]FES Cuautitlán UNAM. Campo 1. Fisicoquímica. MADEMS (Química). México
[2] CCH Naucalpan UNAM. Área de Ciencias Experimentales. México

ABSTRACT

This paper reviews the different learning styles in science, NLP, Kolb, Felder and Silverman, Hermann, McCarthy explaining their main characteristics and concluding with the socalled 4 MAT, which integrates them into a single model with eight pedagogical steps that must be covered in their entirety to connect teaching with student learning in an effective way.

KEYWORDS

learning styles, science, pedagogical steps, 4 MAT

1. INTRODUCTION

Learning styles are the way students respond to or use stimuli in the learning environmentthat is, the educational conditions under which a student is most likely to learn.Learning styles are the cognitive, affective, and physiological traits that serve as relatively stable indicators of how students perceive interactions and respond to their learning environments (Alonso, *et al*., 2002).
Learning styles depend on several components:

1. Environmental conditions
2. Cultural background
3. Age
4. Grouping preferences (working best individually or in teams)
5. Style followed for problems olving
6. Type of motivation, internal or external.

The concept of learning styles is directly related to the conception of learning as an active process, according to the constructivist theory of learning where it requires the manipulation of information, by the receiver, to achieve knowledge (Aragón and Jiménez, 2009)

There is a relationship on the behavior of students in class, and their way of learning, this is reflected in learning styles, giving the types of pedagogical strategies that are most effective, either by thematic content or social interaction with their classmates.

According to Bloom (1964), the areas covered by learning must be considered in an important way, described as domains which can be classified as:

1. Cognitive: related to knowledge
2. Comediative: related to practice or doing.

3. Affective: related to feelings.

A permanent change in behavior that occurs because of practice (Moussa,2014), aconcept of learning from the didactic point of view must have three dimensions:

1. Cognitive dimension
2. Behavioral dimension
3. Operational capabilities

Learning is the process of acquiring a relatively durable willingness to change perception or behavior because of an experience (Gokalp, 2013)Therefore, it is important that students understand what are the best learning strategies that they should follow so that their performance is optimal.

2. NEURO LINGUISTICRE PRESENTATION SYSTEM (NLP)

According to this model, several factors intervene in learning, but one of the most influential is related to the way in which it selects and receives information (O'Connor, 2001).

NLP representation systems are basically dependent on the internal senses, that is, we perceive them with the external senses (see, hear, feel, smell and taste), but each person interprets them differently as they feel them inside, so the brain selects only part of the information, and the rest ignores it.

Therefore, we have three major systems to represent the information received:

1. Visual representation system: it remembers more the information that is presented through abstract and concrete images.
2. Auditory representation is more reminiscent of spoken information; It's easier to remember a conversation than a note on the board.
3. Kinesthetic representation system remembers information by interacting with it, manipulating it.

It is estimated that 40% of people are visual, 30% auditory and 30% kinesthetic (Romo *et al.*, 2006). That is why, not all students in a class remember the same, some will find it easier to remember what they read on the board, others what they heard from the teacher and finally students who will remember the impression that the class caused them.

3. HOW TO PROCESS INFORMATION (DAVID KOLB)

Kolb (1984), states that the survival of human beings depends on our ability to adapt to the changing conditions of the world. Therefore, it proposes that each individual approaches learning in a particular way, which is the product of:

1. Your heredity (intelligence)
2. Your previous experiences
3. The demands of the environment in which it operates.

However, Honey & Mumford (1986), partially dispense with the intelligence factor, which is not easily modifiable and stay with the other two.

Later Kolb (1984), highlights two main dimensions of learning, with its four different components giving rise to the four-quadrant model:

1. Active: Engages fully and non-judgmentally in new experiences. They get bored with long deadlines, choose short activities and quick results. They prefer to dialogue; they like to lead debates or make presentations. The question triggering learning for them is the How?
2. Reflective: analyzes your experiences from various types of view. To reach a decision, you need time to collect data and analyze it in detail. They prefer to observe and listen to others and do not intervene until they have become familiar with the situation. The question triggering learning for them is why?
3. Theoretical: Problems are solved logically; they tend to be perfectionists. They integrate coherent facts and theories. They dislike the subjective or ambiguous. Logic is indispensable in events. The question that triggers learning for them is what?
4. Pragmatic: They seek the practical application of ideas and take the first opportunity to experience them. They show little interest in knowledge that does not help them in their immediate needs. The question triggering learning for them is what if? (Honey & Mumford, 1986).

4. THE BIPOLAR CATEGORY

Another model based on bipolar characterization (Felder & Silverman 1988), explains the different learning styles of students based on the following postulates:

1. The type of information the learner receives is predominantly sensitive or intuitive.
2. The sensory modality preferably used by students is auditory or visual.
3. Students have two ways of organizing information: inductively or deductively.
4. Students process and understand information in two ways: sequentially or globally.
5. Students work with the information received in two ways: actively or reflectively.

These postulates give rise to five dimensions of learning styles, which entail categories opposed to each other; That is why this model is known as the bipolar category model. Dimensions of learning styles and the characteristics of each are:

1. Sensitive or intuitive

Sensitive students are concrete and practical, they like to solve problems following established procedures, they like practical work and memorize facts with ease. Intuitive learners are rather conceptual and innovative, oriented towards theories and meanings, preferring to discover possibilities and relationships; They can quickly grasp new concepts, like to work with abstractions and mathematical formulas.

2. Auditory or visual

Auditory learners prefer to obtain information in spoken form, as they remember it better; They like the oral presentations of the teachers. Visual learners prefer to obtain information through visual representations such as flowcharts, concept maps, mind maps, as they remember better what they see.

3. Inductive or deductive

Inductive students understand information best when they are presented with particular facts and observations and then inferences are made toward principles or generalizations. Deductive students prefer to be presented first with the generalizations or guiding principles of phenomena or facts and then to deduce the consequences and applications themselves.

4. Sequential or global

Sequential students learn best with small incremental steps, their reasoning is orderly and linear; They solve problems by logical steps. Global learners learn in leaps and bounds, visualizing the whole; In general, they solve complex problems quickly in innovative ways.

5. Active or reflective

Active learners retain and understand new information better when they manipulate it (discuss it, apply it); they like to work in teams and rehearse things. Reflective students tend to retain and understand new information by analyzing and reflecting on it; they prefer to work alone (Vargas et al, 2021).

5. THOUGHT PREFERENCE

Ned Herrmann (1991) describes the thinking preferences associated with some quadrant of the brain and develops a model according to which, once we know the ways of thinking that satisfy us more and allow us better results, the door is opened to develop communication, problem solving, leadership and decision making, among other factors.This model helps the teacher compare the characteristics of their students with the way they are acting according to the situation they live, being able to infer if they feel good about what they are doing and thus achieve meaningful learning for them. Additionally, the model allows comparing the different styles among students when creating effective work groups (Dijksterhuis, 2004)

.According to Ned Herrmann's whole brain model, you have four areas of the brain and each corresponds to different characteristics.

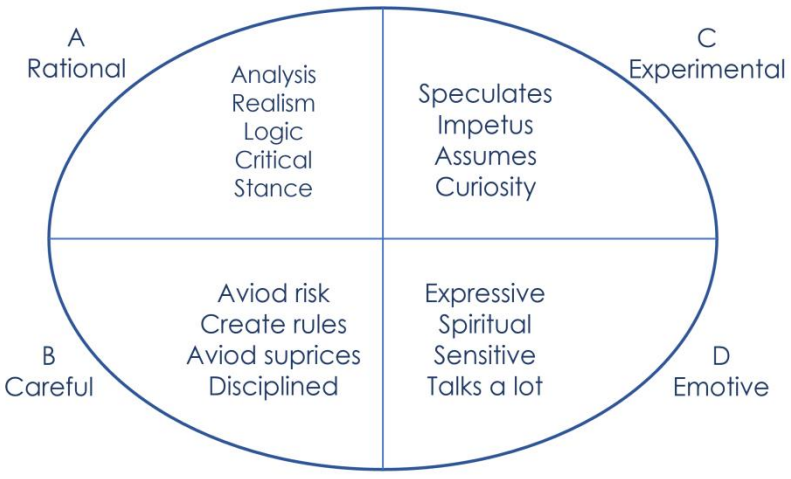

Figure 1. Brain Areas (Ned Hermann)

6. CAPACITY BUILDING (BERNICE MCCARTHY)

For McCarthy (1987), styles have different characteristics and require certain steps in teaching, the inclusion of brain specificity as another determinant of differences in learning, is an extension that McCarthy makes to Kolb's model.

Kolb's first proposed style is*Divergent,* and McCarthy describes it as *imaginative*. Students use their imagination and look for a personal meaning of what they are going to learn and want to know the why of things.

1. Strength: Imagination.
2. It works by classification of values.
3. Goals: be involved in important goals and create harmony.
4. Favorite question: Why? (Guild & Garger, 1998)

The second style, *Assimilator,* is described as *analytical*. People perceive information abstractly and process it through reflection. The student must imagine beyond reality to integrate the experience and must be informed by introducing significant concepts.

1. Strength: generation of concepts and models.
2. It works through reflective thinking.
3. Goals: intellectualrecognition.
4. Favorite question: What? (Guild & Garger, 1998).

The third style, *Convergent*, is described as the commonsense style. The person perceives abstract information and actively processes it. For the next steps, students must extend the knowledge by doing something of their own by making use and application of what they have learned. In the same way they practice what they have worked through some type of exercise or activity using workbooks.

1. Strength: practical application of ideas.
2. It works by gathering objective information through direct experiences.
3. Goals: focus your present activity on future results that give you security.
4. Favorite question: How does it work? (Guild&Garger, 1998).

Finally,a style described as *Dynamic*. People perceive concrete information and actively process it. To finish with the seventh and eighth steps, what the student needs to do is go beyond the objective and share and integrate what has been learned to analyze it in terms of its relevance and meaning.

1. Strength: action and goals.
2. They work through action checking, creation of new experiences.
3. Goals: Bring ideas to action.
4. Favorite question: What if...? (Guild & Garger, 1998).

In addition to Kolb's learning styles, McCarthy was interested in the relationship between laterality and specialization of certain tasks. Therefore, I include some of the research on cerebral hemisphererecity in his theory. In general, the cerebral hemispheres specialize in the following functions, cited in Table 1.

Table 1. Cerebral hemispheres (McCarthy& McCarthy, 2006)

Left	Right
The left-brain hemisphere operates through structure and sequence. Prefers language, is sequential, examines elements, has number sense. Work to analyze information.	The right cerebral hemisphere operates in an unstructured way, comprehends images, looks for patterns and sequences, creates metaphors. Seeks to synthesize and consolidate information.

All the above resulted in the system generated by McCarthy, in which a quadrant is considered by learning style, and each quadrant an activity for the right hemisphere and one for the left. This provides us with an eight-step guide to the general construction of science-oriented learning cycles (McCarthy& McCarthy,2006).

7. THE 4MAT SYSTEM

The 4MAT theory, which holds that our students perceive information differently and that the cerebral hemispheres perform different functions. The combination of these two circumstances means that we have in the classroom students who could be typified into eight different learning styles. "Sensitive" students need to place a personal value on what they are learning; the "logicians" require knowing or creating rules to get into activity; The "precise" need to put into action what the teacher encourages them to learn and, finally, the "innovators" learn by creating and moving in freedom. These learning styles are doubled in eight when we consider that in each of them the right cerebral hemisphere (the rational of learning) or the left hemisphere (the emotional) can dominate.

The study of McCarthy & McCarthy (2006) aims to help teachers detonate the capabilities of their students and complete the cycle of meaningful learning, so a model was developed with eight pedagogical moments that should be covered in their entirety to connect teaching with student learning in an effective way.

The eight moments start from the sequence of a learning process and combine the different learning styles (Kolb, Felder and Silverman and Ned Herrmann's model) with the characteristics and functions of each hemisphere (Germain, 2002).

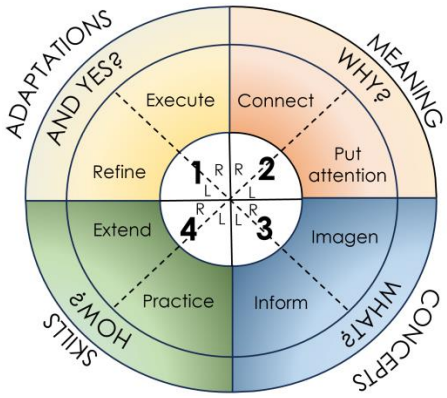

Figure 2. Characteristics and functions of each hemisphere

The 4MAT model is conceptualized as a natural learning cycle. For thestudent learn, he needs to connect the four quadrants with his two cerebral hemispheres (left/right).

According to this model, starting with quadrant 1 and following eight sequential steps, any content or process can be taught and learned by the learner.

Suggested diagrams are shown to generate a planning of a didactic sequence through the 8-step learning cycle of the 4MAT system previously described, in the circle on the left of the figure, the activities of both the teacher and the student are listed, for each of the quadrants, each with two activities, one for each cerebral hemisphere (right/left). In the circle on the right side some didactic strategies are shown to cover the activities of both, having to take or combine two of them for each quadrant (Shaughnessy, 2021).

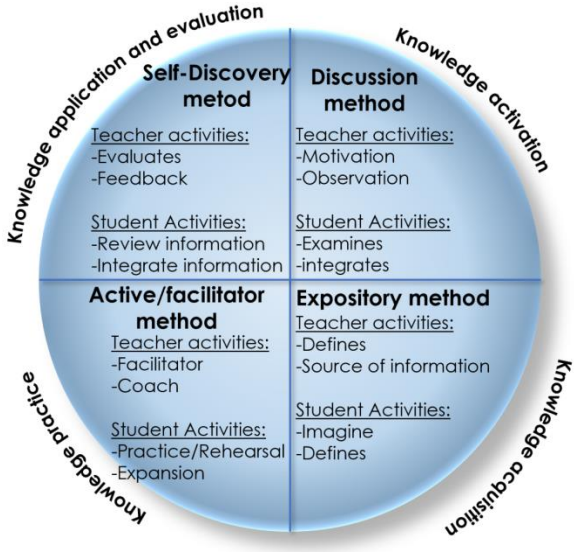

Figure 3 Quadrants with their two cerebral hemispheres (left/right).4MAT.

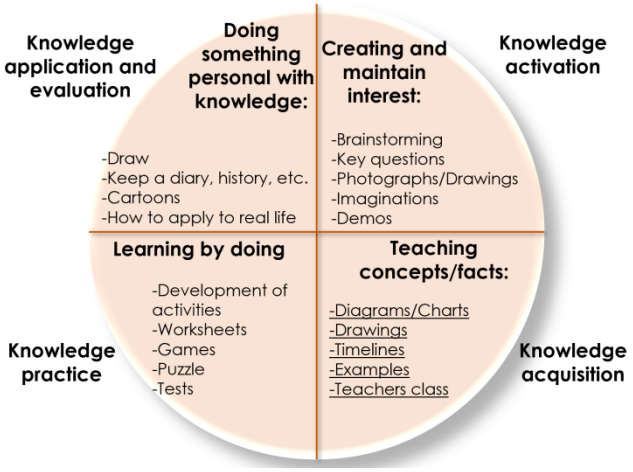

Figure 4. Activities to be carried out in the four quadrants.

8. CONCLUSIONS

The 4MAT system is compatible for the teaching of chemical sciences (Ilkorucu et al, 2022) the activities can be very varied and that gives the possibility of generating new strategies with various modifications that support students to generate greater confidence and comfort which allows them to be open to learning.

In general, the 4 MAT system is viable, since, by covering the 4 learning styles and brain comforts (Alanazi, 2020) it makes students motivated, being comfortable in carrying out the activities, actively participating and willing to learn, the main factor mentioned by Moreira (2000) in his article on meaningful learning.

In addition to being a virtue of the 4MAT system, no learning style is privileged since the activities are perfectly distributed so that all students have the possibility of acquiring the same knowledge. When the 4MAT system of learning styles was applied, in the teaching of the subject of Biomolecules of the chemistry program of the upper middle level in the analysis of results can be observed that, if relevant since the general average of conceptual gain in terms of relative gain index of conceptual learning is 0.524, which is interpreted as an average gain. In percentage, the master class obtained 14.8%, while the class of biomolecules with the recommendations of the 4MAT system obtained 52.4%, which is reflected in an advance of 37.6% compared to the master class.

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