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MEANINGFUL LEARNIG IN PHYSICS EDUCATION. IS OUR BRAIN PHYSIOLOGICALLY CONSTRUCTIVIST?

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Abstract

About 50 years ago the most widespread method of teaching was purely receptive. Discovery learning (causal or directed) followed afterwards, and now is widely accepted that meaningful learning is the more effective educational system. The question is what will the preferred pedagogical method in a few years be? How many years will last this trend to consider meaningful learning as the best teaching method? In the present work we have constructed a reasoning entitled "Is our brain physiologically constructivist?" in order to highlight the need for meaningful learning in the teaching of physics. Specifically, we want to show that constructivism is not just another pedagogical trend. Physiologically, our brain is so constituted that works searching for the meaning of the information it receives and, therefore, meaningful learning is not a teaching option, but a physiological requirement of our brain.

Initial approach

Since the processes of visualization and conceptualization have many common features (both abstract the constant features of either "objects" or "objects or events", and build either a visual world [1] or a cognitive structure [2]), we will try to "extrapolate" what is known about the visualization visual process to the brain cerebral process of conceptualization. Some authors define the conceptualization as an abstract and simplified view about the knowledge we have of the world that we want to represent. This representation is our knowledge of the world, in which each concept is expressed in terms of verbal relations with other concepts and their real-world examples (attribute relationships, not necessarily hierarchical), and also with multiple hierarchical relationships (categorization, or object allocation to one or more categories). Conceptualizing, therefore, can be considered as "the development or construction of abstract ideas from experience: our conscious understanding of the world" [3].

Let's try a little exercise as an example. First, think in our image of chair, and then think of our concept of chair. Aren't we doing the same? In both cases (visualization process [1] and conceptualization process [4]) we are abstracting the constant features that "all" the chairs have. As many authors as Ausubel have analyzed extensively, we can abstract its attributes, properties or characteristics that make them similar to each other, forming a category mentally represented by a concept and denoted by the same word [4].Also, innumerable sets of objects, such as that formed by wooden chairs, plastic chairs, chairs in our work offices or in our homes, with rectangular or round seating, large or small, all the existing chairs in the world, belong or are members of the same category, mentally represented with the same "chair" concept and denoted by the same word: chair.

If you made this little exercise and you thought both on the image of a chair and on the concept of a chair, consider the following question: Don't you think that the brain acts very similarly when it visualizes and when it conceptualizes? If we conclude that it is very likely, we can extrapolate what we know about the physiology of the visualization process (which is a great amount) to the field of the conceptualization process (where very little is known). In the following sections we highlight that when the brain visualizes, it looks for the meaning of the information received through the retina, and that can be generalized to the conceptualization process and conclude accordingly.

Our vision is meaningful

Consider the following example using the illusory figure of a duck or a rabbit by Jatrow [5,6]. If you were asked what do you see in Figure 2, you will find that you are looking at your "database" of visual images to see which of them you can relate to what you are seeing. The result is that there are two possibilities; you can relate it to a duck looking to the left side or a rabbit facing the right side. In the process we have been relating what we're seeing (what we are learning) with what already exists in our brain (what we already know). That is exactly what is stated in the meaningful learning theory [2].

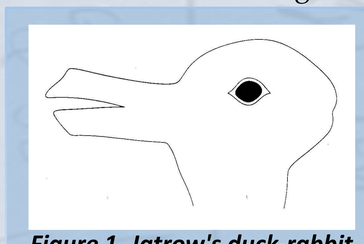

Figure 1. Jatrow's duck-rabbit

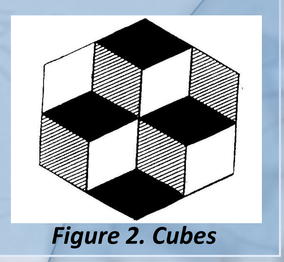

Figure 2. Cubes

Now look at the picture in Figure 2, taken from the book "Recreational Physics" [7]. If we look closely we can see that the perception of it changes and alternates between seeing a cube located over three other cubes, and seeing a cube below other three cubes. This figure shows that, sometimes, the same information can be interpreted by our brain in different ways, and associate it with different prior knowledge existing in the "visual structure" of the individual.

Reading is also meaningful

We may continue our reasoning with a vision application so common as reading. How does our brain work when reading? If you look at the image in Figure 3, we find that we can read it until the end, even though the three bottom lines feature only one half of each letter and, moreover, some letters are wrong. Our brain is getting enough visual information to find the meaning of the sentence, which is what really interests us. We really do not read letter by letter. We are looking for meaning, so we look at more letters (even whole words) at a time, and when we find the meaning we continue to the next group.

Whenever our brain receives the minimum necessary information, its work will focus on finding the meaning of what is written, and thus it can successfully complete its task (See Figure 4).

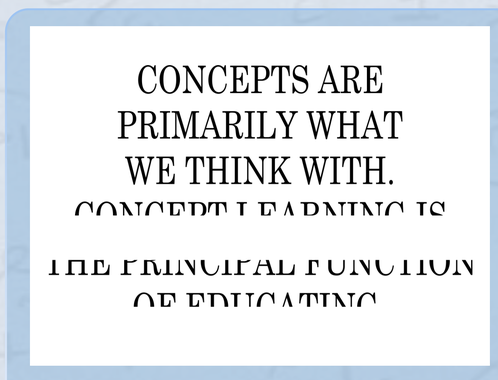

Figure 3. Example of incomplete text

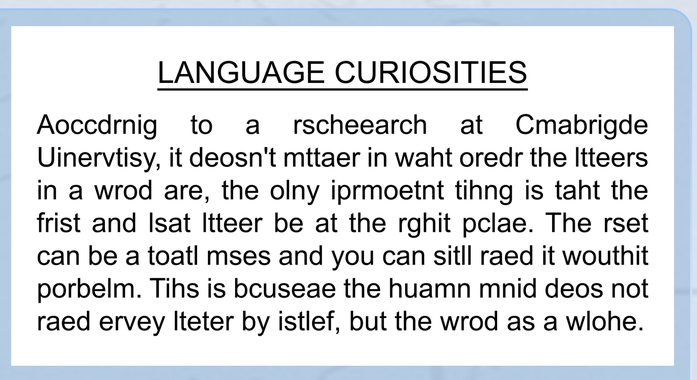

Figure 4. Language curiosities

Conclusions

At the beginning this communication we accepted that the brain process of conceptualization is very similar to that of visualization. Due to their physiological constitution, during the visualization process, the function of our brain is to seek the meaning of the visual information that arrives. We must then conclude that, because of their physiological constitution, also during the conceptualization process the mission of the brain is to seek the meaning of the information that arrives. Therefore, meaningful learning theory is not just the pedagogical paradigm of the moment; our brain is physiologically constituted so its function, when forming concepts, is to look up the meaning of the information it receives. This finding is of great significance, because it is a key motivation for our students during the study of the Constructivist Theory of Learning.

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