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# PROPOSAL OF APPLICATION OF CONCEPT MAPS TO A CASE OF BIOLOGY IN CONTEXT: PERFORMING A PHYSICAL EXERCISE

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**Abstract**. Application of the concept mapping technique to the study of a case of biology in context: taking a physical exercise in which most of the human physiological systems are involved. The physical exercise is used as a motivation activity. From these results, the teacher conducts a class discussion, organized in work teams, which will lead students, using their previous knowledge, to establish a relationship between all these systems. The use of concept maps is an essential tool for the study of science in context because it allows us to establish a sequence of knowledge, the relationship and the hierarchical structure between the different concepts involved. Thus, students can establish a general frame of work which allows them understand the whole process.
**Keywords**: Concept map, Biology in context, Physical exercise, Human Systems, Sequence of concepts.

## 1 Introduction

Knowledge of biology has traditionally been developed around levels of organization. This division is adequate for research and progress in science, but this reductionist and fragmentary system hinders learning. Students can learn the elements that make up any biological system, but they often have difficulties relating these concepts to each other, so they remain as isolated units (Lewis, 2006). Recently, the existing curricular proposals have been extensively reviewed (Vázquez et al., 2012). This system has been applied in the United Kingdom for students between 16-18 years of age (Hall et al., 2006), as well as in Germany (Elster, 2009). The achievements attained have been reviewed (Braund et al., 2013).

Concept maps are a particularly adequate tool to study biology in context because they allow establishing the relationship between various concepts involved in a system, facilitating their comprehension and function (Novak et al., 2006; González, 2008).

This article has the goal of showing that applying the technique of concept mapping to the study of a case of biology in context—performing physical exercise—improves learning. Practically all the human physiological systems are involved in this activity (Córdova, 2003). Concept maps allow establishing a general conceptual framework in which it is possible to observe the relation between all the systems involved in the process. This activity has been successfully applied in the Balearic Islands in primary, secondary, and university studies (Bennàssar et al., 2013).

## 2 Methodology

To perform this activity, the following work resources were taken into account (Hall et al., 2006; Lewis, 2006; Elster, 2009): a real biological process was dealt with; a motivating activity was performed— physical exercise—; an investigation was carried out—the effect of physical exercise on respiratory and heart rate—; students' prior knowledge was used; concept maps were made; a sequence of knowledge was developed; discussion in class; organization in workgroups.

Teachers should act like the drivers of the activity, they should control the performance of the physical test and subsequently guide the dialogue and discussion with the workgroups, leading to the accomplishment a consensus concept map among all the participants. This map will be developed as a sequence of knowledge based on the students' prior ideas and the results obtained in the motivating activity. The teachers will introduce questions for the students to develop and translate into their group concept maps to finally arrive at the consensus map. In the section of results, a possible consensus map is represented.

The class is organized in groups of four students. As the motivating activity, physical exercise was performed (it can be done in the classroom or in physical education classroom). The exercise can be light because the organism responds quickly. Pulse and respiratory rate are measured before and after the exercise.

The results of each student are written on the blackboard, separated by sex. For students as of age 16, data regarding height, weight, BMI (body mass index), habitual practice of physical exercise, and smoker/non-smoker can be added. All these data can also be dealt with in math class.

## 3 Results

*Analysis of the results obtained in physical exercise.* Firstly, the results obtained by performing physical exercise were analyzed. Do all the students show an increase in the parameters studied? Is there any allegedly erroneous result? Are there sex differences? Can the data be correlated with the BMI? With this activity, we are conducting a simple investigation in which we can emphasize the control of variables: all the students are doing the same exercise; data collection and the need for the data to be accurate and comparable. The results show that when doing exercise, respiratory and heart rate increased, indicating a greater need for oxygen. (Fig. 1)

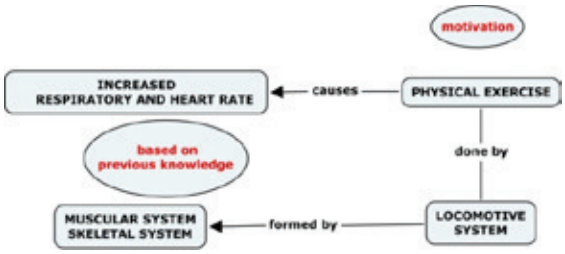


**Figure 1:** Performing physical exercise causes an increase in respiratory and heart rate. The exercise is carried out through the locomotive system.

*What system is responsible for movement?* After performing the former exercise and commenting on the results, the teacher will propose that the students indicate which human system is in charge of physical exercise. Their first response is usually that the muscular system is in charge; not all the students relate exercise to the skeletal system. The teacher should establish the relation between them, the function of these systems and show that, concurrently, they constitute the locomotive system. Therefore, the students will have related the activity between two systems about whose relationship some students were, in principle, unaware (Fig. 1).

*Is a supply of energy needed to perform physical exercise?* The next step is to establish the need of a supply of energy to carry out the process. In primary students, the need for the use of energy can be introduced by comparing the movement of a car, which needs gasoline, to the need of the human body, which requires a source of energy to move and perform diverse activities. Reference could also be made to the section of physics in which the need for energy to perform any kind of work is studied. Energy input is immediately related to food that is captured through the digestive system. The connection between the digestive and the circulatory system is evident due to the need to transport the nutrients to the muscular system (Fig. 1).

*How does the organism collect and transport oxygen and energy?* Once the locomotive system is established as being responsible for movement, we again examine the results obtained in the physical exercise. We can observe that respiratory and heart rate has increased. The teacher asks the reason for this increase. The increase in the respiratory rate indicates that you need to inhale air. Applying prior knowledge, students reply that in order to perform exercise, you need oxygen, which is captured from the air through the respiratory system. When performing exercise, the demand for oxygen increases. The increase in heart rate is related to the need to transport oxygen. The circulatory system is in charge of its transportation within the organism. The circulatory system takes oxygen to the muscular system, which is in charge of exercise (Fig. 2).

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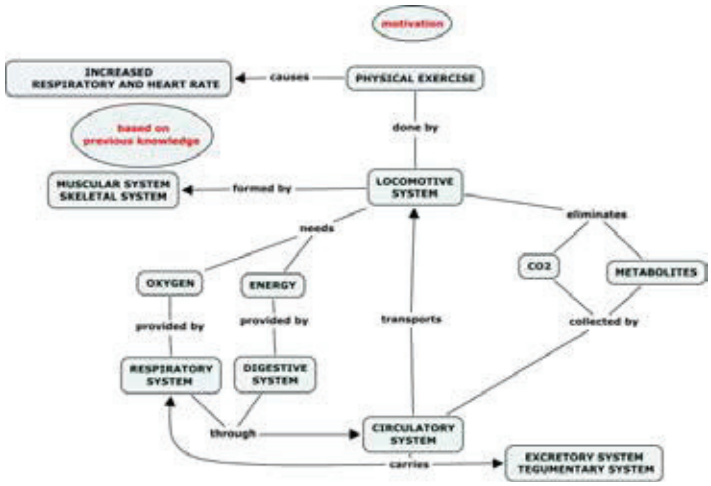


**Figure 2:** Oxygen is provided by the respiratory system, and energy through the digestive system. As a result of the physiological activity, metabolites are eliminated. The circulatory system is the in charge of all these transportations.

*How does the organism eliminate metabolites?* The teacher should now introduce evidence that whenever one performs an activity, waste products are produced (the exhaust pipe of a car or the digestion process). In this case, the students relate the elimination of waste products to the carbon dioxide we breathe out or to the formation of urine or stools. The circulatory system again comes into play, collecting and transporting the metabolites produced as a result of the organism's metabolic activity. CO2 goes to the respiratory system, the metabolites to the excretory system, to be eliminated through urine, and the by-products of digestion go to fecal excretion. The tegumentary system also intervenes in the process; when we perform exercise, it excretes sweat from the body in order to eliminate the body heat produced by the increase of metabolic activity (Fig. 2).

*How is the work of all the systems coordinated?* Lastly, the teacher should introduce the concept of control and coordination among the systems. For this purpose, it should be noted how quickly the organism responds by immediately increasing respiratory and heart rate and, on the other hand, the necessary coordination because of the involvement of a series of systems in the process: muscular, skeletal, respiratory, circulatory, digestive, excretory, and tegumentary systems, which must act harmoniously. This coordination is carried out by the nervous system and endocrine system. The nervous system is in charge of the rapid control over the systems. Control may be voluntary or involuntary. The locomotive system is voluntary, while the remaining systems are coordinated to facilitate this action. The endocrine system also participates in the automatic control process, controlling action in a slow, continuous way. (Fig. 3)

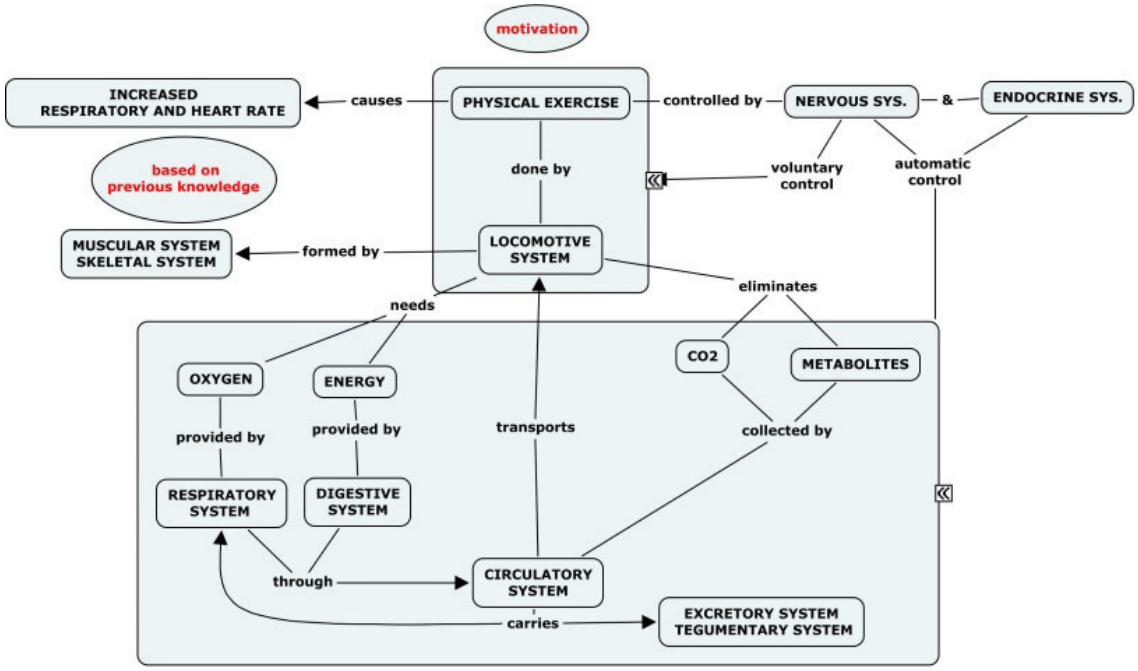


**Figure 3**: The nervous system and the endocrine system control the activity of all the systems.

*How to study individual systems*? Once we have established the concept map which links up all the human physiological systems, they can be studied in an isolated way although keeping always in mind their relationship with the others (Figure 4). For the study of these systems, the following concept map is proposed. It establishes the relationship between the concepts which make up each of them and the relationships they establish with the other systems.

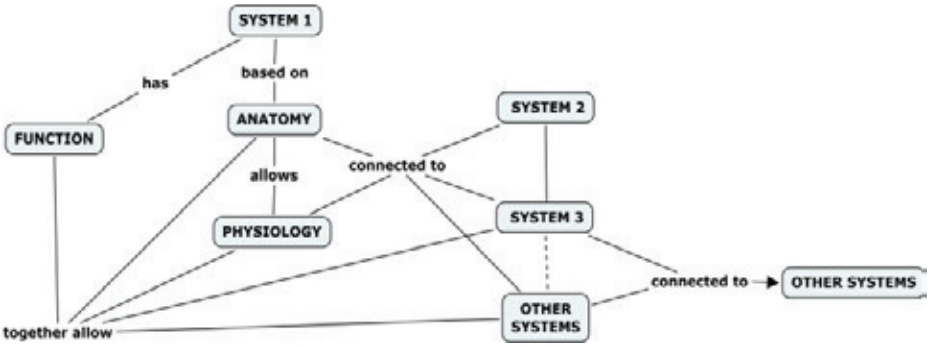


**Figure 4**: Proposal of concept map to study each system individually.

## 4 Conclusions

The use of conceptual maps for the study of a case of biology in context— performing physical exercise— allows the establishment of a general framework of the subject studied, furthering the understanding, relation, importance, and hierarchy among the concepts involved in the system, facilitating meaningful learning. It is important to use activities from the real world that facilitate the students' interest, as well as a motivating activity very close to them that triggers their interest in the subject. By means of questions, the teacher guides the dialogue in class and among the groups causing the students' prior knowledge to emerge, which allows establishing a sequence of logical knowledge that will facilitate meaningful learning. The use of the motivating activity as a scientific investigation in which the control of the variables and data collection are underlined facilitates understanding how to work in science. This proposal is applicable to all educational levels.

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