

Original Article (short paper)

## Use of CMAP tools<sup>®</sup> software to teaching muscle contraction: an experience with undergraduates students in physical education

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**Abstract — Aim:** To evaluate the use of CMAP tools<sup>®</sup> software as a teaching strategy of skeletal muscle components and contraction in undergraduates students of physical education. **Methods:** Nineteen students from the discipline of fundamentals of human physiology of the undergraduate course of physical education of the Centro Universitário Padre Anchieta were engaged in this study. Students were asked to divide into groups of three people and to bring a notebook with CMAP tools<sup>®</sup> software installed. During class, students were responsible for creating conceptual maps in CMAP tools<sup>®</sup> software describing each step of skeletal muscle components and contraction. To assess the effectiveness of this strategy in assisting learning related to skeletal muscle components and contraction, we created a visual learning scale (ranging from 0 (did not help) to 10 (helped a lot)) and applied to students at the end of the class. **Results:** From the students assessed, 47% scored 10 on the visual learning scale. Overall, 74% scored higher than 8 on the scale. **Conclusion:** The use of CMAP tools<sup>®</sup> software was effective in helping students understand concepts related to skeletal muscle components and contraction.

**Keywords:** muscle contraction, skeletal muscle, concept maps, exercise.

### Introduction

Skeletal muscles constitute the major part of the body musculature and amount to about 40% of total body weight<sup>1</sup>. They are responsible for the positioning and movement of the skeleton<sup>1</sup> and, are, therefore, one of the most studied and researched organs within the area of physical education.

Microscopically speaking, skeletal muscles are composed of several muscle fibers, these being, in turn, composed of several myofibrils. Myofibrils are made up of sarcomeres, which are the smallest contractile units within the muscle<sup>2,3</sup>. Sarcomeres are made up of six proteins that are divided into contractile proteins, regulatory proteins and giant accessory proteins<sup>2</sup>. The contractile proteins, also known as thick filament and fine filament of the sarcomere, are, respectively, myosin and actin<sup>2,3</sup>. During the process of muscle contraction, actin and myosin slide one over the other, generating contraction. Regulatory proteins refer to tropomyosin and troponin<sup>2</sup>. Tropomyosin allows muscle contraction whenever calcium is present and linked to a troponin subtype (troponin C)<sup>2,3</sup>. And, finally, regulatory proteins are known as titin and nebulin. Titin is responsible for providing elasticity and stabilizing myosin, while nebulin assists in actin alignment<sup>2,3</sup>.

All of the proteins mentioned above play important roles in the complex process of skeletal muscle contraction. Due to the complexity of associating the function with each of the constituent parts of the muscle, undergraduate students in physical education have difficulty learning these basic concepts of muscle physiology. The basic understanding

of these parts is necessary for the comprehension of how the muscle contracts and generates movement.

Since physical education is the major area of study of the movement of the human body, understanding the processes by which muscle contraction occurs is necessary. Thus, in the present study, we used a teaching strategy as a way to aid in learning the components of skeletal muscle and muscle contraction.

### Methods

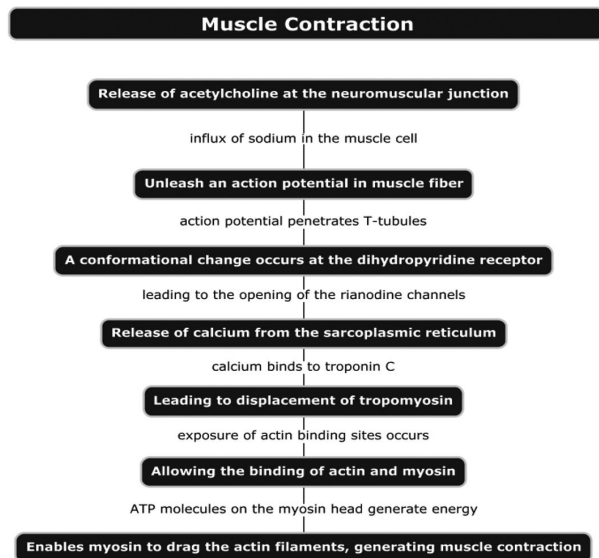
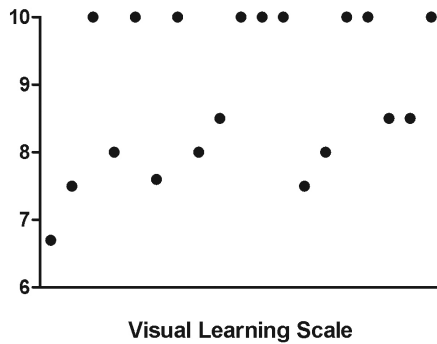
This cross-sectional study was carried out at the physical education faculty of the Centro Universitário Padre Anchieta (Jundiaí- Sao Paulo). For this study, we included 19 students of the discipline of fundamentals of human physiology in the course of a bachelor degree in physical education.

In order to teach the basic concepts related to the components of skeletal muscle and skeletal muscle contraction, the students had the following theoretical classes: cell physiology, membrane physiology, membrane potential, and finally, components of skeletal muscle and muscle contraction. These classes were divided by one week of difference between them.

After the last theoretical class, we asked the students to divide into groups of three people and bring at least one notebook per group with the CMAP tools<sup>®</sup> software installed. The software empowers users to construct, navigate, share and criticize knowledge models represented as concept maps, as the description of the manufacturer (Institute for Human & Machine Cognition). Thus, during class, we asked students to

create two conceptual maps in CMAP tools® software (Figure 1), one with the components of skeletal muscle (structures, membranes, and proteins) and one with the components of the muscle contraction process.

To assess the effectiveness of this strategy and how much it has helped to retain knowledge, we have used a visual learning scale that ranged from 0 (did not help) to 10 (helped a lot) and applied to students at the end of the class.



## Results

The results from visual learning scale are presented in Figure 2. From the evaluated students, 47% scored at 10 (helped a lot) on the visual learning scale. Altogether, 74% of the students scored at 8 or above on the visual learning scale.

## Discussion

In the present study, we demonstrated that the use of CMAP tools® software, where it is possible to create concept maps, was effective in helping to absorb knowledge related to skeletal muscle components and skeletal muscle contraction in undergraduate students in physical education.

Physiology courses are considered to be challenging for students to master due to the highly conceptual nature of the

discipline and the substantial cognitive effort required to understand disciplinary knowledge<sup>4</sup>. Students' understanding of physiology is dependent not only on the nature of the disciplinary knowledge but also the efforts that they make to gain a full understanding of them. Therefore, it is essential that students utilize effective learning strategies to cope with these difficulties and develop a deep understanding of physiology<sup>4</sup>.

In our experience, undergraduate students in physical education have difficulty learning the concepts of muscle contraction, mainly because of their complexity. As described elsewhere, one of the most common complaints heard from the students is that there is too much to remember<sup>5</sup>. Students usually make the mistake of trying to memorize hundreds of individual pieces of information, causing them to become overwhelmed and discouraged<sup>5</sup>.

As observed in this study, in addition to conventional theoretical classes, students can learn concepts related to skeletal muscle components and muscle contraction using conceptual maps. Strategies that promote alternatives to conventional classes are important for the teaching of physiology, due to the complexity of this discipline.

Concept mapping is a pedagogical tool initially proposed by Joseph Novak as a method to represent the relationships between relevant concepts within a given subject area<sup>6</sup>. In the process of creating concept maps, students put pieces of information together to create and illustrate the "big picture", something students often fail to see<sup>5</sup>. As a result, teachers can use concept maps as a tool to guide students into being able to visualize the integrative nature of physiology rather than viewing it as dozens of independent concepts<sup>5</sup>.

New physiology teaching methods, should be tested to verify their real efficacy and contribution to students' learning, as well as the students' acceptance/opinion of them<sup>7</sup>. It is important to know if a specific method is effective in teaching physiology since professors must perform extra work to prepare it and expend additional classroom time to implement it. In addition, the use of inefficient teaching methods or incorrect usage will negatively impact the students formation<sup>7</sup>.

Three categories of possible factors contributing to physiology being hard to learn: 1) the nature of the discipline, 2) the way it is taught, and 3) what students bring to the task of learning physiology<sup>8</sup>. However, and as demonstrated in the present study, the use of concept maps seem to help students in the learning process. **Even this study has involved few students, which is a limitation, we could observe that the creation of concept maps in a software, was capable of bringing the students closer to his reality, that is, the student who is connected to technology.** In turn, students have a high adherence to this type of teaching strategy.

## Conclusion

The creation of concept maps in the CMAP tools® software was effective in help in the learning of skeletal muscle components and contraction in physical education undergraduates. Learning

strategies need to be applied in physical education undergraduates to help them to understand physiology.

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