CONCEPT MAPS TO PROMOTE LEARNING IN ZOOLOGY

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Abstract. The construction of concept maps is a good pedagogical task; it is associated with higher-order thinking skills and has received international attention. Considering that this tool has been applied to Biology with special attention, the objective of this study was to highlight an experience with concept mapping as a method to promote learning about invertebrate animals. Using taxonomic descriptions obtained from textbooks, students developed activities to learn about concept maps, built and presented them to their classmates in a dynamic approach. Later the students wrote reports of their experiences in paper form. These papers were evaluated and the concept maps produced are discussed herein with a focus on their importance to improve understanding of animal taxonomy. The strategy of building concept maps related to invertebrates was well received by the students and two concept maps built in the teaching and learning process are being used in others classrooms and generating motivation to use concept maps in Zoology.

Keywords: concept mapping tasks; invertebrates; Gastrotricha; Nematomorpha

1 Introduction

Since its inception in the 1970's by Joseph Novak and his research group at Cornell University, the production of a concept map (CM) is recognized as an excellent didactic element. Novak & Cañas (2006) informed that concept mapping has received international attention, and is in continuous evolution. Their argument is that the extensive and ever-growing use of CMs is reflected in the popularity of digital and concept mapping software, its application in all domains of knowledge, and in the success of the International Concept Mapping Conference.

When re-examining the foundations for effective use of CMs, Cañas & Novak (2006) conclude that one´s comprehension about the foundations of concept mapping and the ability to propose good answers can help deal with the problems involved in building a CM and thus obtain a better-quality product. Novak and Cañas (2008), Cañas, Novak & Reiska (2015), and some authors that use Novakian concept map approach, show us how to access the necessary condition to become a concept mapper and even to reach a good concept mapper condition after following logical criteria. Cañas, Reiska & Novak (2016) consider that getting to build good CMs is 'hard', and inform that once the user gets the mechanics right including concept labels, proposition, hierarchical organization, linking lines, crosslinks, size, etc., the problem turns into the difficulty of expressing his or her understanding of the topic in a CM. Such as informed by Cañas, Reiska & Novak (2016), in relation to the size of a good CM, it is necessary to pay attention to its content and structure, and add: "… we need to consider the task under which the concept was constructed" (p. 131).

Concept mapping has always been associated with higher-order thinking skills, in particular critical thinking (Cañas, Reiska & Möllits, 2017; Novak & Cañas, 2008; Novak & Gowin, 1984). Cañas, Reiska & Möllits (2017) describe how concept mapping promotes the development of higher-order thinking skills and how it associates with critical thinking. According to this paper, the literature is vast and concept maps have been used in several contexts among them: biology, chemistry, medical education, nursing, bioengineering, Earth science, humanities, language, etc. Hay, Kinchin & Lygo-Baker (2008) and Kinchin (2011) have contributed with several papers dealing with operational and theoretical aspects regarding concept mapping in Biology. In Zoology, Stanisavljević & Stanisavljević (2014) investigated the use of concept maps in teaching about Annelida, an invertebrate group.

Anohina-Naumeka (2014) emphasize that "Regardless of the 40-years history of research in the field of concept mapping, CM based assessment mainly has been considered from the viewpoint of finding the most effective scoring mechanism for students' CMs" (p.108). According to this author: "a number of important questions such as effectiveness of different CMTs ['concept mapping task'] in relation to assessment of learning outcomes or elicitation of different cognitive processes, impact of availability of different elements of CMs on the difficulty degree of CMTs, students' preferences, or suitability of different CMTs for different purposes have been left disregarded" (Anohina-Naumeka, 2014, p. 108-109). Along these lines, the goal of the present study was to evidence an experience with concept mapping task as a method to improve learning of invertebrate Zoology in the context of a Biology course.

2 Methodology

A group of 59 first-year students enrolled in the Biological Sciences undergraduate course of the Federal University of Rio Grande do Norte (Brazil) in 2017, and distributed in two classes were assigned the task of building CMs. First, the students were instructed on the process of concept mapping through reading the literature mainly Novak and Cañas (2008) with further information from Åhlberg (2013), Aguilar Tamayo (2012) and Correia et al. (2016). Second, a CM involving contents on the taxonomic characterization of an animal group (e.g. Porifera) was then explained and made available to the students. In the third phase, a total of 16 groups of students (eight teams in each class) was asked to fulfill a "fill-in-the-map" task (following the terminology of Anohina-Naumeka, 2014), exploring concepts and linking words related to a focus question dealing with the taxonomic characteristics that define the taxa Cnidaria, Platyhelmintes, Annelida, Rotifera and Nematoda. Each team was asked to describe the propositions contained in the CM. A period of four class-hours was allocated for each animal group, and the CM construction was assigned as homework.

The fourth moment involved the proposal to construct a CM based on the focus question: "From a basic bibliographic source which characteristics show a general and specific taxonomic description of a group of animals?" Eight teams in each class of students received one of the following groups of invertebrate animals to be explored: Gastrotricha, Gnathostomulida, Micrognathozoa, Acanthocephala, Nematomorpha, Priapulida, Kinorhyncha and Loricifera. Each team was proposed a project using bibliographic references as a source for information aiming at the construction of a CM, as well as an additional didactic activity, based on the textbook by Ruppert, Fox & Barnes (2004). These tasks were later presented as acquired learning socialization involving the classmates. The process was evaluated by the course teacher, and all the teams, after some instructions, were motivated to write a full paper reporting the experience. Three teams wrote papers describing the whole process experienced with the production of the CMs to learn Zoology.

The first version of these three papers made by the students were reviewed by the senior author and created a new dialogue with the students involved. The papers were published in the proceedings of the 4th Brazilian Congress of Education: Oliveira, Aguiar & Araújo-de-Almeida (2017) (Kinorhyncha), Paiva et al. (2017) (Nematomorpha), Silva & Araújo-de-Almeida (2017) (Gastrotricha). In the present work they were updated by the authors following Brusca, Moore & Shuster (2016) to reflect the latest information available in Zoology textbooks. The new maps were built using CmapTools (Cañas *et al*, 2004), evaluated in: https://www.cmapacademy.org/practice/how-good-is-my-cmap.html.

3 Results

Figures 1 and 2 depict the updated CMs. These graphic organizers emphasize the taxonomic descriptions within the general characteristics of each group of animals, obtained from Brusca, Moore & Shuster (2016). These CMs became important teaching elements for the teaching process of Zoology, and students of later periods have accessed them as reference models for the visualization of concept structuring. With the development of a CM by students, the content presented in textbooks (i.e the zoological taxonomic descriptions), initially perceived as cryptic information, became more accessible for understanding, as Hay, Kinchin & Lygo-Baker (2008) said: “making learning visible”. This format of presenting information allowed us to discuss the characterization of the animal taxa in a more dynamic way, with potential for comparison with the original bibliographic source.

According to Aguilar Tamayo (2004): “La estrutura de los textos descrita es relevante para entender la manera en que es abordado el tema y la función que tiene el mapa conceptual al interior del texto”. The CMs inserted in Paiva et al. (2017) and Silva & Araújo-de-Almeida (2017), as well as their updated versions presented herein (Figures 1 and 2), allowed the senior author to stimulate the students to search for information more efficiently than simply reading the textbooks used for consultation. The pedagogical experience of teaching how to construct maps based on topics related to Invertebrate Zoology was well received by the students investigated. The positive experience demonstrated by the students during the accomplishment of the various tasks also promoted writing skills in the process of constructing the CMs themselves and writing down their propositions. The publication of the works from the students allowed us to bring to the classroom a new didactic strategy to motivate other textual productions related to the acquisition of knowledge in Zoology. The updating of the CMs by the authors configures the need to

demonstrate, in the teaching and learning process, that scientific knowledge is always being reviewed and updated, a condition that, according to Novak & Cañas (2008), is also present in the construction of a concept map.

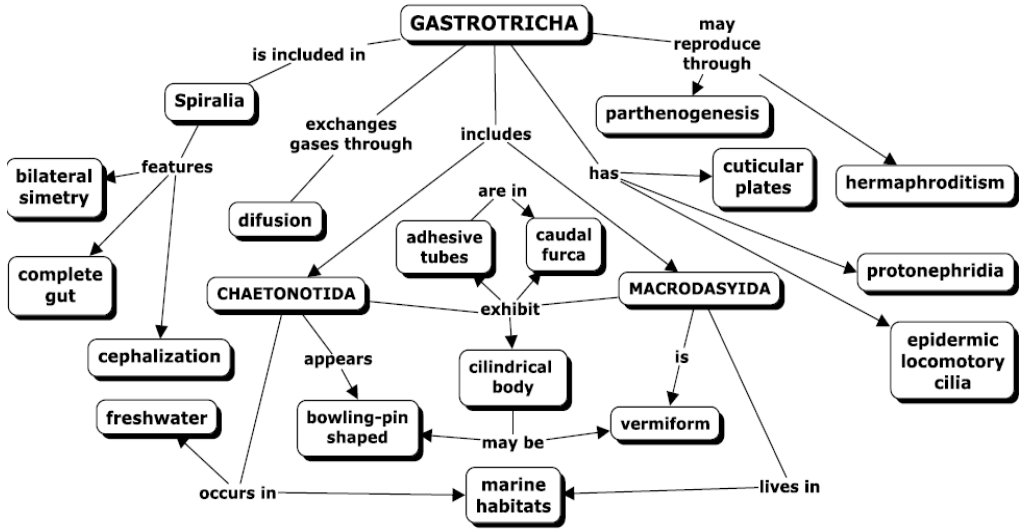

Figure 1. Concept map answering the focus question: Which characters show a general and specific taxonomic description of gastrotrichs? (Modified from Silva & Araújo-de-Almeida, 2017).

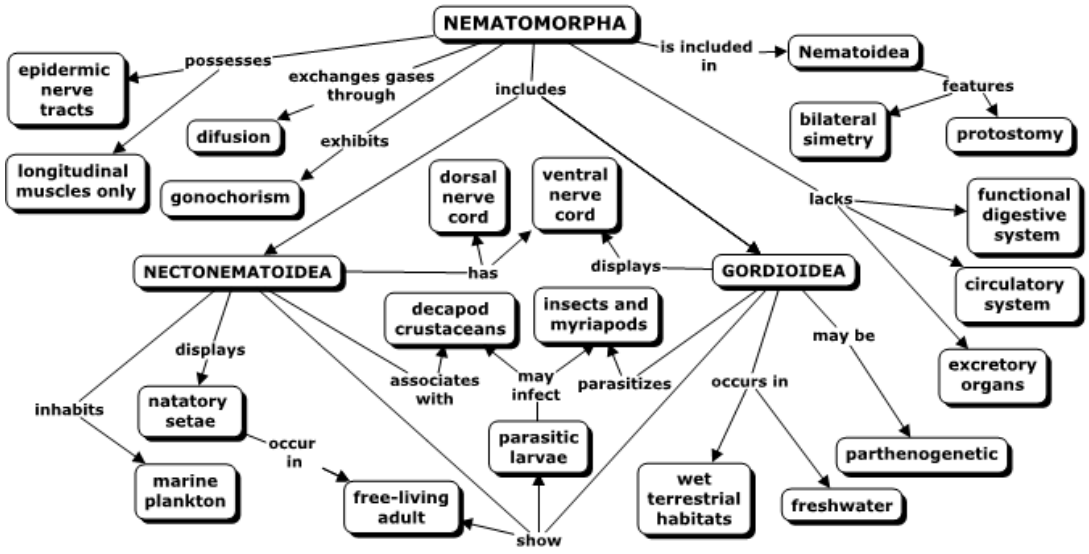

Figure 2. Concept map answering the focus question: Which characters show a general and specific taxonomic description of nematomorphs? (Modified from Paiva et al., 2017).

4 Conclusions

Concept maps built on the information available on animal taxa are dynamic elements for learning in Zoology, as well as for understanding and/or deepening the process of concept mapping by students. The product obtained from the concept mapping task offered to the students, emphasizing the taxa Gastrotricha and Nematomorpha, are relevant didactic sources for future practical applications on concept mapping. Furthermore, the ordering of updated information in the CM permits the development of several proposals of activities to be considered in the teaching

process at different moments of learning. The development of activities involving teacher and student interaction in the construction of knowledge concurs with an effective and motivating teaching and learning process.

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