Teaching Unit on Geometry designed from the point of view of the Theory of Nuclear Concepts

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Abstract

This work has the main objective to present a practical aspect of Theory of Nuclear Concepts (Casas and Luengo, 2003), in particular present a model of a didactic unit completely governed by the ideas of that theory. Thus, we intend to show that consists of a didactic unit based on this theory by highlighting the benefits of its implementation and transfer tools will lead to construction of new teaching units on the same line of ideas. The Theory of Nuclear Concepts is recent, but many studies have been done about it, exploring various aspects of that theory. This theory is based on the theories and ideas coming Ausubel (1968), Novak and Gowin (1984) among others, who argue that concepts are organized hierarchically around general concepts (concepts includers). The Theory of Nuclear

Concepts differs from them in holding that the students' cognitive structure is organized around specific concepts that are not necessarily the most general and also argues that as learning progresses the students' cognitive structure is transformed into a simpler structure. To explain these facts the authors propose a "Theory of Nuclear Concepts" whose main elements are the "geographical organization of knowledge", the "core concepts" and "paths of least cost." This theory provides a broad knowledge of students' knowledge and this enables a better intervention by the teacher, it is important to note that the study refers to the Pathfinder associative networks. The practical approach and broad knowledge of the conceptual frameworks of students during the learning process is a tool that contributes to student success in mathematics. In our study, we propose the development of mathematics teaching sessions based on this theory, and also propose the assessment of student learning based on the changes produced in their cognitive structure.

1.- Introduction

This article briefly describes an ongoing investigation that aims to understand the impact of the implementation of a mathematics didactic unit, taught according to the Theory of Nuclear Concepts [1], on the cognitive structures of students. For the collection and representation of cognitive structures in the form of Pathfinder Associative Networks [5] used the software GOLUCA [3].

2.- Theory of Nuclear Concepts.

Theory of Nuclear Concepts (TNC), developed by Casas and Luengo (2005), sought their epistemological background in cognitive science, focusing on the theoretical foundations for the organization of human knowledge [2]. The TNC uses terms, methods and techniques (Pahfinder Associative Networks, RAP) of work themselves. The elements of this theory are the organization's geographical knowledge, the notion of core concepts and the notion of “lower cost path” [1] [2].

2.1 .- Geographical organization.

According to this theory, the acquisition of a concept is similar to the acquisition of geographical knowledge, where there are points highlighted in the landscape within which to establish routes [2]. Similarly, the learning of a new concept is always associated to others and never alone, forming a structure. When you dominate the relationships established in this structure was reached a general understanding of the concept [1].

2.2.- Nuclear concepts.

The most prominent points of geographical knowledge are not necessarily the most important points, but those who for various reasons have called more attention to the subject [1]. Similarly, a cognitive structure, the points highlighted are not only the more significant by their degree of generalization or abstraction, but also examples used in the teaching process, which for various reasons the subject is most identified. These are the Nuclear Concepts [1] [2].

2.3.- Lower cost paths.

Cognitive structure organized around a concept does not necessarily become more complex as knowledge increases, but that subjects used, depending on the purposes for each case, simpler structures, called "lower cost paths" [2].

2.4.- Pathfinder Associative Networks.

The authors of the theory of nuclear concepts, proposed to identify relationships between the concepts of a cognitive structure [2], the Pathfinder Associative Networks [5], highlighting the lower cost paths and most important concepts [4]. These networks are graphical representations in the form of graphs, in which the concepts are represented as nodes and relations between them and the line segments of varying length, depending on the importance given to the semantic proximity.

3. GOLUCA.

For the collection of semantic relatedness, calculation and graphical representation of the RAP it has been developed the software GOLUCA. This software organizes and stores the values of proximity or similarity between concepts in a matrix and the Pathfinder algorithm finds the indirect routes between the concepts and selects only links with the shortcut shortest distance [5]. Despite all the concepts are interrelated (Figure 1), only the strongest relationships are considered and represented graphically in a RAP (Figure 2).

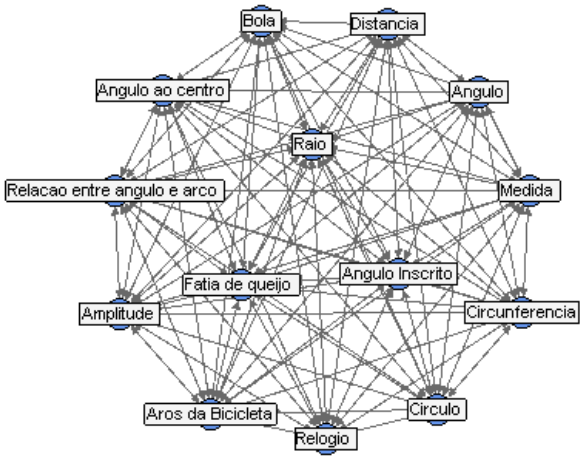

Figure 1 – Pathfinder Associative Network with all connections between the concepts.

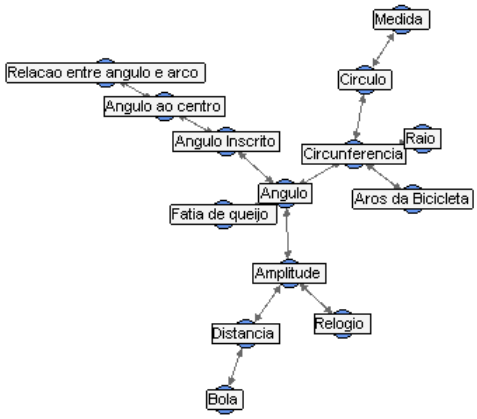

Figure 2 – Pathfinder Associative Network with stronger links between the concepts.

GOLUCA works in Microsoft Windows environment and its overall objective is to collect, analyze and graphically represent Pathfinder Associative Networks [3]. The data collected are organized into similarity matrices stored in a single file, named MGoluca project. Afterwards, and automatically, the matrices are represented graphically and analyzed statistically [3].
GOLUCA assumes the role of questioner, questioning students and collecting their answers without the direct influence of the investigator and finally stores them in a file [3]. We believe that this type of collection has advantages because there is no direct influence of the investigator, the time for

collecting and organizing data is faster because it is done automatically and stored directly in digital format. The processes of classification, coding and data counts are simplified [3].
The interface for data collection consists of various objects of which are noted for their importance, the pair of concepts and the scale of weights to assign to the proximity of concepts. These may take words, phrases, images or sound [3].
The data collected are organized into similarity matrices, which in its own interface, are represented in the form of RAP and statistical studies are made, such as Medium Network, Consistency Index and the index of complexity of networks [2] [5].

3.1.- Network average.

The average network corresponds to a Pathfinder associative network, whose similarity matrix is composed of the average weights of two or more similarity matrices of one or more individuals. The calculation of average networks has the advantage of linking data from several networking groups and makes comparisons between networks of students with teachers [4].

3.2.- Coherence measure.

The coherence measure reflects the consistency of the data collected. Corresponds to the degree of learning and indicates whether the user assign the values of similarity attentively or rashly. This measure varies between -1 and 1. Its calculation is based on the premise that the relationship between a pair of concepts can be determined from these relations with the rest [5].

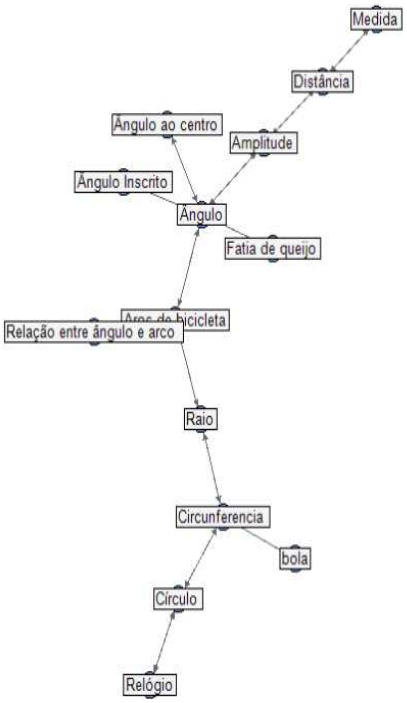

Figure 3 - Network of reference used to prepare the didactic unit TNC.

3.3.- Networks complexity measure.

The Networks complexity measure, developed by Casas and Luengo [1] from Novak recommendations for concept maps assessment, is a quantitative indicator designed to measure the complexity of a network and varies between 0 and 1.

4. Didactic unit based on the Theory of Nuclear Concepts.

A didactic unit based on the Theory of Nuclear Concepts is governed by an ideology totally distinct from the traditional didactic units, not worrying only in structuring the content to be taught, but simultaneously with the students' cognitive organization.
To develop a teaching unit based on TNC, the first duty is make a preliminary identification of the concepts that form a conceptual reference network (Figure 3), recognizing the most significant concepts and build from that network instruments that will change the students' cognitive networks. This selection of concepts must follow certain criteria: must be based on scientific literature, on the practice of various professionals and textbooks. The scientific literature gives the concepts that are more related to the subject matter, on the other hand, the practice of teachers is an essential tool that allows a closer view of the reality of the students, because they transmit knowledge and select the tasks, examples and exercises. The teacher, through practice teaching, easily identifies the most common gaps and the more often associations between concepts make by students. The textbooks are a teaching tool, because they present in a particular organization, descriptions of contents and reflect the practice of teachers, allowing thus identify which concepts are most often used on a same content.
After having obtained a conceptual reference network, proceed to the elaboration of didactic unit according to TNC. The approach of the contents and the elaboration of the tasks are conditioned by the conceptual reference network, thus distinguishing itself from the usual lesson plans. In the preparation of resources have in mind the relationships that considered correct among the most significant concepts and reinforces those that are considered most important. Also produce tools to help eliminate possible erroneous relationships in students' cognitive structures. This didactic unit is distinguished, too, the usual units, regarding the evaluation, since it is concerned not only with school results (quantitative) of the students but simultaneously with the cognitive structures developed by

them. In a particular way, we can quantify and analyze these structures in the rate of Coherence and similarity to others.

4.1.- Description of experience.

This investigation has the objective to research the impact about the implementation of the didactic unit Mathematics "Circle, central angle and angle inscribed ", governed by the ideas of the TNC. The data presented in this article correspond to a sample of thirty-three students from the ninth grade, of a Portuguese school.
For preparation of the reference network (Figure 3) were selected fourteen concepts in the manner described above and performed a preliminary study with a sample of 75 ninth grade students from the same school, to detect the absence of links considered important or erroneous connections. The concepts circumference, bicycle rims and angle have more connections to other concepts, for what are considered nuclear concepts. Of these, only angle and circle are mathematical concepts so it was from them that were produced the entire didactic unit.
On this base, it were developed tools, such as worksheets, problems and files, so as to enhance, delete, and create relationships between mathematical concepts. For relations: radius - circle; circle - circle, angle - amplitude, angle - inscribed angle, angle - angle to the centre; it were designed tasks that strengthen these relationships, because in several structures of the previous study found that were lacking. It was noted also that many of the students established wrong relationships between ball (sphere) - circle, circle - ball, so we created tasks to eliminate these relationships.

4.2.- Application of the didactic unit.

The sample was divided into two groups, one that consists of sixteen students under the new methodology and the other eighteen students under the usual methodology.
To understand the cognitive structures of the two groups, students were subjected to a pre-test before being taught the didactic unit and later a post-test using the software Goluca.

4.3.- Data and discussion.

It was observed that the coherence of the cognitive structures of students, evaluated by Goluca Software, under the new methodology showed an improvement compared to students who were subject to the usual methodology.

	N	Minimum	Maximum	Mean	Std. Desv.
coh tnc pre	16	-,41	,62	,1503	,28497
coh tnc post	16	-,04	,70	,2029	,21885
coh control pre	17	-,30	,56	,1507	,29422
coh cont post	17	-,30	,47	,1203	,20480
N	16				

Legend:
coh tnc pre – coherence pre-test group of students under the TNC methodology
coh tnc post - coherence post-test group of students under the TNC methodology
coh control pre- coherence pre-test group students under the usual methodology
coh cont post- coherence post-test group students under the usual methodology
N- number of valid data
The data are not statistically significant, perhaps given the small number of elements in the sample. However the study is still ongoingl, and we expect that, vith a larger sample we would observe a more conclusive impact.

References

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