Concept Maps: Making Learning Meaningful
Proc. of Fourth Int. Conference on Concept Mapping
Viña del Mar, Chile, 2010

CONCEPT MAPS IN THE HISTORY OF DEFINITIONS SI BASE UNITS: A COLLABORATIVE LEARNING PROPOSAL FOR THE TEACHING OF METROLOGY

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Abstract. This paper aims demonstrating the use of concept mapping in the teaching of Metrology. Concept maps are schematic structures used to represent a group of concepts within a proposition net, considered as a technique or teaching resource created by Novak and supported by Ausubel's Meaningful Verbal Learning Theory. The elaborating of concept maps promotes learning facilitation and knowledge appropriation by personal elaboration, obtained from preexistent concepts in one's cognitive structure.

1 Introduction

The knowledge over the world that surrounds us and the capacity to take action on it making correct and effective decisions depend greatly on our ability to make measurements, in other words, to quantify attributes by means of a process of comparing patterns. (Jornada, 2005) Metrology, the "science of measurement and its application" (Vim, 2008), accreditation, standardization and quality are the technological tools of MAS-Q practices, which provide a vital link to global trade, market access and export competitiveness as they contribute to consumer confidence in product safety, quality, health and the environment (PNADP, 2010).

MAS-Q practices are an answer to market requirements and depends on capacitating people in order to apply all of the tools. (Zapata et al., 2009) Metrology is one of the basic tools for technology and innovation, having transversal content present in diverse areas of knowledge and specially in the teaching of Natural Sciences, Mathematics and its Technologies.

The teaching of metrology or metrological education is an object of study in various countries, including Brazil (Ohayon; Neiva; Palhares, 1998), due to its strategic character (Correia, 2004), and one of the biggest problems it faces is of cultural nature. (Hojo et al.*,*2005*).* The scales and units of measurement are key-concepts for the teaching of metrology and various studies have identified difficulties in dealing with these subjects in classroom. Perez (2008) indicates the need to take a step forward in the social representation of math teachers from a point of view restricted to four elements – length, meter, scale and size – towards a relational system of concepts. The document named under "Curricular Reorientation for High School – Natural Sciences and Math" from the State Education Division of Rio de Janeiro, underlines the importance of the student's perception that the definition of physical scale is not arbitrary, but originates from previous experiences and ideas (Pereira, 2009).

Once Inmetro, Brazilian National Metrology Institute (NMI), is responsible for maintaining and preserving Brazil's units of measurement patterns, the translation of posters about the history of definitions base units of the International System of Units – SI, produced by England's National Physical Laboratory (NPL), was identified as an action towards the diffusion of the metrology and conformity assessment culture in the country. The translated posters show the evolution of the definitions of SI base units along history, besides curiosities on measurement methods, applicable devices and its social-economic relevance. Base units are measuring adopted for base quantities. These quantities were chosen in such a way so that none of them can be expressed in function of others. Base quantities and its units are respectively: length – metre, mass – kilogram, time – second, electric current – ampère, thermodynamic temperature – kelvin, amount of substance – mole, and luminous intensity – candela.

Printed in paper size 3x3 m for exhibit during the National Science and Technology Week in Rio de Janeiro (October 2009), these posters mobilized the interest of teachers for its use in the classrooms. Due to this, Inmetro's Capacitating Center research group developed a didactic sequence proposal for there application throughout the use of concept mapping in order to promote collaborative learning on the history of the definitions of SI base units.

2 The Didactic Sequence Proposal: results and conclusion

- The didactic sequence was as follows:
- The teacher receives a kit composed of seven posters referring to each one of the base units;
- Students are organized in groups and each group gets a poster;
- After reading the information on the poster, the groups make up a concept map about the history of the base unit described in their poster using CmapTools (v. 5.03) software;
- The concept map is presented to the rest of the class;
- In a collaborative manner, the class changes the initial proposal of the map and produces new and exclusive material.

To this proposal consolidation, two experiments aim to compare different views of same subject, was applying using CmapTools (version 5.03) based on information from the International Units System (SI) History poster: the first showed on Figure 1, was a concept maps made by Inmetro's Capacitating Center experts research group; it was followed by a educational experience made with collegial students from a Rio de Janeiro state school in a physics class where they developed in a workgroup the conceptual map showed in Figure 2.

On compare both maps, the expert's maps showed more concepts relations against the students group's map witch in spite use all poster information, it only show concepts displayed without connections, not applying labels links or conceptual categories. The student's focus was to reproduce the poster information about Measure Instruments History timeline. On the other hand, the expert's conceptual map ignored the timeline information, it show somehow the complement of both view.

The class experiment demonstrated the needs of students teaching about conceptual map subject in order to build students capability skill else they would not able to have it done.

The students did enjoy the class dynamic using conceptual maps since it was a different way to learn about physics concepts. The results were considered very satisfactory and indicate that concept maps helped to build a meanfull learn about metrology concepts in the elementary school.

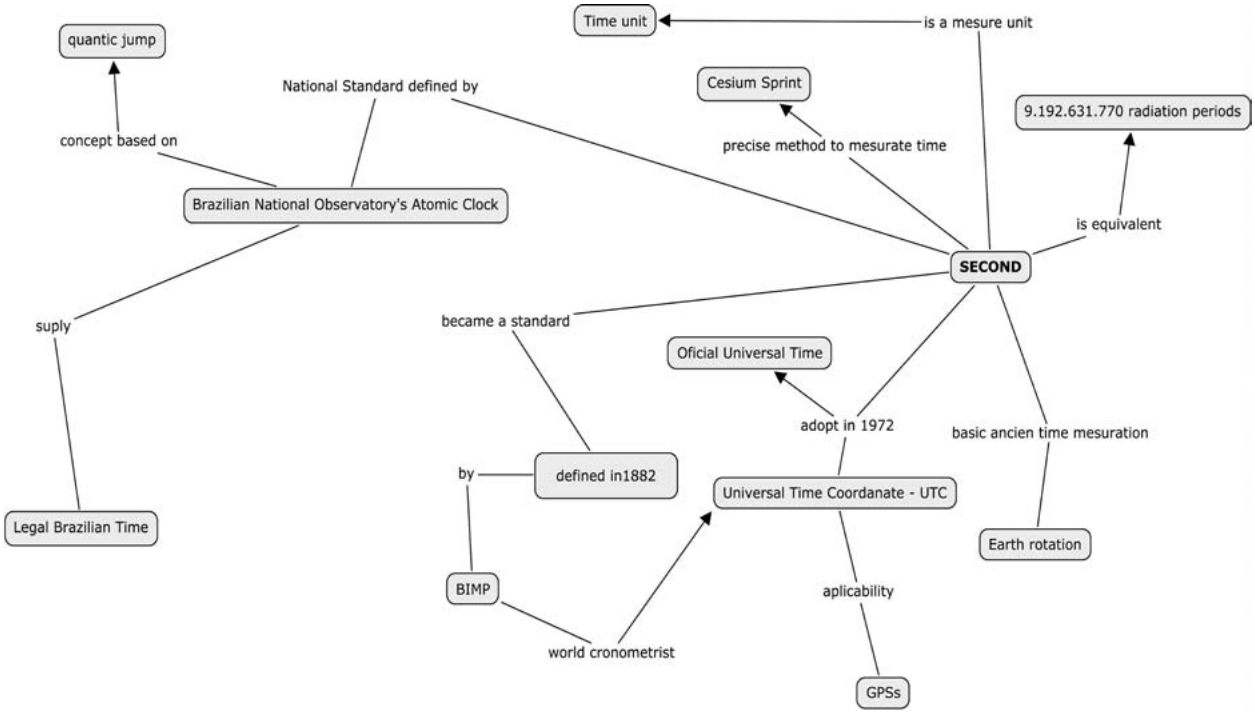

Figure 1. Time Unit Concept Mapping by an expert

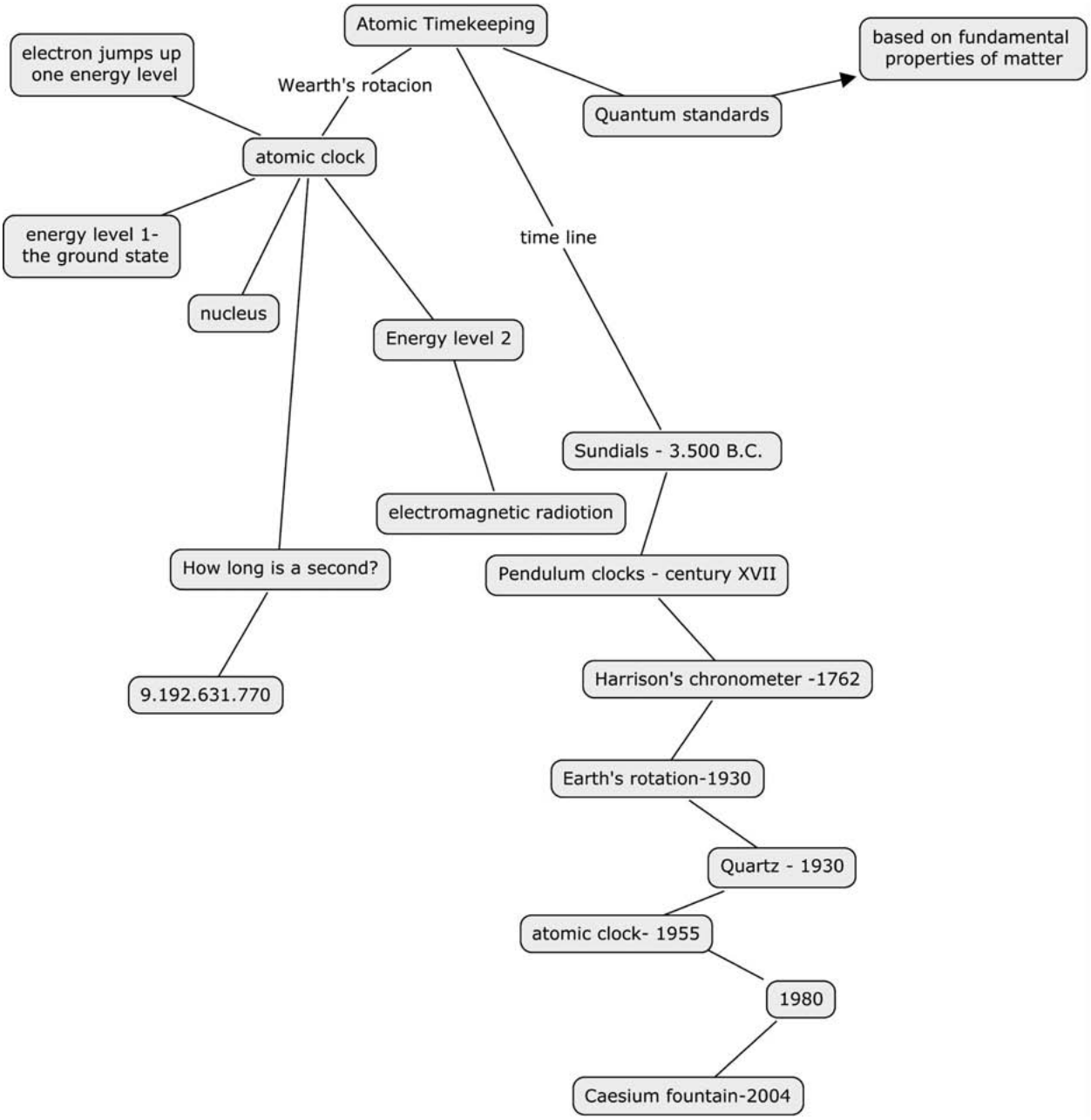

Figure 2. Time Unit Concept Mapping by beginners

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