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THE DEVELOPMENT OF A NEUROSCIENCE-BASED METHODOLOGY FOR THE NUCLEAR ENERGY LEARNING/TEACHING PROCESS

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ABSTRACT

When compared to other energy sources such as fossil fuels, coal, oil, and gas, nuclear energy has perhaps the lowest impact on the environment. Moreover, nuclear energy has also benefited other fields such as medicine, pharmaceutical industry, and agriculture, among others. However, despite all benefits that result from the peaceful uses of nuclear energy, the theme is still addressed with prejudice. Education may be the starting point for public acceptance of nuclear energy as it provides pedagogical approaches, learning environments, and human resources, which are essential conditions for effective learning. So far nuclear energy educational researches have been conducted using only conventional assessment methods. The global educational scenario has demonstrated absence of neuroscience-based methods for the teaching of nuclear energy, and that may be an opportunity for developing new strategic teaching methods that will help demystifying the theme consequently improving public acceptance of this type of energy. This work aims to present the first step of a methodology in progress based on researches in neuroscience to be applied to Brazilian science teachers in order to contribute to an effective teaching/learning process. This research will use the Implicit Association Test (IAT) to verify implicit attitudes of science teachers concerning nuclear energy. Results will provide data for the next steps of the research. The literature has not reported a similar neuroscience-based methodology applied to the nuclear energy learning/teaching process; therefore, this has demonstrated to be an innovating methodology. The development of the methodology is in progress and the results will be presented in future works.

Keywords: Implicit Memory, Implicit Association Test, Nuclear Energy and Education.

1. INTRODUCTION

When compared to other energy sources such as fossil fuels, coal, oil, and gas, nuclear energy has perhaps the lowest impact on the environment. Moreover, nuclear energy has also benefited other fields. For instance, in medicine it plays a relevant role within medical diagnosis and treatment processes. In the pharmaceutical industry it has been used to sterilize products. In agriculture ionizing radiation is used as an alternative to chemicals in the

treatment and preservation of foods, being used to produce crops with increased yield or shorter growing time, resistant to diseases, as well as for insect control [1]. However, despite all benefits that result from the peaceful uses of nuclear energy, the theme is still addressed with prejudice. Concerns over safety, waste, terrorism and security public perceptions and acceptance can be cited as examples of barriers for nuclear use.

Although there is a lot of controversy on nuclear energy use, the growth in world energy demand, the availability, security and reliability of fossil fuel supplies as well as environmental effects of fossil fuel provide a great opportunity for the nuclear energy industry.

Education may be the starting point for public acceptance of nuclear energy as it provides pedagogical approaches, learning environments, and human resources, which are essential conditions for effective learning. According to a recent literature review the first educational researches on nuclear energy were published in the 80´s and discussed the characteristics of science teaching, reporting failure to plan and teach students for the development of positive attitudes toward science [2].

Several studies on nuclear energy education have been conducted addressing the conceptual and practical issues of nuclear energy, and the results have demonstrated that the theme should be better addressed, encouraging students to research more about it [3-8]. So far nuclear energy educational researches have been conducted using only conventional assessment methods. The global educational scenario has demonstrated absence of neuroscience-based methods for the teaching of nuclear energy, and that may be an opportunity for developing new strategic teaching methods that will help demystifying the theme consequently improving public acceptance of this type of energy [2].

Educational neuroscience is an is an emerging scientific field that explores the interactions between biological processes and education by doing researches in cognitive neuroscience, developmental cognitive neuroscience, educational psychology, educational technology, and other related disciplines. The ability of the brain to learn supports the link between neuroscience and education. While education is connected to enhancing learning, neuroscience is connected to understanding the mental processes involved in learning. Neuroscience provides conditions for the understanding of early brain development, and how the brain changes may relate to learning processes. By providing new measures of the effects of learning and teaching, including brain structure and activity, neuroscience may contribute for adopting different types of teaching/learning methods [9-12].

This work aims to present the first step of a methodology in progress based on researches in neuroscience to be applied to Brazilian science school teachers in order to contribute to an effective teaching/learning process.

2. RESEARCH DEVELOPMENT

One of the great successes of modern neuroscience is the analysis of the anatomical and physical bases of learning and memory. Human memory includes multiple systems. An essential aspect in memory research is the distinction between implicit and explicit memory. Implicit memory refers to the retrieval of pre-acquired representations without conscious

awareness of memory while explicit memory refers to conscious reflection of previously studied information. Besides being associated with procedures and automatic responses, the implicit memory makes strong associative connections, which occur without conscious awareness towards an attitude object or the self [13].

Studies on implicit memory emphasize the influence of spontaneously activated cognitive processes on behavior through means that do not require conscious deliberation. Both implicit and explicit memory experiences can be present in transference, influencing each other [14]. Information that is encoded in the implicit memory may be modified by new knowledge; thus, implicit memory is subject to changes by the explicit memory.

Attitude is the positive or negative evaluation of a certain concept – person, place, idea. While an explicit attitude is the kind of attitude that is thought and reported deliberately, the implicit attitude occurs outside of conscious awareness and control. Besides attitudes, stereotypes may also be implicit or explicit. Stereotypes are the belief the most members of a certain group have some characteristics [15].

Concerning nuclear energy, people worldwide have explicit and implicit attitudes and stereotypes, which influence their behavior towards the theme and drive decision making. The explicit evaluation and/or belief may be easily recognized by others; however, the implicit attitudes and stereotypes cannot be recognized except through specific types of implicit association tests such as the Implicit Association Test (IAT) [16].

This research will use the IAT to verify implicit associations of science teachers concerning nuclear energy. The IAT is a chronometric procedure that quantifies strength of conceptual associations by contrasting latencies across conditions. The IAT measures the relative strength of association between concepts in different categories by measuring how long it takes to categorize stimuli from the four categories with just two response options. The test relies on the assumption that it ought to be easier to make the same behavioral response (a key press) to concepts that are strongly associated than to concepts that are weakly associated [16]. The test has been widely administered and the successful results have demonstrated IAT to be reliable [17-19].

The IAT procedure has five steps, with steps 3 and 5 providing critical data. Participants are asked to quickly sort words into that are on the left and right hand side of the computer screen by pressing the “E” key if the word belongs to the category on the left and the” I” key if the word belongs to the category on the right.

2.1. Demonstration of the 5 steps of the IAT designed for science teachers

For the present research a group of science teachers will categorize representing four categories – nuclear power plant, hydropower plant, advantage words, disadvantage words – in two different conditions: (a) categorizing nuclear power plant and advantage words together with one response key, and hydropower plant and disadvantage words together with another response key; and (b) categorizing hydropower plant and advantage words together with one response key, and nuclear power plant and disadvantage words with the other. The difference in average response latency between conditions is taken as an indicator of differential association strengths among the concepts.

In order to demonstrate the 5 steps of the IAT designed for his research, one example of possible association will be provided in Figures 1 to 5.

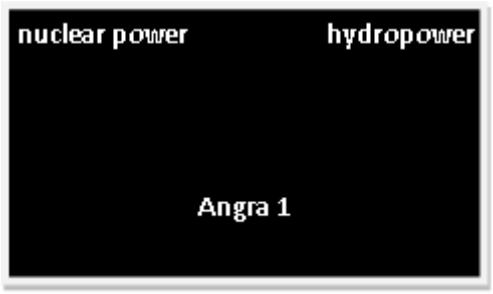

Figure 1: Demonstration of step 1: the concept dimension.

Figure 2: Demonstration of step 2: the attribute dimension.

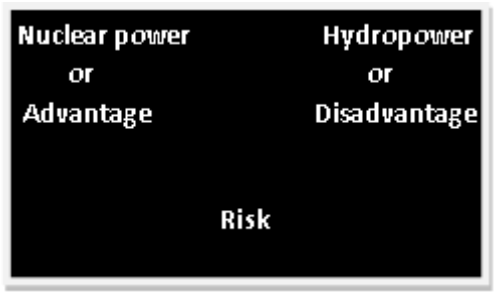

Figure 3: Demonstration of step 3: concept-attribute pairing.

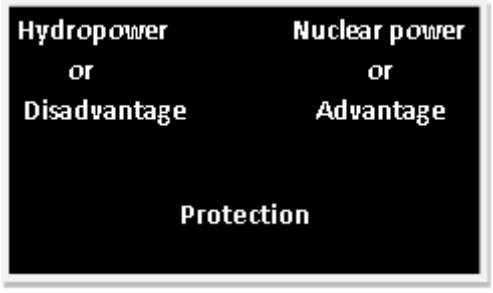

Figure 4: Demonstration of step 4: switching the spatial location of the concepts.

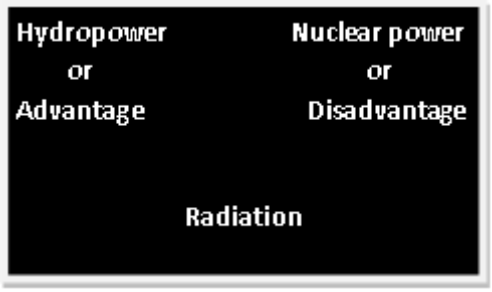

Figure 5: Demonstration of step 5: the categories are combined in an opposite way.

The IAT effect is calculated using latency data from steps 3 and 5. The software MS-Excel and the Statistical Package for Social Sciences (SPSS) will be used for data analyses: for descriptive statistics and multivariate analysis, respectively.

3. CONCLUSIONS

Results from the IAT administered to science teachers will provide data for the next steps of the research. The literature has not reported a similar neuroscience-based methodology applied to the nuclear energy learning/teaching process; therefore, this has demonstrated to be an innovating science- based methodology. The development of the methodology is in progress and the results will be presented in future works.

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