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NUCLEAR ENERGY EDUCATION SCENARIO AROUND THE WORLD

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ABSTRACT

Nuclear energy has been used as a source of clean energy with many benefits.. Nevertheless, it is still addressed with prejudice. The atomic bombing of Hiroshima and Nagasaki during World War II (1945), the Three Mile Isl and accident (1979), Chernobyl accident (1986), the crash of the cesium-137 in Goiânia, Brazil (1987), and the recent accident in Fukushima (2011) may have been responsible for the negative image of nuclear energy. Resea rches on education have been conducted with students concerning the conceptual and practical issues of nuclear energy. This work aims to review the literature about nuclear energy education around the world in both, elemen tary school and high school. Since most educational researches on nuclear energy were published after 1980, this literature review covered the researches that have been published since 1980. The data were presented in chronological order. The results from the literature review provided a clear visualization of the global nuclear en ergy educational scenario, showing that the theme is still addressed with prejudice due to an incorrect view of nuclear energy and a limited view of its benefits. Concerning the science textbooks, the literature reports that the theme should be better addressed, encouraging students to research more about it. The data from this literature review will serve as a reference for a future proposal for a teaching training program for Brazilian scie nce/physics high school teachers using a new teaching approach.
Keywords: Nuclear energy, education, teaching, learning.

1. INTRODUCTION

Nuclear energy has been used as a source of clean energy with many benefits. The use of nuclear energy in place of other energy sources, such as fossil fuels, coal, oil and gas, contributes to keep the environment clean, preserve the Earth's climate, avoid ground-level ozone formation and prevent acid rain. When compared to other energy sources, nuclear energy has perhaps the lowest impact on the environment.

Furthermore, nuclear energy has meant a lot of improvement in other fields. It is widely used in the field of medicine, playing a role within medical diagnosis and treatment processes. In the pharmaceutical industry, it is used for the sterilization of pharmaceutical products. In agriculture the ionizing radiation from radioisotopes is used to produce crops that are more drought and resistant to diseases, crops with increased yield or shorter growing time, as well as for insect control. Ionizing radiation is used as an alternative to chemicals in the treatment and preservation of foods [1].

Despite all benefits, nuclear energy is still addressed with prejudice. The atomic bombing of Hiroshima and Nagasaki during World War II (1945), the Three Mile Island accident (1979), the Chernobyl accident (1986), the crash of the cesium-137 in Goiânia, Brazil (1987), and the recent accident in Fukushima (2011) may have been responsible for the negative image of nuclear energy.

Information dissemination through mass media provides a controversial knowledge of nuclear issues among the general public. This work aims to review the literature about nuclear energy education around the world in both, elementary school and high school.

2. METHODS

This is a literature review on energy nuclear education around the world. Since most educational researches on nuclear energy were published after 1980, this literature review covered the researches that have been published since 1980. Books published on the subject were not included in this literature review. Nuclear energy, education, teaching and learning were the keywords used for searching data. The results were presented in chronological order.

3. RESULTS AND DISCUSSION

Most educational researches on nuclear energy were published after 1980. That fact may be due to the first accident at a nuclear power plant: the Three Mile Island accident, in 1979. Since then, studies on education have been conducted with students, concerning the conceptual and practical issues of nuclear energy.

The first researches published in the 80´s discussed the characteristics of science teaching, reporting failure to plan and teach for the development of positive attitudes toward science. Lessons focusing on the recall of facts, concepts and principles did not prepare students to make judicious decisions about science [2]. It was also reported that TV had far more influence on what students believed about science than did several science courses; therefore the challenge to science educators would be to use the media effectively in combating incorrect views about science [3].

Since the introduction of energy education into existing curricula and implementation strategies of it in the classroom of secondary schools were matters of discussion in Italy, Viglietta emphasized the role of school physics as a powerful tool for students´ better understanding of energy [4].

Although the national associations in the United States urged on the early energy teaching, a national probability sample of American high school students was assessed, and the results revealed low levels of environmental knowledge. Most students were not able to apply their knowledge to understand the consequences or potential solutions related to environmental problems. The authors discussed educational implications and recommendations to help students learn how to apply their knowledge [5].

In 2003, a research investigated the conceptual understandings of 78 16-year-old Australian high school students' and their knowledge about several issues related to nuclear energy. The results demonstrated that although the students knew about applications of nuclear technology, they retained their fears of the potential for nuclear energy to cause widespread damage or disaster [6]. Also in 2003, a study conducted by the Department of Earth Sciences, National Taiwan Normal University, Taipei, Taiwan, and the Department of Mathematics, Science and Technology, Teachers College, Columbia University, NY investigated senior high school students' cognitive orientation toward scientific or social information, designated as information preference, and associated preferential reasoning modes when presented with an environmental issue concerning the use of nuclear energy. Statistical analyses demonstrated that students' performance in science was a good predictor of the information preference presented by students. Interview content analysis showed that students' preferences and reasoning modes were mutually consistent [7].

Samagaia and Peduzzi developed, applied and evaluated a Physics teaching unit for Brazilian 8th grade classroom. The unit contents include nuclear fission, radiation, energy, chemical and biological weapons research and utilization. The Role-Playing Game (RPG) technique, which suggests the use of a problem-situation, was applied to approach these issues [8].
In Germany, disappointing results of international monitoring studies like Third International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) fomented debates on the need of improvement the quality of science instruction in schools. Duit concluded that research and development activities have to be intimately linked, because science education research drawing on this framework is an imperative prerequisite for improving instructional practice and hence for the further advancement of scientific literacy [9].

Researchers from the University of Washington and the University of Udine, Italy, published a paper illustrating the process of curriculum development guided by research on student learning at every stage. Guidelines provided by national American associations claiming that energy should be taught as a central theme beginning in primary school and Italian national curriculum indications for kindergarten and primary school, which stressed energy as one of the four main cognitive organizers of great importance in the first school cycle, were the foundations for the work [10].

In Brazil a series of researchers on nuclear energy education were published from 2009 to 2011. Based on the Programa Nacional do Livro Didático (PNLD) and Parâmetros Curriculares Nacionais (PCN), Zorzi and Santin, examined the theme radioactivity in chemistry textbooks used by most high school teachers in Brazilian public schools The authors provided suggestions, such as texts and activities that relate nuclear energy to social, political and ethical issues for a better understanding of the theme. The authors also suggested topics such as the use of nuclear energy in several fields – agriculture, medicine, pharmaceutical industry and others – to be included in the textbooks [11]. Also having the PCN and the LBD – Leis de Diretrizes e Bases da Educação Nacional – as references, Benites and Gordon investigated the knowledge of Brazilian high school students from public schools about nuclear technology and its applications. The students answered a questionnaire about nuclear technology and basic concepts of nuclear physics before and after attending a speech on the theme. The students also attended round table discussions on the theme. The authors reported that 55% of the subjects had an incorrect view about nuclear energy and 84% had a limited view about the benefits of nuclear energy [12].

In order to observe how the theme nuclear physics was addressed in Brazilian high school textbooks, Souza and Germano examined the content, text organization and activities proposed by the books´ authors. They concluded that the content related to nuclear physics is presented apart from a social and/or cultural context [13].

Again the theme radioactivity was considered in a study conducted by Castro and Ferreira, who observed how the theme had been addressed in high school Chemistry textbooks from 2008 to 2010. PNLD, PCN and PNLDEM – Programa Nacional do Livro Didático do Ensino Médio – were taken as references for the study. They reported that although the books addressed the alpha, beta and gamma rays as well as their use in industrial processes, the environment, the social, political and ethical issues, and the nuclear energy risk-benefit analysis were not discussed. Moreover, the books neither encouraged research nor the search for complementary texts [14].

In order to observe the level of knowledge of the population from the surrounding areas of the research reactor IEA-RI, located at the Instituto de Pesquisas Energéticas e Nucleares (IPEN), questionnaires were administered to subjects aged 12 -80 from different socio-economic and cultural backgrounds. Based on the results the authors suggested that the creation of a project using media accessible to the public could contribute for a better understanding of nuclear energy [15].

Kiiper reported that after administering questionnaires on forms of energy, nuclear energy and its benefits to high school, physics and engineering students as well as to general public 6 months after the accident in Fukushima, the results demonstrated rejection and decrease of perception of nuclear energy benefits [16]. According to Villar, better physics teaching with emphasis on radioactivity and radiation science could improve public awareness through education of the environmental benefits and relative safety of nuclear power generation [17].
Regarding the accident in Fukushima, a longitudinal study conducted in Switzerland before and after the accident assessed acceptance, perceived risks, perceived benefits, and trust

related to nuclear power stations. Results demonstrated that the acceptance and perceptions of nuclear power as well as its trust were more negative after the accident [18].

In 2012, a research published in the United States investigated 1043 eighth-grade students' knowledge of energy resources and associated issues including energy acquisition, energy generation, storage and transport, and energy consumption and conservation. .Findings revealed that students did not have a correct understanding of the issues assessed. The author discussed implications for teacher enactment of energy resources curriculum activities [19]. Modanez argued that early teaching in schools about the benefits of nuclear energy – mainly the food irradiation – would be crucial for the acceptance of new technologies [20].

New standards – The Next Generation Science Standards – for science teaching have been recently discussed by researchers from the University of Illinois, USA. These standards focus on science skills and content, and were developed by education leaders representing 26 states. Aiming to make high school graduates more competitive in the global economy, the new standards may be adopted as early as 2014 after a rigorous assessment research conducted by states in in collaboration with teachers and curriculum specialists [21].

4. CONCLUSIONS

Since 1980 studies on nuclear energy education have been conducted addressing the conceptual and practical issues of nuclear energy. Different assessment methods such as questionnaires, surveys, and round table discussions have been applied to check the level of knowledge concerning nuclear of both students and public in general. Furthermore, researchers have analyzed the nuclear energy content presented in school textbooks.

This literature review provided a clear visualization of the global nuclear energy educational scenario, showing that the theme is still addressed with prejudice due to an incorrect view of nuclear energy and a limited view of its benefits. Even knowing about the benefits of nuclear technology, people retain their fears of the potential for nuclear energy to cause widespread damage or disaster. The accidents in nuclear plants accidents have been responsible for the negative image of nuclear energy. The media have also influence on what people believe about science; therefore it could be used as an accessible tool for a better understanding of nuclear energy.

Concerning the science textbooks, the literature reports that the theme should be better addressed, encouraging students to research more about it. Some authors claim that a better physics teaching could improve public awareness through education of the environmental benefits and relative safety of nuclear power generation.

The data from this literature review will serve as a reference for a future proposal for a teaching training program for Brazilian science/physics high school teachers using a new teaching approach. As far as education provides conditions such as pedagogical approaches, learning environments, and human resources, it may be the starting point for the correct and impartial interpretation of the use of nuclear energy.

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