

## **Energy sources: theme for science education**

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### **Abstract**

This paper describes an investigation on the topic of energy matrices carried out by high school students. The proposal was to use the theme energy matrices to conduct an interdisciplinary study on sources of electricity, addressing technical, historical and environmental aspects. The objective was through the chosen theme to interweave science content covered in high school with the theme focusing on matters of industrial development, new technologies and environmental impacts. The specific forms of electricity generation under study were: hydroelectric, thermal, wind, solar photovoltaic and heliothermic energy. The discussion of energy matrices is directly related to the impacts generated by different forms of electricity generation. The emission of gases that cause the greenhouse effect by power plants and the environmental demands of hydroelectric power plants configure contemporary issues that should be present in any discussion on development strategies, since these two sources are characterized as the main forms of generating electricity today. Meanwhile, renewable energy such as solar

photovoltaic and wind, are structured today as viable sources from the technological and economical standpoint. The implementation of the project consisted on the preparation of the demonstrative artistic and technical scale model. The public communication of the project involving Science and Technology took place through participation in school fairs, conferences on energy and events promoting science and technology.

## **Introduction**

The discussion on energy matrices is directly related to the impacts generated by different forms of electric power generation. The emission of gases that cause the greenhouse effect by thermoelectric plants and the environmental demands of hydroelectric power stations set current issues that should be present in any debate on development strategies, since these two sources are configured as the main forms of electric power generation nowadays. In its turn, the renewable energy solar photovoltaic and wind power are viable from a technological point of view and economic. Heliothermal power plants represent a new process to the use of solar energy but still in restrict use. The proposal of the work was to use the thematic of energy matrices aiming to develop an interdisciplinary study on generating sources of electrical power, addressing technical aspects, historical and environmental. In this way, it was structured the project *Energy Matrices* aiming at linking high school curricular content with energy topics addressing issues related to industrial development, new technologies and environmental impacts. The specific forms of electric power generation studied were hydroelectric power, thermoelectric power, wind, solar photovoltaic and solar thermal. The project *Energy Matrices* was funded by FAPES - Research Foundation of the Espírito Santo - and was developed by students from a public high school through a scientific initiation program.

## **Methodology**

The STS approach - Science, Technology and Society - was the methodology used in the project. Different authors such as Driver (1999), Mortimer (2002), Beach (2005), Bazzo (2007; 2011) and Delizoicov (2009) advocate the application of the STS approach in science education as a way to leverage the educational processes. The

proposal of the STS approach in education consists of studying the contents of Physics, Chemistry and Biology interwoven with technological applications and impacts generated by such applications, using general themes, such as, water, waste, pollution, energy. The study of the characteristics of the technology for the generation of electric energy was linked to the curriculum content and the technological applications, taking as reference the analysis of environmental impacts. The project consisted of two phases of development followed by public presentations of results in events related to communication of science. The first stage consisted of discussions about the topic among students and teachers. The second step involved the creation of materials for divulgation.

## **Results**

The first step involved the discussions on the energy matrices theme, the study of the technical characteristics of energy sources and the analysis of impacts of energy sources. It was proposed to students an itinerary that contemplated science, work and culture through the study of historical context and environmental issues related the theme of the project, i.e. energy matrices. Through the reports of experiences of science on the part of students it was discussed the teaching of sciences in Brazilian schools in their limitations and weaknesses, but also in their strategic role in the development of the country. The interfaces between science and technology were addressed in order to link curriculum content and technological applications, i.e. in order to reflect on the formative role of the school in relation to technological applications. Following this line of thought, the situation of Brazil was analyzed in the context of renewable energy, emphasizing the need to address teaching of science and sustainability. From the discussions held the group chose the confection of a kit of disclosure as a way to communicate the results of the project. The kit was composed by an artistic maquette, a technical maquette and a leaflet.

The second step consisted of planning and building the divulgation kit. This phase began with the general design of the artistic maquette. To start the process, it was distributed to the students blank sheets of paper for each one to make an outline of a proposal for the maquette. The idea was to allow the free expression on the subject at the same time focusing on the creation of a proposal for implementation. Students worked

with issues related to the definition of low plant of the maquette, the scale to be used, the layout of different power generating plants and the provision of necessary environmental elements to each source. After that, they studied the materials needed for the confection: styrofoam, plaster, elements of texture such as sand and dirt, paint finishes, wood and aluminum tubes. The artistic maquette objective was to demonstrate different forms of energy generation, in a didactic and playful way, allowing students at any age to interact with the theme of the project. The technique maquette consisted of a solar photovoltaic system complete and objective was to demonstrate a practical application of a system of renewable energy. The leaflet focused on helping the explanation of different energy sources to the public aiming at contributing to the spread of the ideas proposed.

It stands out that the planning and preparation of the kit was based on the discussions held by the group: what type of raw material could be used, which form of storage of raw materials, characteristics of relief, positioning in relation to consumer centers and issues related to the connection from the source to the electrical power system. Another important point concerns the use of mathematical concepts used for the design of the maquette, involving the concept of level curves and notions of scale and proportions.

The kit was presented during the Sciences Fair of the Arnulpho Mattos High School located in Vitória, Capital of Espírito Santo State in Brazil where this project was developed. Subsequently the kit was selected in a state contest to be presented during the 9th Week of Science and Technology of the State of Espírito Santo in 2012. Finally the kit was presented in I Week of Energy of the State of Espírito Santo in the same year.

## **Discussion**

The outcomes of this study transcended the initial goals of the project *Energy Matrices*. A first consideration concerns the methodology applied and its relationship with the teaching of the sciences. By using the STS approach, the work had the objective of providing the experience of activities that join curricular content, technological applications and social and environmental implications. We explored the teaching of science under the focus of society, i.e. from the analysis of the real world and their economic, technical and historical issues

Three main questions guided the actions: *What is the relationship between the curricular content and the real world solutions?; There are other possible configurations?; What is the role of individuals in relation to the society in which they live?.* From such issues, the initial discussions have allowed the reflection on energy matrices having as starting point the generation of electrical energy. This topic allowed divide the five ways of energy generation previously mentioned in two categories: traditional electrical generation technologies; alternative electrical generation technologies. In This way, the project allowed a debate about on ways of generating energy using renewable and non-renewable arrays. From the counterpoint of these matrices was possible to address the issues related to historical bases, political choices, energy production organization, environmental impacts and characteristics of each technology.

The second consideration addresses the implications for the teaching of science and to the educational processes. During the project development, concepts of Physics and Chemistry were addressed to the understanding of the characteristics of the technologies discussed. Mathematical concepts of scale and proportionality were used to design the artistic maquette. Geography and Economic issues permeated the study of relations between space and power generation, underscoring the discussion about the use of water in conversion processes and raw materials. Historical and political aspects have been discussed in the pursuit of understanding of how energy matrices are structured in different countries. Finally, the art was present in the finalization of the maquette with searching for materials, paints and finishes that best them utterance the project idealized. In relation to the educational aspects, it is important to emphasize the social aspects involved in the implementation of the project: education understood as a wider context that articulates social experiences. The students that participated had the opportunity to reflect on the social dynamics involved in any kind of human activities.

## **Conclusion**

Science and Technology are interconnected to everyday events of modern societies. Major social issues, such as energy generation, atmospheric pollution, combating diseases, organization of urban space and public transport are directly related

to the use of technological devices which, in its turn, has its basis in the development of scientific research & development. For this reason, we believe that the discussion about the connection between science and technology with social and environmental issues can be a vector of action for public communication of science and technology. In this perspective, it is noteworthy that the educational processes should comprise social issues more comprehensive as a way to contextualize the content of science and technology the everyday life of the people. Therefore, this kind of initiative being developed within a high school context including public communication of science and technology might contribute for experiencing and spreading different perspectives of knowledge and promote social, technological and scientific inclusion of all citizens under construction into the educational set of a country.

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