Teaching Sciences and Mathematics through the reuse of waste to produce a solar heater

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Abstract: Plastic has become the most common material since the earlier 20th century and the modern life (LAW *et al*., 2014). However, at the same time that it is very useful because of its properties, like durability, lightness and low cost, it also become a problem at the end of its life cycle, in other words, in the moment to disposal. The European Commission for environmental issues highlights that much energy and raw material are lost, instead of recycling into new products. The aim of this project is develop new pedagogical practices for teaching the subjects sciences, geograph and mathematics through Environmental Sciences, raising awareness in children from Elementary School regarding to the importance of reuse of waste and solar energy. The Project was developed in a public school in São José town, Santa Catarina State, where a workshop for reuse of PET bottles and milk long-life packing was carried out to produce a solar healer.

Keywords: plastic waste, healer solar, solar energy, science education

1. Introduction

Currently the planet has seven billion human beings living on it, and they produce 1.4 billion tons in urban solid waste (USW), the average 1.2kg a day per capita. Almost half of it is generated by less than 30 countries; the world most developed ones. If the number seems scary, an even darker scenery is traced by United Nations (UN) and World Bank studies: in ten years will be 2.2 billion tons by year (BRASIL, 2014). Still according to the study performed by UN, at this century half, if the current rhythm is kept, we will have 9 billion inhabitants and 4 billion tons of urban waste a year. Most part of USW produced in the world, about 800 million tons/year is disposed in landfills, what brings expressive environmental costs for governments (BRASIL, 2014). We also highlight the massive presence of plastic on landfills and oceans (Piccoli *et al*, 2016, MOORE, 2015). The plastic has become the most common material of actuality (LAW *ET AL*, 2014). Plastics properties like durability, lightness and low cost, it also becomes a problem at the end of its life cycle, in other words, in the moment of disposal. Tens of million tons of plastic residue are floating on the ocean, achieving turtles, marine mammals and birds, which die when they eat these residues. European Commission for Environmental issues highlights that much energy and feedstock are loosen, instead of reused in new products. About 50% of plastic waste in EU are still disposed in landfills (European Commission, 2016). Jambeck *et al* (2015) highlight that plastic debris in the marine environment is widely documented, but the quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, we estimated the mass of land-based plastic waste entering the ocean. We calculate that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025.

Brazil, through the Environmental Ministry, accounts with the National Program for Environmental Education (ProNEA in its Portuguese acronym) in order to ensure, within the education scope, balanced integration of multiplex dimensions of sustainability – environmental, social ethics, cultural, economic, space and politics – to development of the country, with the aim to improve the quality of life for all Brazilian population. One of the actions to achieve this aim is the protection and conservation of planet environment through the environmental education on Policy Pedagogical Projects of teaching institutions (CUTTER-MACKENZIE, 2014).

The aim of this project is develop new pedagogical practices for teaching the subjects sciences and mathematics through Environmental Sciences, raising awareness in children from Elementary School regarding to the importance of reuse of waste and solar energy. The Project was developed in a public school in São José town, Santa Catarina State, where a workshop for reuse of PET bottles and milk long-life packing was carried out to produce a solar healer.

2. Methodology

Solar healing workshop: the students produced a water healer with milk long life packing waste (card paper, polyethylene films, and aluminum) and PET bottles (pop), at the same time than work principles of environmental sciences and physics, when related the ways of heat transfer and mass transfer. Besides the contents of physics, mathematics (trigonometry) and geography (Geographical coordinates) were also discussed in this workshop (Xue, 2016). The long life packing (tetra pak) were painted in black, in order to retain the Sun heat and PET Bottles, which have the function to protect the set of external influences, like wind and rain. The pipes were also painted in black, and they passed inside the bottles to transfer the heat from packs to the water. With this system is possible heat the water until 55°.

3. Results

The activities of the Project enable the high school students to comprehend and experiment the concepts of environmental sciences, geography and basic principles of exact sciences (chemistry, physics and mathematics), using as theme the reuse of waste to produce new product with aggregate value.

The current number of students attended the project were 240, from 7 to 10 years old, they participated effectively in the workshops and were invited to answer a questionnaire for evaluation. The questionnaire brought the following questions: Did you like to know the Project? Did you like to participate the workshop? Is the workshop related to the knowledge of the subject science? Did the project help to comprehend the importance to separate waste? Did the project help to comprehend the reuse of waste to produce new products?

The answers were compiled and we concluded that: 96% of students answered they liked to know the project, 95% answered that liked to attend the workshops and 5% answered they are indifferent or did not like. Regarding to the workshops with subject contents, 92% of students answered yes; in other words, the workshops were related to the contents studied, 8% answered no or they are indifferent. The question about the contribution of workshops in the comprehension of waste separation, 77% answered yes, 33% answered no or they are indifferent to the question. Regarding to the question about the workshops help to comprehend that waste can be reused to produce new products, 80% answered yes and 20% no or they are indifferent.

The workshop involving science, geograph and mathematics contents had the aim to build a solar panel, and showed the importance of residues like PET bottles and milk packs to build a water healing system using only the solar energy. The professors' team responsible by project and the schools' teams believe that activities developed during the workshop sensitize students to preserve the planet, and that is the reason to show possibilities to use waste to generate new products with aggregate value. The contents of exact sciences area was Always developed in abstraction way. However, when worked supported by diverse pedagogical practices, the abstraction materializes itself, enabling students to comprehend the context of knowledge on science and mathematics boosted by this Project, with current themes addressed to the planet's preservation. Creating new products from waste enabled students connect the reality with theories learned in the classroom. Stronck (2005) highlights, from his study with teaching versus environment that, when the environment preservation is

Figure 1: Solar water healing

used as an integrative context for teaching students overcome other colleagues in evaluations on Reading, Mathematics and Social Studies. Most students, besides achieving higher grades, showed themselves involved and enthusiastic for learning.

4. Conclusions

The results from this project were important for everyone, University and schools, mainly for high school students, because they received the benefit of knowledge from workshop, and could to understand the importance of residues like PET bottles and milk packs to build new products like a water healing system using only the solar energy. The university professors' team and students strengthened the Project, which involved community extension and research activities, working crosscutting themes like environmental education.

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