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Exploration of socio-scientific issues in upper primary science textbooks developed by NCERT

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Abstract
Socioscientific issues are science related issues and are of interest to society. Viewing its importance, its inclusion in curriculum and textbooks has become a trend internationally. In India also, it is recommended to include socioscientific issues in textbooks by National Curriculum Framework (NCF). National Council of Educational Research and Training (NCERT) has strived to develop the textbooks on the basis of recommendations given by NCF so that the gap between school science and real life could be bridged. The aim of this paper is to examine how NCERT met the challenge of inclusion of socioscientific issues in science textbooks. This paper has therefore, explored the inclusion and discussion of socio-scientific issues in science textbooks developed by (NCERT) of upper primary stage. For this purpose they classified the socio-scientific issues into two: issues related to health and issues related to environment as they are emphasized by NCF. In this study researchers found that several health issues (balance diet, cloning, reproductive health etc.) and environmental issues (pollution, water harvesting, deforestation etc.) have been included but they are discussed superficially.

Keywords: socioscientific issues, NCERT, textbook, health issues, environmental issues

Introduction

In the beginning of 20th century, the need of such kind of science education felt that not only contains the facts, principles and laws of science but that could develop an informed populace capable of using science in their daily lives. These views were previously advocated and supported by John Dewey (1974) [6] and later revalidated by various science educators, education reform documents, professional associations and organizations (AAAS, 1989 & 1993; NRC, 1996; Millar & Osborne, 1998; Sadler, 2004; NSTA, 2010; OECD 2000, 2003, 2006, 2013) [2, 15, 28, 22, 23, 24, 25, 26].

As the 21st century unfolds science education has occupied a very important place in general education and it has been taught as compulsory subject at some level of school education in most of the countries. One of the major aims of science education is to achieve scientific literacy as declared and emphasized by numerous curriculum documents of various countries. (AAAS, 1989 & 1993; NRC, 1996; Millar & Osborne, 1998; Laugksch, 2000; Sadler, 2004; NCF, 2005; Wenning, 2006a; Holbrook & Rannikmae, 2009; NSTA, 2010; UNESCO, 2010) [3, 15, 28, 35, 11, 22, 34].

Myriad of definitions of scientific literacy entail application of science in society as a chief component of scientific literacy. The definitions and meanings that are given by Pella 1967, Shen 1975, Miller 1983, AAAS 1989, NSES 1996, Millar & Osborne 1998, Robert 2007, and Feinstein 2010 and many others show that science and society are inseparable and can't be seen in isolation, rather both impact each other and science gives a person the abilities to deal effectively with the science related social issues. These definitions also suggest that scientifically literate individual is able to confront, negotiate and make informed decisions about the situations in life that involve science.

There are a number of real life situations and social issues that involve science and hence could be termed as socioscientific issues (SSI). Socioscientific issues as defined by Sadler (2003) *encompass social dilemmas with conceptual or technological links to science*. He further explains that issues like cloning, stem cells, genome projects, global warming, and alternative fuels have central roles of both social and scientific factors in their dilemmas, so they have been termed socioscientific issues. He make it more clear by adding the topics described by the phrase socioscientific issues display a unique degree of societal interest, effect, and consequent.

One more comprehensive meaning is given by Zeidler in 2003 (cited in Zeidler & Nichols, 2009) [38, 37] as Socioscientific issues (SSI) involve the deliberate use of scientific topics that require students to engage in dialogue, discussion, and debate. They are usually controversial in nature but have the added element of requiring a degree of moral reasoning or the evaluation of ethical concerns in the process of arriving at decisions regarding possible resolution of those issues. The intent is that such issues are personally meaningful and engaging to students, require the use of evidence based reasoning, and provide a context for understanding scientific information.

Ratcliffe & Grace (2003) [27] pointed out the nature of Socio Scientific Issues as:

They have a basis in science, frequently that at the frontiers of scientific knowledge; involve forming opinions, making choices at personal or societal level; are frequently media-reported, with attendant issues of presentation based on the

purposes of the communicator; deal with incomplete information because of conflicting/incomplete scientific evidence, and inevitably incomplete reporting; address local, national and global dimensions with attendant political and societal frameworks; involve some cost-benefit analysis in which risk interacts with values; may involve consideration of sustainable development; involve values and ethical reasoning; may require some understanding of probability and risk; are frequently topical with a transient life (p. 2-3).

Importance of socioscientific issues

As we know science is a human construct and a function of societal needs, therefore, science and society are inseparable. So every person is required to tackle the socioscientific issues which impact his present or future world (Driver *et al.*; 2000; Kolstø 2001) [7, 12]. Many authors (Hodson 2008; Schwartz 2007 cited in Saunders & Rennie 2011) [10, 32] believe that if the general community remained unaware of socioscientific issues they will develop negative feelings like fear, anger and distrust towards the scientific community. Some other authors (Driver, Newton, & Osborne, 2000; Kolstø, 2001a; Zeidler, 1984) [7, 7, 12] consider its importance in development of informed and responsible citizenry and hence also advocate their inclusion in science classrooms. Several SSI researchers suggest that it develop in students an understanding of science and nature of science, interest and motivation for learning sciences (Sadler & Dawson 2012) [30]. Zeidler & Keefer (2003) argued the inclusion of socioscientific issues in science curriculum for holistic development of students at cognitive, social, moral, ethical and emotional levels.

Besides this, today's society is driven by recent development in scientific and technological field so everyone including students need to be equipped with the knowledge and skills for their own sake and for the good of society and environment, then only we can pave the way for morally sensitive scientists and scientifically literate humanists (Allchin1991) [2].

Methodology

This paper reviewed, analyzed and discussed the National Council of Educational Research and Training (NCERT) science textbooks to explore how many socioscientific issues are included, how they are discussed and what additional information is provided to address them. The study focuses on NCERT science textbooks as it claims to implement the basic idea of National Curriculum Framework (NCF), 2005 to connect the science studied by students in school with their life outside the school. Upper primary stage of education consists of classes VI to class VIII in India, so, the science textbooks of class VI, class VII and class VIII are reviewed in this paper. The socioscientific issues regarding health and environment are classified as health issues and environmental issues. These textbooks are divided into many chapters as 16 chapters in class VI textbook and 18 chapters in class VII and VIII textbooks. These chapters may belong to physics, chemistry or biology. Every chapter was then reviewed for the inclusion and discussion of socioscientific issues.

Socioscientific issues in Class VI science textbook

The textbook of class VI has sixteen chapters out of which only four chapters consisted of socioscientific issues. Overall the textbook covers merely 11 issues as shown in table-1. The 1st chapter strives to make the students aware of poisonous plants and not to eat unknown plants. List and pictures of poisonous plants found in the surroundings could be added to make it more informative. The 2nd chapter defines the term balanced diet and obesity, without addressing their impact on health. While discussing balanced diet apart from telling the students how nutrients lost during cooking and washing vegetables it should have been told that what amount of nutrients are required for their age group. They should have also informed about junk food so students could make decision to eat junk food or not. In 14th chapter 'water' the techniques of water conservation and rain water harvesting have been told but how and where this harvested water could be used is not discussed. Further, it is also mentioned that water needs to be used carefully but the vital issue practices that conserve water have not discussed. The 18th chapter taught the students to make compost from kitchen waste. Through a short story it motivates the students to reuse and recycle papers. *Plastic boon or a curse* describes the students both aspects of plastics so they could decide when and how they have to use it and when not.

Table 1: Socioscientific issues included in Class VI science textbook

	Name of the chapters	Issues related to health	Issues related to environment	Total number of issues
1	Food: where does it come from?	Poisonous plants	Nil	11
2	Components of food	Balanced diet, Obesity, Preservation of nutrients while preparing food, Deficiency diseases	Nil	
3	Fibre and fabric	Nil	Nil	
4	Sorting materials into groups	Nil	Nil	
5	Separation of substances	Nil	Nil	
6	Changes around us	Nil	Nil	
7	Getting to know plants	Nil	Nil	
8	Body movements	Nil	Nil	
9	The living organisms and their surroundings	Nil	Nil	
10	Motion and measurement of distances	Nil	Nil	

11	Light, shadows and reflections	Nil	Nil	
12	Electricity and circuit	Nil	Nil	
13	Fun with magnets	Nil	Nil	
14	Water	Nil	Overuse of ground water, Soil erosion, Rain water harvesting	
15	Air around us	Nil	Nil	
16	Garbage in, garbage out		Vermicomposting, Recycling of paper, Hazards of plastics	

Socioscientific issues in Class VII science textbook

The textbook of class VII consisted of seventeen chapters out of which eight chapters consisted of total 21 issues. The 2nd chapter in the textbook has dealt with diarrhoea in blue box (non evaluative box) as additional information, where the term has been defined and its causes and consequences have also been told. Further, preparation of Oral Rehydration Solution (ORS) has also told but it is a major neglected tropical disease and who is vulnerable to this disease have not discussed or mentioned there. In the chapter 3rd anthrax as an occupational hazard has discussed in non evaluative box. However, its mode of infection prevention and cure should also be told to the students. In the 9th chapter soil, soil pollution and soil erosion have been discussed in non evaluative box. In both the issues only some causes are mentioned and how they impact the society is missing. In 10th chapter it has mentioned that *smoking damages lungs and linked with cancer* though it has discussed in non evaluative box still passive smoking and ban on public smoking should also have discussed. In the 15th chapter it is told that why ambulance is written in strange manner, further our duty as citizen to give way to ambulance has also told but our duty is not restricted to ambulance only we should also give way to fire-truck we should follow traffic rule and signals so these aspects should have added to it. In the 16th chapter it has discussed that water shouldn't be wasted and how scarcity of water affect the life of women and children, a case study of water harvesting has described. Further, students have given a list of two water-wise habits and they have supposed to add more points. A comprehensive discussion on social aspect of water conservation, reuse of grey and black water was lacking. Chapter 17th has been developed as a visit of children to forest and it addressed several socio-scientific issues like forest as green lungs, environmental and other benefits of forests, forest as a home for tribes, effect of overgrazing, and deforestation etc. however, these issues are discussed from environment point of view only and no opportunity is being provided for judging its impact on society. Since the beginning the 18th chapter seems to connect science aspect of waste-water to society as it gives the students a question, that not getting safe drinking water is a matter of human dignity. This chapter suggests an activity (18.4) to understand water treatment and encourages students to be an active citizen by realizing their responsibilities. Socioscientific issues in class VII is shown in table-2.

Table 2: Socioscientific issues included in Class VII science textbook

	Name of the chapters	Issues related to health	Issues related to environment	Total number of issues
1	Nutrition in Plants	Nil	Nil	21
2	Nutrition in Animals	Diarrhoea		
3	Fibre to Fabric	Occupational hazards	Nil	
4	Heat	Nil	Nil	
5	Acids, Bases and Salts	Nil	Nil	
6	Physical and Chemical Changes	Nil	Nil	
7	Weather, Climate and Adaptations of Animals to Climate	Nil	Nil	
8	Winds, Storms and Cyclones	Nil	Nil	
9	Soil	Nil	Soil pollution, Soil erosion	
10	Respiration in Organisms	Smoking	Nil	
11	Transportation in Animals and Plants	Nil	Nil	
12	Reproduction in Plants	Nil	Nil	
13	Motion and Time	Nil	Nil	
14	Electric Current and its Effects	Nil	Nil	
15	Light	Ambulance		
16	Water: a precious resource	Nil	Water day, Women's duty to fetch water, Depletion of water table and its causes, Water management, Rain water harvesting, Water wise habits, A successful initiative in Rajsthan	
17	Forests: our lifeline	Nil	Forest as green lungs, Environmental benefits of forests, Overgrazing, Deforestation	
18	Wastewater story	Nil	Sewage treatment, Better housekeeping practice, Water borne diseases, Vermin-processing toilets	

Socioscientific issues in Class VIII science textbook

There are eighteen chapters in class VIII textbook out of which ten chapters dealt with socioscientific issues. Nonetheless, Maximum numbers of socio-scientific issues (as

shown in table-3) are identified in this textbook. The 2nd chapter of the textbook has dealt with three socio-scientific issues, first of them is antibiotics. It is informed to the student how antibiotics should be used. It has also told that people use it in the feed of livestock and poultry but the probable side effects and misuse of antibiotics and certain kinds of ban on antibiotics in several countries should have discussed there to develop awareness in students so they could make proper decision on antibiotics. Pulse polio program has just mentioned in the description of vaccination, though it impacts the society at large. Another socio-scientific issue in this chapter is food poisoning. The textbook superficially dealt with this issue and emphasizes preservation of food, while it is very serious issue which needs to be discussed with students because they are considered as at-risk population. So the causes, symptoms, prevention, treatment, dos and don'ts should have discussed in order to connect them with day to day life. Chapter 3rd includes plastics and environment and considers the plastics bad for environment and cause of many environmental problems including pollution, death of cows and clogging of drains etc. It further gives students a chance to suggest measures to keep environment free from plastics. It also suggests some points on the matter. Chapter 5th has included exhaustible natural resources. Through an activity (5.2) the textbook tries to make the student more concerned and sensitive about the use of exhaustible natural resources. Chapter 6th has superficially dealt with the issues global warming, acid rain and deforestation. Chapter 7th dealt with many socio-scientific issues through various activities (7.1-7.7). In the activity 7.7 students have said to visit a nearby zoo and give their opinion about the captivity of animals in zoo. This activity will certainly develop insight in students for this issue. Deforestation, global warming, protected area, project tiger, endangered species, and reforestation have discussed but Kyoto protocol, carbon credits and policies and act for wildlife and environment in our country should have added to develop more clear understanding. In the chapter 9th three burning socio-scientific issues have included, test tube babies, in vitro fertilization and cloning but discussed them superficially, legal, ethical and religious aspect of the issues were totally missing. Chapter 10th includes many socio-scientific issues (reproductive health, balanced diet, drug abuse, personal hygiene, HIV, aids, adolescent pregnancy) that are very important for our adolescent students but unfortunately their scientific aspect is discussed and social aspects of the issues are not much emphasized. Chapter 13th comprises noise pollution its causes, effect and measures to limit it, however, it lacks various aspects of noise pollution like categorization of areas and legal limits of sounds there, silence zone and statuary control etc. in the 16th chapter braille system and care of eyes but eye donation could be added. Who can and can't donate eyes, its procedure and importance could have developed decision making in students for eye donation. The last chapter of the textbook comprises of many socio-scientific issues and with the help of various case studies and activities connects the students with society very efficiently. It also provides various opportunities to discuss on the issues mentioned in the table. It also informed about the campaign to curb the air pollution. In each topic it motivates the students to think, to discuss, to suggest and to decide what is good for their environment, causes that ruining it and most importantly what is their role and responsibilities.

Table 3: Socioscientific issues included in Class VIII science textbook

	Name of the chapters	Issues related to health	Issues related to environment	Total number of issues
1	Crop production and management	Nil	Nil	33
2	Microorganisms : friend and foe	Antibiotics, Pulse Polio Program, Food Poisoning	Nil	
3	Synthetic fibres and plastics	Nil	Plastics and Environment	
4	Materials : metals and non-metals	Nil	Nil	
5	Coal and petroleum	Nil	Exhaustible natural resources	
6	*Combustion and flame*	Nil	Global Warming, Acid Rain, Deforestation	
7	Conservation of plants and animals	Nil	Deforestation, Global warming, Protected area, Project tiger, Endangered species, Reforestation	
8	Cell- Structure and functions	Nil	Nil	
9	Reproduction in animals	Test tube babies, In vitro fertilization, Cloning	Nil	
10	Reaching the age of adolescence	Reproductive health, Balanced diet, Drug abuse, Personal hygiene, HIV, AIDS, Adolescent pregnancy	Nil	
11	Force and pressure	Nil	Nil	
12	Friction	Nil	Nil	
13	Sound	Nil	Noise pollution	
14	Chemical effects of electric current	Nil	Nil	
15	Some natural phenomena	Nil	Nil	
16	Light	Braille system, Care of eyes	Nil	
17	Stars and solar system	Nil	Nil	
18	Pollution of air and Water	Nil	Air pollution, Greenhouse effect, Global warming, Car pool, Water pollution, Ganga Action Plan	

Conclusion

NCERT has strived to develop the textbooks on the basis of recommendations given by NCF (2005) so that the gap between school science and real life could be bridged and students become aware of socioscientific issues like environment, health and hygiene, water scarcity and energy conservation and could become responsible citizens of tomorrow. After going through the books it could be said that except for some issues most of the issues are discussed superficially. Moreover, their impact on society has not discussed properly.As it becomes obvious from the tables that the major environmental issues included in the textbooks are mainly focused on water and its conservation, pollution and deforestation while the health issues comprises balanced diet, food-poisoning besides this, drug abuse, smoking, test tube babies, in vitro fertilization, cloning, reproductive health, drug abuse, personal hygiene, HIV, AIDS, adolescent pregnancy have also been included.

On the basis of review it could be said that though a number of burning socio-scientific issues have been included in the upper primary textbooks of science which have developed by NCERT but still they are lacking those aspects of the issues which connect the students with their surroundings. The three textbooks comprise fifty two chapters in which numerous socioscientific issues related to health and environment were identified. The textbooks are required to connect the students with society and develop them in a way so they could make informed decision about socio-scientific issues, then only the vision of NCF (2005) could be realized.

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