

Full Length Research Paper

Investigation on the inclusion of socio-scientific acquisitions in curriculum of science and technology lesson

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Accepted 28 November, 2013

According to its definition, socio-scientific subjects emerge during scientific and technologic developments. Besides information, attitude and value constraints are effective in decision-making processes and thus there is no consensus on socio-scientific subjects yet and it leads to social discussions. These subjects comprise decision making processes in which analysis, synthesis and assessment processes are active, ethical and moral values take part and scientific literacy stands out. In our era when we define our society as a science society and frequently encounter these decision making processes, the science and technology lesson in which scientific processes are most commonly used is particularly important for the investigation of the subject. To this end, the curricula of 6th, 7th and 8th grade science and technology lessons were investigated within four basic frameworks. To conclude, it was found that a total of 9 socio-scientific acquisitions were included in curricula, the main emphasis was put on biologic themes and no other themes but 7th grade includes these subjects. Socio-scientific subjects examine the relationship between science and society and activate the information usage and self-expression processes of children; thus, it is recommended that more acquisitions should be placed in science and technology curricula.

Key words: Socio-scientific acquisitions, science and technology curriculum.

INTRODUCTION

Scientific and technologic development affects social and ecologic system in all aspects. The man encounters decision making processes in many issues such as global warming, sustainable development, energy generation and consumption, the issue of nuclear plants, genetically modified and hormonal products, disadvantages of mobile phones and base stations, the issue of being vaccinated against various diseases (bird flu, etc.). While some of these decisions are discussed on emotional grounds and rejected, some of them are discussed on scientific ground and could not be determined in terms of conclusion and process. The issues which emerge from scientific processes and lead to social discussions (Sadler and Zeidler, 2005) and in which scientific literacy,

decision making, analysis, synthesis and assessment processes are active and ethical and moral values take part (Zeidler, 2001) are named as socio-scientific subjects. Socio-scientific subjects are often discussed within the light of scientific data but mostly individual and social value and ethical judgments are effective in decision making mechanisms (Driver et al., 1996, 2000; Kolsto, 2001; Sadler, 2004). Socio-scientific subjects are associated with scientific dilemmas, individual ethical values and emotional development (Zeidler et al., 2002) and the acquisition of scientific information required for value, boundaries of science, social processes, critical attitudes and citizenship is important in scientific and social issues (Kolsto, 2001). Such issues are also important for

enabling children to acquire ethical and moral issues and offering these issues with an interdisciplinary approach (Zeidler, 1984, 2002).

Although socio-scientific subjects are analyzed in international literature within the scope of training scientifically literate citizens, they are recently gaining importance in Turkey. Scientific issues have a determining role in both social and political, individual decision making processes. In this scope, science and technology literacy issues have recently been included in national and international science and technology curricula; however, these issues related to science-technology-society-environment pattern are not interested in social, moral and ethical issues. On the contrary, socio-scientific subjects focus on ethical and moral decision making processes of individuals (Sadler and Zeidler, 2005).

The inclusion of socio-scientific subjects in curriculum improves the skill of presenting concepts and scientific information used in the course content in a holistic approach (Driver et al., 2000), it raises awareness and creates social sensitivity in citizens as well (Solomon, 1993). However, there are some researchers who believe that the inclusion of such issues into curricula would be disadvantageous. For example, Levinson (2008) stated that socio-scientific subjects are mostly discussed through media and when the issues such as gene cloning, cell projects, global warming, genetically modified foods are not well understood by people, some problems will occur and in this scope, information offered at primary school and university level does not include adequate content to express one's opinion. In addition, Levinson stated that although socio-scientific subjects take place in biology lessons as an interdisciplinary area; physics has the main focus in science education. As socio-scientific subjects are also closely associated with values, even teachers could not express their opinions freely and have to adopt a cognitive positivist approach. Another question is about which part of the information should be considered in discussion of such issues. In an issue about stem cell, the views of a patient relative and an irrelevant person differ (Levinson, 2008).

The sustainability of socio-scientific subjects is another question. For instance, much new scientific information has emerged with the global climate change and many research have been conducted in biomedical fields. This case could cause people to be perceived as a biological meta (Levinson, 2008).

To conclude, social hierarchy of participants for determining socio-scientific subjects consists of the content of the subject, epistemological approach towards science and society, the status of participants for the content of the subject, pedagogical field information and assessment processes and enables children to develop in many fields at the same time. To ensure the development of children in mentioned fields will be possible through science and technology lesson. Because, science and technology is the only lesson which has socio-scientific acquisitions and subjects. In this scope, 6th, 7th and 8th

grade science and technology lesson curricula were examined in terms of including socio-scientific acquisitions based on themes and following questions were answered:

1. Are socio-scientific acquisitions included in the theme of Organisms and Life at 6th, 7th and 8th grade?
2. Are socio-scientific acquisitions included in the theme of Matter and Change at 6th, 7th and 8th grade?
3. Are socio-scientific acquisitions included in the theme of Physical Phenomenon at 6th, 7th and 8th grade?
4. Are socio-scientific acquisitions included in the theme of World and Universe at 6th, 7th and 8th grade?

METHODOLOGY

In this study, qualitative research method was adopted and document analysis of descriptive analysis methods was used. Document analysis refers to the analysis of written materials which include information about an event or phenomenon (Madge, 1965). Course books and curriculum contents in the field of education are regarded as significant documents (Bogdan and Biklen, 1982). In this study, curriculum of science and technology lesson which was prepared by Vural (2008) was considered as a document and content analysis was used to analyze this document. Content analysis of written texts is a special technique through which one can investigate the content of various texts methodically, systematically and objectively so as to categorize and interpret their fundamental components which cannot be seen with a superficial reading (Robert and Bouillaguet, 1995 cited by Bilgin, 2006, 2). This technique helped to determine socio-scientific acquisitions in science and technology education. The progress of the study was performed within the framework of the content analysis stages.

Procedure

The content analysis consists of three stages. These stages are analytic definition and coding, inference, validity and reliability of the content analysis (Bilgin, 2006,11). The first stage; stage of analytic description and coding consists of the investigation of the content by various categories and the evaluation of the content by the frequency of categories. Science and technology curriculum is built on the same themes from 4th to 8th grade. These themes are; Organisms and Life, Matter and Change, Physical Phenomenon, World and Universe. In this study, these four themes were considered as the main category. The units within these themes were investigated by the frequency of categories in terms of including socio-scientific acquisition at 6th, 7th and 8th grades. The theme and unit pattern of science and technology curriculum is presented in Table 1.

Science and technology curricula of 4th and 5th grade were not included in the study. This is because of the fact that children in those periods are in a cognitively concrete period and yet decision making processes in socio-scientific field include cognitively abstract period.

The second stage, the stage of inference consists of the socio-scientific acquisitions of 6th, 7th, 8th grades. In the next stage, Milies and Huberman technique was used for reliability and validity analysis. The reliability of content analysis is related to the reliability of encoders and coding categories. Encoders expressed opinions about whether the acquisitions in the units are socio-scientific or not. The determined acquisitions were submitted to opinions and evaluations ("applicable" or "non-applicable") of 4 academicians studying on socio-scientific subjects in Ahi Evran, İnönü and Kocaeli Universities. The evaluations of specialists were compared

Table 1. 6th,7th,8th grade, theme and unite pattern of science and technology curriculum.

Themes	6th grade	7th grade	8th grade
Organisms and Life	Reproduction, growth and development in organisms	The systems in our body	Cell division and heredity
	The systems in our body	Human and environment	Organisms and energy relationships
Matter and Change	Matter and heat	Structure and characteristics of matter	Structure and characteristics of matter
	Particular structure of matter		States of matter and heat
Physical Phenomenon	Force and movement	Force and movement	Force and movement
	Electricity in our life	Electricity in our life	Electricity in our life
	Light and sound	Light	Sound
World and Universe	What does earth crust consist of?	Solar system beyond: outer space puzzle	Natural processes

Table 2. The inclusion of socio-scientific acquisitions in the theme of organisms and Life at 6th, 7th and 8th grade.

Theme	Grade Level	Unit	The number of socio-scientific acquisitions	Total
Organisms and Life	6	Reproduction, growth and development in organisms	-	9
		The systems in our body	2	
	7	The systems in our body	3	
		Human and environment	1	
	8	Cell division and heredity	3	
		Organisms and energy relationships	-	

with the categories of the researcher and the numbers of consensus and conflicts were determined and Miles and Huberman (1994)'s formula ($\text{Reliability} = \frac{\text{consensus}}{\text{consensus} + \text{conflict}}$) was used to determine the reliability of the categories and the result was found to be 0.94. In line with this coefficient of concordance, the evaluation was repeated and the non-applicable acquisition was excluded and 100% consensus was achieved. In this scope, all acquisitions in Primary School Science and Technology Curriculum and Guideline (6th, 7th, 8th grade) issued by Education Board of Ministry of National Education were investigated by the researcher according to the inclusion of socio-scientific subjects.

After the categorization process, the stage of comprehending and analyzing the documents started and in this stage all units within the categories were defined digitally. In the first stage, investigations were conducted on the basis of unites at each grade and the acquisitions in units were analyzed in terms of whether they include socio-scientific subjects or not. The each of acquisitions in this stage was quoted and presented by the researcher.

Conclusion, discussion and recommendations were presented in the last stage of the content analysis; the stage of inference.

FINDINGS

Following findings were obtained from the investigation of

the curriculum pattern within the scope of themes, grade level and units according to the inclusion of socio-scientific acquisitions.

Theme 1: Organisms and Life

1. Are socio-scientific acquisitions included in the theme of Organisms and Life at 6th, 7th and 8th grade?

According to the investigation of the theme of Organisms and Life on the basis of units (Table 2), it was found that the unit of Reproduction, Growth and Development in Organisms which is a 6th grade unit generally consists of reproduction, growth and development in cells, human, animal and plants; germination and growth in plants and involves no socio-scientific acquisition. In another unit named Systems in Our Body generally touches upon support and movement, circulatory, immunity and respiratory systems and includes 2 socio-scientific acquisitions. These acquisitions are as follows;

It is emphasized that vaccinate, serum and medicines are

Table 3. The inclusion of socio-scientific acquisitions in the theme of matter and change at 6th, 7th and 8th grade.

Theme	Grade level	Unit	The number of socio-scientific acquisitions	Total	
Matter and Change	6	Matter and heat	-	-	
		Particular structure of matter	-		
	7	Structure and characteristics of matter	-		
		8	Structure and characteristics of matter		-
			States of matter and heat		-

produced more cheaply and in greater amounts thanks to technologic developments (p:144).

The negative and positive effects of technologic developments on respiratory system are discussed (p:145).

In the 7th grade pattern of the same theme consists of urinary, compensatory and regulatory system, sense organs and organ donations which are the follow-up subjects of 6th grade. The socio-scientific acquisitions in this scope are as follows:

Technologic developments used in the treatment of some kidney disorders are exemplified (p:192).

Diagnostic treatment methods such as kidney failure, kidney stone, kidney transplant, dialysis, high-frequency sound waves and laser are applied (p:192).

The importance of organ transplant is emphasized (p:196).

In the unit of Human and Environment of the same theme, environments where organisms live and the human impact on the environments are discussed and the following socio-scientific acquisition is included:

The relationship between organisms and inorganic factors is explained and suggestions are made about the protection of endangered plants and animals in our country and the world (p:266).

The 8th grade unit of Cell Division and Heredity generally consists of mitosis and meiosis, Mendel's heredity studies, DNA and genetic structure, mutation, modification and adaptation. The included socio-scientific acquisitions are as follows:

The effect of scientific and technologic development on the diagnosis and treatment of genetic diseases is investigated and presented (p:292).

Information about the practices of genetic engineering are summarized and discussed; the possible results of genetic engineering are predicted; positive results are appreciated; information about the importance of biotechnological studies are collected and the fields of study are exemplified (p:295).

Of genetic engineering practices, cloning, gene

treatment, breeding species and genetically modified organisms are exemplified (p:295).

The unit of Organisms and Energy Relationships generally includes food chain, recycle, renewable and non-renewable energy resources and does not include socio-scientific acquisitions.

Theme 2: Matter and Change

2. Are socio-scientific acquisitions included in the theme of Matter and Change at 6th, 7th and 8th grade?

According to Table 3, it can be seen that no socio-scientific acquisition is involved in the theme of "Matter and Change" at any grade level.

The 6th grade unit of "Matter and Heat" takes place in the theme of Matter and Change and includes heat conduction and insulation; another unit "Particular Structure of Matter" includes information about atom, associating the characteristics and states of matter with particular structure of matter, physical and chemical change and no socio-scientific acquisition is included.

The 7th grade unit of "Structure and Characteristics of Matter" includes elements and element symbols, structure of atom, modelling and atom models, associating electron array with chemical properties, chemical bonds, compounds and formula, mixtures and no socio-scientific acquisition is included.

The 8th grade units of the theme are "Structure and Characteristics of Matter", "States of Matter and Heat." The unit of Structure and Characteristics of Matter includes periodic system, chemical bonds, chemical reactions, acid-base reactions (primary acid-bases used in food and industry), concept of pH, water chemistry and water purification. The unit of States of Matter and Heat consists of heat and temperature concepts, heat exchange, temperature change, change in states of matters, fluxing, freezing and evaporation, heating and cooling curves. Neither of the units include any socio-scientific acquisitions.

Theme 3: Physical Phenomenon

3. Are socio-scientific acquisitions included in the theme

Table 4. The inclusion of socio-scientific subjects in the theme of physical phenomenon at 6th, 7th and 8th grade.

Theme	Grade level	Unit	The number of socio-scientific acquisitions	Total
Physical Phenomenon	6	Force and movement	-	-
		Electricity in our life		
		Light and sound	-	
	7	Force and movement		
		Electricity in our life		
		Light		
	8	Force and movement		
		Electricity in our life		
		Sound		

of physical phenomenon at 6th, 7th and 8th grade?

Another theme of the curriculum, the theme of Physical Phenomenon begins with the 6th grade unit of Force and Movement (Table 4). This unit consists of speed, acceleration, position and time concepts towards an object moving along a straight line, direction and measurement of force, force types, weight concept, mass gravitation. Another unit, the unit of Electricity in Our Life includes electric energy, conductivity, resistivity and law of ohm. The last unit, the unit of Light and Sound includes the reflection of light, light resources, reflection, mirrors, sound waves, echo formation, sound insulation, sound dissemination and acoustic.

7th grade unit of the same theme begins with the subject of Force and Movement. This unit includes the characteristics of spiral springs; force, work and energy concepts; basic machines, energy loss which results from force of friction. The next unit, the unit of Electricity in Our Life consists of electrification and types, electric circuits, current, voltage, resistance relationship, lane connection ways. The unit of Light includes light absorption, color vision of objects, light refraction and lens. No socio-scientific acquisition is included in these units.

Of 8th grade units of the same theme, the unit of Force and Movement includes lifting force of liquid and gas, concentration concept, unit and compression; the unit of Electricity in Our Life includes magnetic effect of electric current and energy transformations, the use of electrical energy and electrical power; the unit of Sound includes sound waves, characteristics of sound, sound change, sound as an energy type, spreading speed of sound, the effects of noise and high-volume music on human health. None of these units include any socio-scientific acquisitions.

Theme 4. World and Universe

4. Are socio-scientific acquisitions included in the theme

of world and universe at 6th, 7th and 8th grade?

The last theme of curriculum, the theme of World and Universe begins with 6th grade unit of What Does Earth Crust Consist of? This unit includes fossils, underground and aboveground waters and nature monuments (It is stated that dams are built with the use of aboveground waters. No details on the energy generation in dams etc. are mentioned).

The 7th grade level of the theme begins with the unit of Solar System and Beyond: Outer Space Puzzle. This unit consists of astronomical objects in outer space, solar system and outer space, stars, satellites, planets, space research, outer space pollution and in this unit, it is mentioned that the knowledge about outer space is limited and can be changed with new research; observatories should be located away from settlement areas due to light pollution.

The unit of Natural Processes takes part on the 8th grade level which is the last grade of the theme. This unit includes formation process of World, plate motions, weather events, climate and meteorology concepts.

It was found that no socio-scientific acquisition is included in the theme in general (Table 5).

DISCUSSION AND CONCLUSION

According to the general investigation on the inclusion of socio-scientific acquisitions of science and technology curriculum:

1. *It was found that socio-scientific acquisitions are included in the first theme; the theme of Organisms and Life (9 acquisitions); the main focus is on physical and chemistry subjects. In other three themes, no socio-scientific acquisition was included.*

2. *As for the grade level; the highest number of socio-scientific acquisitions take place in 7th grade (4 acquisitions) and 8th and 6th grade, respectively.*

Table 5. The inclusion of socio-scientific acquisitions in the theme of world and universe at 6th, 7th and 8th grade.

Theme	Grade level	Unit	The number of socio-scientific acquisitions	Total
World and Universe	6	What does earth crust consist of?	-	-
	7	Solar system and outer space puzzle	-	
	8	Natural processes	-	

Science educators and prominent education institutions in science field frequently emphasize the importance of training people with developed science and technology knowledge. Science literacy generally aims to enable people to acquire scientific information such as concept, principle and theory and to use these information for social values and norms as well (Zeidler et al., 2002). Another aim of science education is to raise awareness towards complex relationship between science, technology and society (Abd-El Khalick et al., 1998). Students should both know process and method skills but also use these skills to generate ideas about social issues (Zeidler et al., 2002). In this scope, socio-scientific subjects develop skills of decision making, expression and information usage. Especially the 6th, 7th and 8th grade curricula should give more place to these subjects. Children in this age group want to be independent from adults and thus social relationships and responsibilities gain importance. For that reason, they start to have an idea about environmental issues, social problems and responsibilities and moral values. Especially science and technology curriculum has a significant importance in this area (YÖK-World Bank, 1997). The existing science and technology curricula are based on science, technology, society and environment pattern. Unfortunately, this pattern does not involve the processes for questioning ethics and moral values. Although this pattern aims to present the relationship between science and daily life, samples used in this pattern do not involve real scenes of daily life and are not exciting for students (global warming, nuclear energy) (Shamos, 1995); and thus the process is not efficient. In order to ensure the ethics and scientific literacy of students, socio-scientific subjects should be included in curriculum and a functional curricula should be flexible enough to enable students to have multi-dimension views. In addition, such subjects ensure the development of psychological, social, emotional and cognitive moral processes (Keefer and Zeidler, 2003) and also develop skills of discussion with reasons, comprehending the social wholeness, expressing ideas about the nature of science (Zeidler et al., 2005).

Recently, especially the importance of socio-scientific subjects in science education has been emphasized (Zoller, 1982; AAAS, 1989; Jenkins, 1994; Driver et al., 1996; Millar, 1996; Kolsto, 2001; Sadler and Zeidler, 2004; Zeidler et al., 2002). In an environment equipped

with technology and science, more and more socio-scientific subjects take place. In this scope, a wider space should be allocated for socio-scientific subjects in curricula and mass communication tools to achieve a scientific literacy level (Rundgren, 2011). Socio-scientific subjects include not only information of students about subjects but also have high level cognitive effects such as the use and definition of world order, political values, language, image and metaphors (Garb et al., 2008).

Socio-scientific subjects should be included in curriculum so as to develop thinking skills of students, help students to comprehend subjects better (Lee et al., 2006); however, insufficient course hours, teachers' difficulty in managing information and discussion process, lack of teaching environment and such reasons make it impossible to achieve this. For that reason, it is recommended that subjects should be included in the curriculum in a planned way.

Socio-scientific subjects education is not solely related to the inclusion of applicable subjects in curriculum but it is also associated with pedagogic competencies of students, suitable teaching strategies and the curriculum itself (Ratcliffe and Marcus, 2003). Students bring such subjects to class environment sometimes and teachers give short answers instead of giving a satisfactory explanation (Sadler et al., 2006). The conducted studies show that teacher do not want to get involved with such subjects due to the fear of losing job, the effect of local culture, unconformability in such issues (McGinnis and Patricia 1998). Today, the most commonly used course material is course books (Geçer and Özel, 2012). Therefore, the inclusion of these subjects in curriculum and examinations within the framework of discussion methods will be a comforting development for teachers as well (Lumpe et al., 1998; Lee et al., 2006; Borgerding et al., 2012). One of the most commonly used tools while preparing curricula about socio-scientific subjects is dilemma. Dilemmas enable people to reflect their cognitive, social and emotional skills, personal values and belief systems. However, if they are not well-planned and do not focus on the interests of students, they can distract students from these issues and result in abnormal data (Sadler et al., 2006).

Subjects and acquisitions that can take place in curriculum according to cognitive and emotional development levels of students and dilemmas that can be used in

this scope on the basis of grades and units are presented below as recommendations:

RECOMMENDATIONS

Theme 1: Recommendations for the organisms and life theme

In the framework of scientific information in 7th grade theme of Organisms and Life which includes socio-scientific subjects:

To conduct research on human for the treatment of malignant diseases makes those people disease carriers. Do you think such research should be conducted on human beings?

Do you think hormones should be used to get more yield from plants and animals?

Do you think animals should be used as testers of medicines and such dilemmas can be submitted?

Zeidler (2003,110) recommended that such issues should be submitted to students in a semi-structured protocol. He also stated that students' skills for offering reasons to persuade friends (justification, explanation), proving, acquiring/making others acquire alternative point of view, generating alternative theories will develop and thus one could have information about the epistemological processes of students and such subjects will also shed light on personal and sociocultural structures of students. Sample scenarios can be submitted to students.

"Do you think the human should interfere in natural life or leave it in its natural process?"

"Do you think the construction of touristic facilities should be allowed for the development of sport and tourism activities or human should not interfere in nature?"

The dilemma (Üstün, 2004) of "Do you think there should be a limitation on technologic and scientific research for the protection of human life and health and the development of medicine?" can be submitted about the limitation on scientific research.

Theme 2: Recommendations for the Theme of Matter and Change

In 8th grade *Structure and Characteristics of Matter*; on issues about nuclear energy concept, following discussion can be presented: Despite the risk of nuclear leakage in nuclear facilities, nondisposable part of solid wastes; nuclear facilities are still important for continuous and uninterrupted energy generation. Do you think nuclear plants should be built despite to all well-known risks?

Theme 3: Recommendations for the Theme of Physical Phenomenon

In 7th grade unite of *Electricity in Our Life*, dilemmas

about the construction of hydroelectric plants, thermic and nuclear plants despite their negative effect on ecologic balance can be submitted.

Theme 4: Recommendations for the Theme of World and Universe

In the scope of the natural monuments subjects in 6th grade unit of "*What does earth crust consist of?*"; historical places and monuments (Hasankeyf, Halfeti etc.) which were damaged due to the construction of hydroelectrical plants could be discussed and energy or natural monuments dilemma could be submitted or students can be asked to put forward suggestions.

There are also some views that disagree with the inclusion of socio-scientific subjects in curriculum (Lewinson, 2008). However, the main question here is whether the gap between society and science can increase with the distance between youth and such issues. It should be known that students do not consider scientific information as their own information and here is the point that socio-scientific subjects come into play (Rao, 2005, 20).

Socio-scientific subjects develop high-level cognitive skills such as decision making, reasoning and argument etc. (Zohar and Nemet, 2002; Sadler and Zeidler, 2005). Fowler et al. (2009) raise ethical awareness, encourage to learn the nature of science (Zeidler et al., 2002) and develop the awareness of effective citizenship (Ratcliffe and Marcus, 2003). Democracy and human rights education is a multi-dimension tool that can be used in environment education, values education and sustainability as well. There can be effective tools to measure the sufficiency of education given in these fields. For that reason, it is one of the issues which program developing specialists worldwide focus on (Dawson, 2001).

Although the inclusion of such subjects in curriculum looks like the duty of education institutions, these institutions actually are a part of state policies. In this scope, information considered as a personal product is a product treated by the state (Levinson, 2008).

Today, positive and negative aspects of scientific developments on social life are frequently discussed. Rapid transformation of life due to these development requires people who are exposed to this transformation to be well trained. To provide enriched and reproduced participation is a must rather than a necessity today. For that reason, it is recommended that education institutions and policies should enrich curricula with the real-life samples.

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