Science, technology and society (STS) issues priorities of secondary school students and physics teachers in Yemen

Mohammed Yousef Mai Lilia Halim Ruhizan Mohammed Yaseen and T. Subahan M. Meerah
University Kebangsaan Malaysia, Bangi, Malaysia
mai65m@hotmail.com
lilia@ukm.my
ruhizan@ukm.my
subahan@ukm.my

ABSTRACT

This paper discusses the priorities given by secondary school students and their teachers in Yemen to the Science, Technology and Society (STS) issues. Firstly, it reviews the literature in order to seek for STS issues that should be infused in physics curriculum in Yemen. Secondly, it reports the results of the survey that measure the priorities of Science, Technology and Society issues. A valid and reliable questionnaire containing STS issues is administered on a sample of 465 students and 34 teachers from 15 schools in Sana'a city. The results of the study revealed that human health and disease, water supplies, air pollution, and energy shortages are the most important issues that should be infused in physics curriculum in Yemen. When the mean scores of students and teachers were compared, the results showed no significant differences. Implications for research and development in science education are discussed.

Keywords: Science, technology and society (STS), STS issues, physics curriculum.

INTRODUCTION

In the midst of discussion and debate concerning educational reform, Science-Technology-Society (S-T-S) has been suggested as a new conceptual organization for science education (Bybee & Mau, 1986). STS education provides the students with a real-world connection between the classroom and society. It helps the students practise identifying potential problems, collect data with regard to the problem, consider alternative solutions and the consequences of a particular

decision. (Yager 1990). STS approach become one of the current goals for science education, it attempts to place as much emphasis on technology and society as on science in presenting a coherent view of the relationship between these three strands. Figure 1 symbolizes the relationships between science, technology, and society (Rubba et al. 1995; Waks 1992).

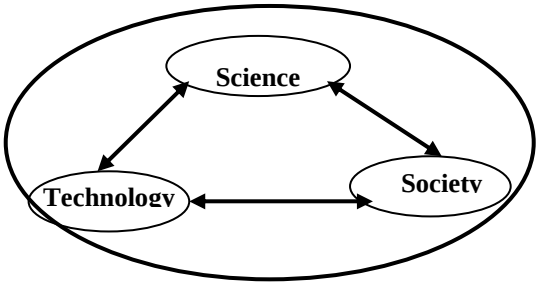

Figure 1: Interactions between science, technology, and society

STS means starting with students, their questions, using resources available to work for their resolution, and wherever possible, advancing to the stage of taking actual actions individually and in groups to resolve actual issues. STS approach is expected to increase general interest and understanding of science. It is also expected to fill a critical void in the traditional curriculum. Harms and Yager (Yager 1993) further derive four main purposes of the STS approach, namely:

1. Preparing students to use science for improving their own lives and as a corollary to be able to better understand and cope with an increasingly technological society.
2. Enabling students as they progress through life to deal with STS issues in a responsible manner.
3. Identifying a body of knowledge that would enable them to deal with STS issues.
4. Acquiring knowledge and understanding about career opportunities in the field. Enabling the students plan for their careers by comprehending the possible job opportunities available in their job market.

This allows students to relate the scientific concepts to problems they may have already encountered, makes science curricula to be closely related to their life in order to strengthen their understanding of the concepts, reaction of STS, and develops self-learning in the future in order to be good citizens and have the ability to make use of science as well as technology to help contribute to their societies.

STS science content is dealing mainly with social issues that connect science with a societal problem; it derived from students constructing problems and investigations from real-world issues and concerns. Therefore, the starting point for STS content is a list of possible social issues that might interest the students. It

is clear that issues should have a basis of scientific or technological knowledge and involve a variety of beliefs and values that cause difficulty in resolving the issues. The issues must be of some social significance, and should contain an interaction between science, technology, and society.

RATIONALE

The primary function of science education at the middle and junior high level is to provide students with the opportunity to explore science in their lives, and to become comfortable and personally involved in it. Consequently, science curriculum might be able to create citizens who understand science in ways that will enable them to participate intelligently and to make decisions on how science and technology can change the society. Such science curriculum is human and society focused, problem centered, and responsive to local issues (Blosser & Helgeson 1990).

Al-Mekhlafi (1998), Sailan (2000), Al-Aghbari (2003), Al-Duais (2004), Azize (2004) and Aswad (2005) have made studies to evaluate science curriculum in Yemen. The results of such studies reveal that: a) science curriculum is overcrowded with content, b) pupils' interests and achievements in science have steadily declined, c) traditional science teaching is not effective in terms of developing positive attitudes, and promoting the understanding of the processes of science.

Other studies such as Al-Mihi (1993), Al-Nemer (1991), Al-Rafi'i (1998), Bybee and Bonnstetter (1987), Chi Lun (1995), Fadhli (2000), Rhoton's (1990), and Rubba (1989) address the inclusion and implementation of STS in science curriculum. The findings of these studies indicate that the overall inclusion of STS issues and activities in science curricula was low, students need to understand STS, the major constraints in teaching the STS themes include lack of STS curricular materials and many scientific topics related to STS should be included in science curriculum. Likewise, the study of Bybee and Mau (1986), Robinson, Trojok and Norwisz (1997) and Robinson and Bowen (2000) interested in reporting and interpreting the priorities given to Bybee's 12 environmental problems. A sample of science educators and students were surveyed. Findings included a ranking of twelve global problems; the top issues were Air Quality and Atmosphere, Hazardous Substances, Water Resources, World Hunger and Food Resources, and Population Growth.

The main objective of this research is to identify the most important STS issues related to physics that should be infused in Yemeni physics curriculum. This study most probably be very useful for the curriculum developers. It contributes ways of creating a model for developing an STS issues-based physics curriculum.

METHOD

The Sample

The sample in this study was randomly selected from 93 public and 78 private secondary schools in 11 districts in Sana'a city. The researcher used the "Multi-stage" sampling method. The 11 districts with the 171 secondary schools in Sana'a city were 'clusters' of the population, and the researcher selected randomly 15 schools: which resulted in 465 students and 34 teachers with respect to geographical and economical variations. The following table illustrates the research sample in terms of gender and percentage:

Table 1: The Sample.

	Female		Male		Total	
	N	%	N	%	N	%
Student	260	55.9%	205	44.1%	465	93.2%
Teacher	18	52.9%	16	47.1%	34	6.8%
Total	278	55.7%	221	44.3%	499	100%

Bartlett, Kotrlik and Higgins (2001) indicated that "with the given population sizes of 100,000, a sample size of 384 is required". Based on this argument, the sample size in this research was appropriate with margins of error (0.03) and alpha (0.05) (Bartlett et al. 2001).

A List of STS Issues

Priorities of STS issues differ from a country to another, according to the level of development and the setbacks faced as a result of the interaction between science, technology and society. Therefore, it is important to specify and rank STS issues that are relevant to the Yemeni society from the points of view of the students and educators.

To set a list of STS issues, the researcher reviewed a related literature. Al-Mihi (1993), Al- Nemer (1991), and Al-Rafi'I (1998) set a list of STS issues that should be included in science curriculum in some Arab countries. While, others (Bybee & Mau 1986; Robinson et al. 1997; Robinson & Bowen 2000) evaluated the inclusion of all STS issues in the science curriculum, as well as an international consideration of the issues that are global, and a determination of the possibilities and limitations of implementing the STS issues in educational programs. The Project Synthesis (1985), Bangalore Conference (Marylin 1985), and Bybee& Mau (1986) identified major topic areas that could help bring about the recommended desired state of literacy. In this research, the researcher modified and adapted the STS issues list identified by Bybee. Because of the increasing impact of technology on our life, the researcher add a new topic which was

Table 2: A List of STS Issues

STS themes	No. of Items
1. Air Pollution (Air Quality and the Atmosphere)	8
2. Energy Shortages	10
3. Extinction of Plants And Animals	5
4. Unsafe (Hazardous) Substances	6
5. Human Health and Disease	20
6. Mineral Resources	11
7. Land Use	10
8. Water Supplies	8
9. Population Growth	9
10. War Technology	4
11. Nuclear Power Stations	5
12. World Hunger and Food Resources	7
13. Use and Abuse of Technology	7

The list in table 2 includes general STS issues, whereas the aim of this research is to rank the STS issues that related to physics, the researcher focused on the issues related to physics. Therefore, from this list, the researcher selected (46) issues that related to physics. These issues were derived from (9) STS themes.

Survey Instrument

The survey is aimed at identifing the STS issues priorities by the stakeholders (students and teachers). The survey instrument used in this study was developed based on literature review. It is not a test instrument but it is a descriptive one. A panel of experts used to establish content validity for the instrument. The panel consisted of (10) members, they were selected based on their expertise and experience in teaching physics. All of them were Ph.D holders. They gauged the items for their relevance to physics, and if they reflected issues related to science, technology and society.

According to the results of content validity; the researcher deleted 8 items and

rewrote 9 items. Modifications to the instrument were made with consideration given to the original intent of the instrument with the guidance of the panel of experts. The results of internal consistency showed that there are two items not correlated with the instrument total score; so these items were deleted. Then, for the rest of the items (38 items), the Pearson correlation between each item score and total scores were recalculated. The results show that all of the items were correlated with the instrument total scores. It can be concluded that the instrument had good internal consistency. The results indicate that an alpha coefficient of (0.907) and split–half reliability test of (0.866) was found on the instrument. It was clear that the instrument was reliable.

The respondents completed the questionnaire by specifying to what extent they agreed with each item by using a five choice Likert scale: (strongly agree, agree, don't know neutral, disagree, and strongly disagree). The first section of the questionnaire was designed to obtain demographic information about the respondents. This included sex, nationality and school name. The second section contained 38 items of "STS issues" that were divided into nine subscales related to STS themes (See table 3).

Table 3: No. of Items in Each Subscales

	STS Themes	No. of items	Total
1	Air Pollution	3	7.9%
2	Energy Shortages	6	15.8%
3	Human Health and Disease	3	7.9%
4	Mineral Resources	3	7.9%
5	Nuclear Power Stations	4	10.5%
6	Use and Abuse of Technology	9	23.7%
7	War Technology	6	15.8%
8	Water Supplies	2	5.3%
9	World Hunger and Food Resources	2	5.3%

The subscales of the questionnaire included: air pollution (3 items), energy shortages (6 items), human health and disease (3 items), mineral resources (3 items), nuclear power stations (4 items), use and abuse of technology (9 items), war technology (6 items), water supplies (2 items), and world hunger and food resources (2 items).

Data Collection

The study data collection began on 1st May 2006 to June 2006. The questionnaire was conducted by the researcher himself to obtain a valid study. More than 500 set of questionnaires were distributed by the researcher: a total of 26 respondents did not complete the questionnaires. As a result they were ignored. The total sample size reached about 499 students and teachers.

RESULTS

The purpose of this research is to determine the STS issues related to physics that should be infused in physics curriculum from the students and teachers perspective. When all subjects (N=499) that determined the importance of the STS issues were lumped together regardless of their sex or position (student/teacher), the following mean scores and standard deviations of themes were obtained (Table 4).

Table 4: The Rank Order of STS Themes As Perceived By Overall Respondents

Rank	Themes	M	SD	Level of importance				
				1	2	3	4	5
1	Human Health and Disease	4.155	0.773	0.8%	3.4%	13.0%	42.3%	40.5%
2	Water Supplies	4.131	0.850	0.4%	2.8%	14.0%	29.7%	53.1%
3	Air Pollution	4.070	0.754	0.6%	3.4%	17.2%	44.1%	34.7%
4	Energy Shortages	4.025	0.717	0.6%	2.8%	12.2%	51.3%	33.1%
5	Use and Abuse of Technology	3.978	0.665	0.2%	3.2%	16.8%	57.9%	21.8%
6	Mineral Resources	3.885	0.922	1.8%	7.4%	18.2%	42.9%	29.7%
7	Nuclear Power Stations	3.743	0.771	0.2%	4.8%	27.3%	44.1%	23.6%
8	World Hunger and Food Resources	3.607	1.110	4.6%	7.2%	26.5%	27.1%	34.7%
9	War Technology	3.457	0.802	0.4%	9.6%	39.5%	36.1%	14.4%

***Note. Judgments of importance is made on 5-point scale from "5 = Strongly Agree" to "1= Strongly Disagree". M = Mean; SD = Standard Deviation*.**

Referring to table 4 , the top four STS themes (Human Health and Disease, Water Supplies, Air Pollution, and Energy Shortages) gained a consensus to reach above 4.0 (where 5 = strongly agree) in the mean scores, with standard deviations around 1.00. Respondents viewed other four themes; use and Abuse of Technology, Mineral Resources, Nuclear Power Stations, and World Hunger and Food Resources as important themes but less important than the other first four themes did. The mean of these themes are from 3.5 to 4. War Technology had the lowest mean (3.457) of the STS themes. On the other hand, the standard division values are from 0.665 to 1.1. This close value shows that there are an agreement between the sample about the importance of the STS themes and issues.

The top ranked themes clearly relate to basic human needs (health, water, air) and [the most important thing in daily use] (Energy Shortages). The other ranked themes in the half of the list (Use and Abuse of Technology, Mineral Resources, Nuclear Power Stations, and World Hunger and Food Resources) are [non visual to students and teachers] and are [not related to their daily lives]. The high mean scores of these themes reveals that the students and teachers understand the importance of these themes. Considering the different points of view on the importance of these issues between teachers and students, the researcher used t-test for independent samples, the results included in table 5.

Table 5: Results of T-Test between Teachers and Students about the Importance of STS Issues

	Mean		Std. Dev.		t-value	df	p
	Teacher	student	Teacher	student			
Air Pollution	4.010	4.075	0.559	0.766	-0.633	43	0.530
Energy Shortages	4.044	4.024	0.818	0.710	0.157	497	0.875
Human Health and Disease	4.265	4.147	0.624	0.783	0.857	497	0.392
Mineral Resources	3.941	3.881	0.976	0.919	0.369	497	0.712
Nuclear Power Stations	3.853	3.735	0.710	0.775	0.864	497	0.388
Use and Abuse of Technology	3.873	3.986	0.538	0.674	-0.959	497	0.338
War Technology	3.544	3.451	0.760	0.805	0.657	497	0.512
Water Supplies	4.265	4.122	0.846	0.851	0.948	497	0.344
World Hunger and Food Resources	3.324	3.628	1.476	1.078	-1.179	36	0.246

When the mean scores of students and teachers were compared, the results showed no significant differences. However, the teacher rankings differed slightly from the student rankings. Table 6 presents the students' and teachers' ranking of the STS themes.

Table 6: The Students' and Teachers' Ranking of the STS Themes

STS Themes	Teachers' Ranking	Students' Ranking
Air Pollution	4	3
Energy Shortages	3	4
Human Health and Disease	2	1
Mineral Resources	5	6
Nuclear Power Stations	7	7
Use and Abuse of Technology	6	5
War Technology	8	9
Water Supplies	1	2
World Hunger and Food Resources	9	8

There are much consensus among the teachers and the students to the importance of some STS issues. Both "Water Supplies" and "Human Health and Disease" are the first and the second issues for teachers. On the contrary, students rank "Water Supplies" and "Human Health and Disease" as the second and the first. In a similar way, the priority has been changed between teachers and students in the

issues No. 3, 4. Among the least important issues, teachers ranked (World Hunger and Food Resources) as ninth with mean score less than 3.5, while students ranked "War Technology".

Using our primary question we can summarize the results as follows, (1) Physics teachers and their students indicated that STS issues are important; (2) there is a great support for including STS issues related to physics into physics curriculum; and (3) the most important issues that should be infused in physics curriculum are human health and disease, water supplies, air pollution, and energy shortages.

SUMMARY AND IMPLICATIONS

Physics teachers and the students ranked STS themes, the top ranked issues clearly relate to basic human needs (health, water, air) and one of the most important things in daily use (Energy Shortages). These results are consistent with the reality of the students' lives in Sana'a and the problems they face.

Sana'a city is known to have some of the most severe air pollution in Yemen. It has a lot of dust, in addition to the regular car exhaust. As well as the health services are declining in Sana'a city. Health care services are particularly scarce; only 25 percent of rural areas are covered by health services as compared with 80 percent of urban areas. Although demand for electricity increased 20 percent between 2000 and 2003, it is estimated that only 5 percent of rural households and 30 percent of urban households have access to electricity from the national power grid.

The greatest problem by far is the scarcity of water. As a result of low levels of rainfall, agriculture in Yemen relies heavily on the extraction of groundwater, a resource that is being depleted. Yemen's water tables are falling by approximately two meters a year, and it is estimated that Sanaa's groundwater supplies could be exhausted by 2008. Most of the students who took part in the study were from Sana'a or one of the satellite village in the rural area. If only because of where they live, many of the 12 STS issues; e. g., human health and disease, water supplies, air pollution, and energy shortages; are experienced directly by the students.

The results of this study are aligned with the results of the previous studies, the top-ranked issues are related to basic human needs for long term survival, they are human health and disease, water supplies, air pollution, and energy shortages. War technology had the lowest mean of the STS themes so ranked as the last one; these are the only differences with the other studies.

This differences are due to the nature of each society and the degree of importance of these issues to its members, in Western societies world hunger, population growth, air quality, water resources, war technology and human health is the most important issues, but in developing countries such as Yemen; the "Human Health

and Disease" issues is very important because of the deficiencies in the health services introduced to citizens. Likewise, water sources and energy shortages issue are ranked as a top issues, this may refer to a shortage of water supllies in Sana'a city which threatened by depletion of water, and the daily blackout of electricity.

The following are some recommendations based on the findings of this study.

1. It is desirable to integrate the study of STS issues into the curriculum of science, this may help students acquire awareness of STS issues, to nurture as well as develop students' attitude toward science, and to provide students with challenging learning experiences.
2. Taking into account the relationship between science and technology and society and related issues as the cornerstone in the curriculum development process according to STS approach. This promote the development of a scientifically and technologically literate citizenry capable of understanding STS issues, empowered to make informed and responsible decisions, and able to act upon those decisions.

Many fundamental suggestions emerge from this study.

1. Conduct experimental studies to investigate the impact of the proposed STS issues based physics curriculum, developed STS teaching model on the variety outputs of the learning process.
2. Conduct a study to make summative evaluation of the developed STS issues-based module.
3. A nationwide survey to determine the STS issues in terms of their priorities and student's sources of information about it.

REFERENCES

Al-Aghbari, B. S. (2003). *Reforming and Developing the Leaning in Yemen. Sana'a. Yemen*: Dar Al-Shaokani for Printing.

AL-Duais, R. N. (2004). Evaluation of Science Curriculum and Textbooks for Basic Grades in Yemen Republic in View of the Concept of Scientific Literacy. PhD thesis. Al Jordanian University, Jordan.

Al-Mekhlafi, M. H. (1998). Evaluation of curricula Documents of Reading, Science, Mathematics and Educator's Guides in the first three- Grade at Basic School in Republic of Yemen. *Journal of Social Studies*, Vol. 5: 299-335.

Al-Mihi, R. (1993). Students Needs and the scientific Topics related with STS., E.C.C.I, the fifth conference, Cairo, 3: 1081-1101.

Al-Nemer, M. (1991). A Study of the Inclusion of Science-Technology-Society Topics in general science Syllabuses in Egypt., E.C.C.I, the third conference, Alexandria, 4: 1065-1088.

Al-Rafi'i, M. M. (1998). The Issues and Environmental Problems of the Reaction Between the Science, Technology and Society in the Content of Sciences Curricula for Middle and Secondary Schools for the Girls in the Saudi Arabia Kingdom. *Studies in Curriculum& Instruction*. No. 55: 121-159.

Aswad, S. F. (2005). An Evaluation Of Physics Curriculum For The 11th Grade Yemeni Schools. MA Thesis. Sana'a University, Yemen.

Aziz, M. S. (2004). An Evaluation Of Physics Curriculum For The 10th Grade Yemeni Schools. MA Thesis. Sana'a University, Yemen.

Bartlett, J., Kotrlik, J., & Higgins C., (2001). Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning, and Performance Journal*, Vol. 19, No. 1, Spring 2001, PP (43-50).

Blosser, P. E. & Helgeson, S. L. (1990). Selected Procedures for Improving the Science Curriculum. Bloomington, IN: ERIC Clearinghouse for Social Studies/Social Science Education OH, ED325303.

Bybee R. W., & Mau T. (1986). Science and Technology Related Global Problems: An International Survey Of Science Educators. *Journal of Research in Science Teaching*, Vol. 23, No. 7, 599-618.

Bybee, R.& Bonnstetter, R. (1987). What Research Says: Implementing the STS Theme in science Education: Perceptions of Science Teaching, *School Science and Mathematics* 872: 144-152.

Chi Lun, F. (1995) . A Study of the Inclusion of Science-Technology-Society Topics in Secondary 4 to 5 Chemistry Syllabuses and Textbooks in Hong Kong. Retrieved 2004, from: http://www.fed.cuhk.edu.hk/ceric/cumphil/95clfung/abstract.htm.

Fadhli, Fathi Ali. (2000). The inclusion of Science Technology Society topics in junior high school earth science textbooks. Ph.D. thesis. University of Missouri – Columbia.

Marylin, L. (1985). Science-Technology-Society in the Science Curriculum. ERIC Clearinghouse for Science Mathematics and Environmental Education Columbus OH. ED274513

Rhoton, J. (1990). An Investigation of STS Education Perceptions of Secondary Science Teacher in Tennessee, *School Science and Mathematics*. 905: 383-395.

Robinson, M., & Bowen, W. M. (2000). Global Environmental Priorities of Engineering Students in Krakow Poland , *Electronical Journal for Science Education* , V5, N1. Retrieved 2006, from: http://unr.edu/homepage/crowther/ejse/robinsonetal.html

Robinson, M., Trojok, T. & Norwisz, J. (1997). The Ranking of Global Environmental Issues And Problems By Polish Secondary Students And Teachers. *EJSE*, Vol. 2 No.1 . Retrieved 2005, from: http://unr.edu/homepage/jcannon/ejse/rob_etal.html

Rubba, P. A. (1989). An Investigation of The Semantic Meaning Assigned to Concepts Affiliated with STS Education and of STS Instructional Practices among A Sample of Exemplary Science Teachers. *Journal of Research in Science Teaching*, Vol. 26, No. 8, 687-702.

Rubba P., Wiesenmayer R., Rye J., McLaren M., Sillman K., Yorks K., Yukish D., Ditty T., Morphew V., Bradford C., Dorough D., & Arabas K. (1995). Global Atmospheric Change , Enhanced Greenhouse Effect, Ozone Layer Depletion and Ground Level Ozone Pollution , A Teachers Guide to a Science-Technology-Society Issue Investigation and Action Unit for Middle and High School Science Course , The Pennsylvania State University, College of Education.

Sailan, F. M. (2000). An assessment of Science Curriculum of First Grad of Basic Education in the Republic of Yemen. MA Thesis. Sana'a University, Yemen.

Waks, L.J. (1992). The responsibility spiral: A curriculum framework for STS education. *Theory into Practice, 31*, 13-19.

Yager, R. E. (1990). STS: Thinking over the years. *The Science Teacher*, 573, 52-55.

Yager, R. E. (1993). Science-Technology-Society As Reform. *School Science and Mathematics, 93 (3),* 145-151.