THE EFFECT OF ACADEMIC ACHIEVEMENT AND A SELECTED BIOLOGY-GEOGRAPHY UNIT REGARDING SCIENCE, TECHNOLOGY AND SOCIETY RELATIONSHIP UPON THE OPINIONS OF 11th GRADE JORDANIAN GIRL STUDENTS TOWARD THIS RELATIONSHIP

A Dissertation Presented

by

Salma Nashef

to

The Institute of Social Sciences in Partial

Fulfillment of the Requirements for the degree of

DOCTOR OF PHILOSOPHY

in the subject of

Educational Sciences

Middle East Technical University

July, 1990

Ankara, Turkey

I certify that this dissertation is satisfactory for the award of the degree of Doctor of Philosophy

Assoc.Prof.Dr. Barbaros Günçer

Supervisor

Prof.Dr.Kemal Güçlüol

(Member of Examining Committee)

Prof.Dr. Nurettin Fidan

(Member of Examining Committee)

Assoc.Prof.Dr.Musa Doğan

(Member of Examining Committee)

Assoc.Prof.Dr.Fersün Paykoç

(Member of Examining Committee)

Certify that this dissertation conforms to the formal standards of the Institute of Social Sciences.

Assoc.Prof.Dr.Sabri Koç

Director of the Institute

ABSTRACT

THE EFFECT OF ACADEMIC ACHIEVEMENT AND A SELECTED BIOLOGY-GEOGRAPHY UNIT REGARDING SCIENCE, TECHNOLOGY AND SOCIETY RELATIONSHIP UPON THE OPINIONS OF 11th GRADE JORDANIAN GIRL STUDENTS TOWARD THIS RELATIONSHIP

By

Salma Nashef

Supervisor

Associate Professor Dr. Barbaros Günçer

This study dealt with three hypothesis. The first was to find whether there was significant interaction effect between academic achievement and a selected biology-geography unit emphasizing the relationship among STS upon the opinions of girl secondary school students toward this relationship.

The second hypothesis was to find whether there was significant main effect of the academic achievement upon the opinions of secondary school girl students towards STS relationship.

The third hypothesis was to find if there was significant main effect of a selected biology-geography unit on the relationship among STS upon the opinions of secondary girl students toward this relationship.

The sample consisted of 78 11th grade girl students who specialized in science in Irbid, Jordan. This study's population represented all secondary students enrolled at the 11th grade level in Jordan.

The sample was divided into two groups, where the experimental group studied the unit "pollution" by means of the accompanying STS instructional strategy. The control group studied "Biology" and "Society" courses by the usual method of instruction. The experiment was conducted during the first semester of the academic year 1989-1990.

The interdisciplinary biology-geography pollution unit which emphasize STS relationship has been prepered by the researcher herself The data were collected by administrating a 37 item opinion inventory which had been prepared by the researcher and validated by experts. The data on the academic achievement variable was gathered from the school records. "Two way analysis of variance" and the "Scheffe test" was used in analysing the data. "Two way analysis of variance" showed whether there were significant effect for the independent variables over the dependent variables. The Scheffe test was used to show at which level of the independent variable the significant difference was due. It was found that the interaction effect between academic achievement and the interdisciplinary biology-geography STS pollution unit on the opinions of the 11th grade level girl students was not significant.

It was also found that the effect of academic achievement on the opinions of the students was significant.

The effect of the study of the interdisciplinary biology-geography pollution unit on the opinions of the students was also found to be significant.

In the final section, a number of implications which may prove useful for further research have been presented.

ÖZET

AKADEMİK BAŞARI İLE BİLİM, TEKNOLOJİ VE TOPLUM ARASINDAKİ İLİŞKİYİ VURGULAYAN BİR ÜNİTENİN 11. SINIF ÜRDÜN'LÜ KIZ ÖĞRENCİLERİNİN BU İLİŞKİ HAKKINDAKİ DÜŞÜNCELERİ ÜZERİNE ETKİSİ.

SALMA NASHEF

Danışman

Doçent Dr. BARBAROS GÜNÇER

Bu araştırmada üç hipotez test edilmeye çalışılmıştır. Birinci hipotez, teknoloji ve toplum arasındaki ilişkiyi vurgulayan ünite ile akademik başarı arasındaki etkileşimin Ürdün'lü 11.sınıf Kız öğrencilerin bu ilişki hakkındaki düşünceleri üzerinde anlamlı bir etkisi, olup olmadığını test etmek için hazırlanmıştır.

İkinci hipotez ise, orta dereceli okullardaki kız öğrencilerin bilim, teknoloji ve toplum ilişkileri arasındaki düşünceleri üzerine akademik başarının önemli bir etkisi olup olmadığı idi.

Üçüncü hipotez ise, orta deceli okullardaki kız öğrencilerinin bilim, teknoloji ve toplum ilişkileri hakkındaki düşünceleri üzerine seçilen biyoloji-coğrafya ünitesinin anlamlı bir etkisinin olup olmadığı idi.

Bu çalışmanın örneklemi Irbid'teki Ürdünlü yetmişyedi, onbirinci sınıf fen kolu kız öğrenciler idi. Bu çalışmanın evreni Ürdün'deki örneklemin seçildiği okula benzer nitelikler gösteren okullardaki onbirinici sınıfa kayıtlı olan kız öğrencilerinin tümünü temsil etmektedir.

Örneklem iki gruba ayrıldı, ve deney grubu araştırmacı tarafından hazırlanan "Kirlilik" ünitesini, bilim, teknoloji ve toplum etkileşimini vurgulayacak bir öğretim stratejisi eşliğinde çalıştı. Kontrol grubu ise "Biyoloji" ve "Toplum" derslerini alışılagelmiş eğitim metodu ile çalıştılar.

Bu deney 1989-1990 akademik yılının birinci sömestirinde gerçekleştirildi.

Bu araştırmadaki veriler araştırmacı tarafından geliştirilen ve uzmanlar tarafından da tasdik edilen otuzyedi şıklı fikir envanterinin dağıtılmasıyla toplanmıştır. Akademik başarı değişkeni hakkındaki veriler okul kayıtlarından derlenmiştir.

Verilerin analizinde iki yönlü varyans analizi ve Scheffe Test kullanılmıştır. İki yönlü varyans analizi, bağımlı değişkenler üzerine bağımsız değişkenlerinin etkili (anlamlı) olup olmadığını göstermiştir. Bağımsız değişkenin seviyeleri arasında anlamlı bir fark olup olmadığını bir fark yarattığını göstermek için Scheffe test kullanıldı.

Akademik başarı ve disiplinler arası biyoloji-coğrafya bilim, teknoloji ve toplum, kirlilik ünitesinin etkileşiminin onbirinci sınıf kız öğrencilerinin fikirleri üzerindeki etkisinin anlamlı olmadığı tesbit edilmiştir. Bu arada akademik başarının öğrencilerin düşünceleri üzerindeki etkisinin anlamlı olduğu tesbit edilmiştir.

Aynı zamanda disiplinler arası biyoloji-coğrafya kirlilik ünitesinin öğrencilerin fikirleri üzerindeki etkisininde anlamlı olduğu ortaya çıkarılmıştır.

Son kısımda (bölümde) ise, daha sonraki ileri bir araştırmaya yardımcı olabilecek bir takım öneriler sunulmuştur.

ACKNOWLEDGEMENTS

I'm indebted to those who shared their knowledge and experience with me in this work. First and foremost, I thank my supervisor Associate professor Dr. Barbaros Günçer for imparting the educational and pure scientific way of treating material, for his manner of the art of dealing with people and for his serious approach and encouragement in directing this study. Without his help this dissertation would not have materialized.

I would like to express my appreciation to Professor Dr. Kemal Güçlüol for his valuable cooperation and distinguished presence during this study. And, of course, I am indebted to Professor Dr. Nurettin Fidan and Associate Professor Dr.Musa Doğan and Associate Professor Dr. Fersun Paykoç for their valuable comments.

I owe a great deal to my father, who gave me the strength to continue my studies, through his continuous encouragement and support, such that no acknowledgement can adequately convey my appreciation. My deep gratitude goes also to the 'roses' of my family, my sisters and brother. Rawda, Fadwa and Riad for the love and support they provide.

With special thanks to Mrs. Sheila Köseoğlu for her contributon in bringing the dissertation to its final language form. Any shortcomings of the work are clearly mine. Finally, thanks to Sevtap Erol and Hüreyya Özdemir for their careful typing of this research.

Salma Nashef

Dedication

To my mother,

Lamia

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

Education is responsible for shaping individual socially. Looking at the concept of education from the point of view of science and social studies is to look at it through it's role in society itself with its special culture and individuals. It follows that the process of education will be a social creation and cultural renewal process in that it causes changes and development in the individuals personality and other relationships that the individual lives through.

Individuals live now in an era completely different in character from the previous one, in which there has been a revolution in science and technology both quantitative as well as qualitative. This revolution has caused huge and accelerating changes in economic, social, cultural and political aspects of life. These changes increase year by year and necessitate the acquisition of certain potentialities and skills in order that the individual will be able to face and deal with such changes in the society.

According to Eisner (1979), the aims of education are:

1.To prepare individuals for future life.

2.To help individuals to heighten their self esteem.

3.To prepare individuals for participation in the

democratic way of life.

Fulfilling these aims is increasingly difficult in a rapidly developing world of science and technological innovation.

The science, technology and society approach for instruction and curricula emerged in 1970 and spread widely in the 1980's. STS may help in fulfilling these aims. Science technology and society tries to combine the meanings and roles of science and technology to apply it in the society. It prepares students to think scientifically, using their skills to solve their daily life problems, it helps the students to see the relation between science, technology and society and to see this term in a more comprehensive way than to see each of the concepts of science, technology and society as separate from each other.

The goals of the science, technology and society model are: personal needs, academic preparation, societal needs and career education awareness (Wright, 1988).

The concepts ofeach of science, technology and society have different meanings, for example Ewer and Glatorre defined science as concerned with the development of theories, models and hypothesis establishing relationship between the phenomena of the universe. These theories when they are validated become the working laws or principles of science (Ewer of Galtorre, 1969). Schwab defines science as seeking the general laws that characterize the repeating behavior of natural things, their predictability, the tendency of natural things to be the same from one situation to

another (Groenwald and others, 1975).

As regards technology, Ewer and Galtorre define it as concerned with the application of the working laws of pure science to the practical affairs of life and to increasing man's control over his environment, thus leading to the development of new techniques, processes and machines (Ewer of Galtorre, 1969). Ost defines it as a sophisticated system which expands the human potential (Ost, 1985). Haffar defines it as the media or equipment that was presented and used by man based on scientific principles, skills, experiences and knowledge to serve for his welfare (Haffar, 1988). Example of science is the study of radioactivity as a pure research. Example of technology is the application of this radioactivity in number of ways - as treatment in medicine and the development of fertilization agriculture (Ewer of Galtorre, 1969).

Society is a group of people who share the same values, habits, and ways of life (Shneider, 1989).

Thus technology is applied science and provides the tools for pure science. From now on the science, technological and society model will be referred to as STS.

STS tries to harmonize the focus and feeling of science while at the same time organizing and rationalizing the forces of humanity. It tries to build bridges to link the natural sciences and the social sciences, STS helps young people to find sources of knowledge that are meaningful for generating new insights into the relations of human beings with the realties of

nature (Hurd, 1975).

STS programs require certain things from students in order to be engaged in: first, an understanding of the basic nature of science, second, a distinction between basic science and applied science (technology) and third, STS programmers direct students toward controversial issues such as questions about the limitations of technology and others (Bybee, et. al., 1980).

STS is considered as a major force in shaping goals, curriculum and instruction, evaluation, and teacher preparation. Scientific concepts, principles and theories have meaning and relevance only when presented in societal framework (Roy, 1988).

Bertrand Russel expresses the essence of STS by summarizing the science significant effect:

> "There ar e direct intellectual effects: the dispelling of many traditional beliefs, and the adoption of others suggested by the success of scientific method. Then there are effects on technique in industry and war. Then chiefly as a consequence of new techniques, there are profound changes in social organization which are gradually bringing about corresponding political changes. Finally, as a result of the new control over the environment which scientific knowledge has conferred, a new philosophy is growing up, involving a changed conception of mans place in the universe (Klopfer).

Development in STS are now affecting the education and being applied in Jordan. Since 1947 there has been increased attention to the development of the curriculum and in 1951 a committee was formed to adjust the curriculum towards the country's changing needs. In the 1960's guidelines were defined for the committee to follow. Their purpose was to adjust the curriculum to make it more suitable for a situation of continuous change in the nature of Jordanian society as well as the huge increase in knowledge which we have seen in the 20th century (Educational Covenant Section, 1980 and Tell, 1978).

In 1987, after a national educational conference held in Amman, a committee was established and a number of recommendations were made. These included:

1.Verification of balance, integration and relatedness among different branches of science in the curriculum at different educational levels.

2.Development of creativeness and the ability for solving ecological and social problems.

3.Equating and relating science and technology.

4.Directing the educational system to be more relevant to the needs of the society without affecting the existing balance between the needs of the society and the individual.

5.Establishing value rules to control the carrying out of any educational jobs.

6.Encouragement of the research and evaluation

system in the education system (Educational National Conference, 7 and 20 September, 1987).

These recommendations may make the conference the basis for a big new educational form in Jordan.

In 1988, the first research related to this topic in Jordan checked students opinions about the STS approach which has its origin in the educational national conference. The current study will be the second one concerning the STS theme. Biology-geography material in Jordanian schools will be examined in relation to STS.

In Jordan, at the secondary level, the biology curriculum seeks:

1.to supply student with basic knowledge of biological science in a functional form which will enable them to understand surrounding living organisms.

2.to help students to acquire suitable academic and mechanical skills.

3.to develop scientific interests and attitudes.

4.to develop scientific methods among students which will enable them to follow organized steps in the scientific methods and in problem solving.

5.to acquaint the student with various applications of biological science in his social environment.

While the social studies curriculum which includes geography as one of its constituents the secondary level seeks:

1.to help in the growth of students integrative personality.

2.to acquaint the student with his/her local environment, Arabic home and the world.

3.to strengthen arabic and moslem brother hood connections.

4.to strengthen world humanity partnership.

It can be seen that these objectives in the Jordanian biology and geography curricula do not include what was emphasized and recommended in the educational conference, namely that the student should be prepared to enter the twenty first century. The students must be adapted to the requirements of their society. The curriculum must concentrate on balancing the needs of the society and the needs of the individual, and on finding relation or connection between science and its technology application (recommendations of the national conference, 1987).

In summary, the emergence of the STS model has caused various concepts of science in science education to be reviewed and classified. In one approach the STS theme is seen as being at the center of science education, as was indicated by Yager and others, and there is little mention of other goals such as the development of reasoning. At the other extreme another approach focuses on developing thinking and reasoning, and gives little allowance for goals related to STS, theme as indicated by Good et. al. and others (Bybee, 1987):

Some research studies support the first approach as follows:

1.Science of every day situations should be taught instead of the abstract and hard to learn school science (Layton et. al., 1986).

2.The socially acquired life-world knowledge is stored in the memory separately from symbolic school knowledge which support a two domain theory. It was shown to be easier to retrieve and for the less able, very hard to distinguish from the more recently learnt science knowledge (Solomon, 1985b).

3.An every day context can make the application of logical reasoning more rather than less difficult (Solomon, 1987).

On the other hand, other researches demonstrated that:

1.The effect of the every day social context on the thinking of some secondary school biology students shows no advantages because the performance of the less than average ability students dropped quite significantly (Dreyfus and Jung Wirth, 1980).

2.The recent work of Maple (1986) has shown that when the context is related to some familiar situation to which life's experience might be expected to be applied experimental design suffers. Pupils find it easier, when the context is unequivocally scientific.

3.The work of Solomon (1985b) and Layton et.al (1986) on energy problems, and of Fleming (1986) on radiation or bacteriology indicates how hard the transition between the two domains can be.

4.The high school students basically expressed the belief that science and technology have little to do with social problems (Aikerhead, 1986).

Concerning the present study, which aims at investigating the effect of academic achievement and the

interdisciplinary biology-geography STS pollution unit on the opinions of 11th grade girl students toward this relationship in Jordan, it can be seen to belong to the 1st approach which was presented on the previous page.

The purpose of this study will be to check what effect STS curriculum and instructional strategy has on the opinions of students concerning the relationship between science, technology and society. This will be done with reference to the STS model and recent studies and comments on it. In Jordan, which may be considered as one of the third world countries, such studies relating science and technology to society through the curriculum material have not yet been carried out. This, therefore is the first to be conducted in Jordan and it may result, in changes in the biology and geography curricula especially those related to the affective domain. Moreover, it may add new objectives to the curriculum. These are an essential part of curriculum development due to the presence of objectives emphasizing the relationship and balance between science, technology and society. This will be introduced to the students even though the students may not be specializing in science or technology.

CHAPTER TWO

STATEMENT OF THE PROBLEM

This chapter includes an introduction to the problem, the overview of procedures and the significance of the study.

Problem

This study deals with the following question: What are the effects of academic achievement and the interdisciplinary biology-geography STS pollution unit and the interaction between them on the opinions of the 11th grade Jordanian girl students towards the STS relationship?

Overview of the Procedure

The post test control group design, as described by Camphell and Stanley (1963) has been adopted for evaluating the role of the curriculum unit in causing a change in the opinions of the students about the STS relationship.

Post test control group design can be summerised as follows:

R 02

Where R means random selection, X treatment and O. the post test.

The subjects of this study were girls in the eleventh grade of Jordanian secondary schools located in Irbid, the second large Jordanian city after the capital Amman.

The study was carried out upon a sample of 78 subjects who were randomly divided into experimental and control groups.

The data were collected by the researcher during the 1st semester of the academic year 1989-1990. Only girl students were used in this study because of practical difficulties. "Irbid secondary School for Girls" was the only school that accepted the offer of the researcher to apply the experiment and the headmaster in charge had a good communication with the researcher which help in accepting the offer.

Other schools refused the application of the experiment because of difficulties concerning:

a.the time of conducting this study, which was very near to the time of final exams.

b.the duration of the unit, which lasts for light lessons, which is comparable to one month of the semester in the usual cituation.

c.the method of instruction of the unit, which is a new one for most Jordanian teachers. Two classes of girls were used, taught by their own geography and biology

teachers.

The data on the dependent variable of this study were collected in the 1st semester of the academic year 1989-1990 by administering an opinionnaire prepared by the researcher herself.

The data were collected from the girls sample by using the opinion inventory measuring the relationships among science, technology and society (Appendix C) which was prepared by the researcher herself.

Finally, the data on the independent variable, the achievement, of the 78 secondary girl students was obtained from their school "Irbid Secondary School for Girls".

The content validity of the data gathering instrument was estimated through the review of the relevant literature, comments and suggestions of the supervisor, the researcher, a committee of 6 postgraduates with different specializations at Middle East Technical University and by the Jordanian students themselves who were assigned randomly as a trial run (Pilot study). The number of students in the pilot study was about 200.

The data were analyzed by utilizing two way analysis of variance and the Scheffe test. Two way analysis of variance was used to find the interaction effect of both the independent variables as well as the main effect of each of the independent variables on the dependent variable.

Significance of the Study

As was indicated in chapter one, the Educational National conference that was held in Amman in September 1987 recommended the connection and balance among different branches of science, the development of student creativity and ability to solve ecological and social learner problems, and the verification of the equilibrium between science and it's technological application (El Ray Newspaper, 1987 and New Education, 1987).

The vital importance of studying science and technology was also indicated by the Arab Ministries who were responsible for the application of science and technology at the conference that was held in Ribat, Al-Maghrib in 1976 (New Education, 1987).

It was also pointed out by Al Rawi that the Arab education system is traditional, partial, theoretical and doesn't allow education for all levels of society through it's social context. This can be changed only through changing the goals and content of the overall curriculum (Rawi, 1987).

Therefore, if we look carefully at the points presented, and at the characteristics of the STS objectives and material, we find that if the results show a significant difference due to STS curricula, the STS objectives and material can provide a solution to some of the educational problems cited above by:

1.Preparing students to cope with scientific, social and technological change as we prepare to enter the 21st century.

2.Enabling students to harmonize personal and social needs by increasing their awareness of the changes

that will take place in their society.

3.Enabling students to use the scientific method for solving social life problems.

4.Enabling them to understand the meaning of both science and technology and to know the technological applications of science.

5.Planting moral and ethical values among the students which will give a hope for a better quality society.

6.Encouraging the change over from the traditional curriculum to a new type of curriculum which fits the changes of the society better.

Another practical significance of the study is that it may provide a stimulus for other researchers to conduct similar research at other levels since it is only the second study to be conducted in the area of the STS approach in Jordan and the only one to use STS material prepared by the researcher. Hence it may encourage others to carry out such studies in other subjects and to test its use in changing the understanding of the students to the STS relationship. The Arabic version of the instrument is important because it may become a guide for other researchers.

Finally, conducting this research on secondary level students has further significance in that the students will leave school with a changed attitude towards technology, science and the affect on society. The quality of their thought will be a very important and critical aspect of their personalities and this will affect the society as they take their places in different

occupations with it.

Concerning the theoretical significance of the study, the present study has its value because most of the STS studies were conducted in the west whereas this study was conducted in the east (Jordan) which may give new insights for further research to compare the STS subjects and areas between some of these western countries and some of the developing ones.

CHAPTER THREE

REVIEW OF THE LITERATURE

This chapter deals with the theoretical background of the study and with research which had been carried out in the same field. It consists of three parts. The first deals with the general characteristics of STS, the second deals with a contrast between STS and traditional programmes, and the last deals with research conducted in the area of STS.

I. General Characteristics of STS

STS is a new movement in education which can be characterized as follows:

1. Special teaching material
2. Value, moral and ethical dimensions.
3. Inquiry oriented instruction.
4. New organization of material
5. High motivation of students.
6. Trends toward general education.

1. Special teaching material

STS curricula include special teaching material of the following types:

a. Short Topics

These are chart units or modules about specific

subjects, which will be co-ordinated with the already existed curricula.

The following points should be taken into consideration:

-STS topics must be of the type that is required by the teacher, i.e. the teacher must choose subjects according to the needs of the students and the needs of the society.

-Social issues must be chosen which are very close to the students' experience or within the field of their scientific imagination.

-Issues must attract the attention of the students to stimulate their thoughts and feelings.

b.Discrete Units About STS Issues

These are designed to be taught in several days, weeks or months for the enrichment of the already existing curricula.

These units are sometimes collected together to form a course that is taught throughout one semester or year.

This is a common trend in schools, districts and universities using the STS system/approach.

c.Curricula Bridging Several Grades

An STS unit is distributed to classes across one whole level, two levels or at all levels. This type is not common, but it is advisable to use this type in countries which have central organization and unified curricula for the classrooms since it will be comprehensive for more than one class.

d.Separate STS Courses

One course or more about STS issues is conducted as an elective course which will support the already existing curricula. This type is more widespread in Britain, U.S.A. and Brazil.

e.Interdisciplinary Courses

Alternative subject matter in different fields is linked together in the form of modules instead of text books as is evident in various elementary and secondary school projects.

Examples of interdisciplinary courses are:

Title	Subjects
Man	Science, social studies
Wetlands	Geography, biology
Meat	Geography, biology
Fuel	Geography, chemistry, physics
Traffic noise	Geography, biology, physics
Pesticides	Geography, biology, physics
Waste management	Chemistry

(Gardner, 1979; Schneider, 1989; Nhakiki, 1989, Allen, 1988).

The pollution unit devised by the researcher and described in this study falls into this category. It covers material taught in biology and geography classes reflecting the relationships among STS.

2.Value, Moral and Ethical Dimensions

STS curricula and instructional strategy have

values, moral and ethical dimensions.

Science and technology are not ethically and politically neutral. Science is not value free, it has the following values:

1.longing to know and understand

2.questioning of all things

3.search for data and its meaning

4.demand for verification

5.respect for logic

6.consideration of premises

7.consideration of consequences

(Thelene, 1983 and Bybee et.al., 1980).

These values since they are related to the discipline of science, are known as constitutive values. In addition to these values, science and technology in their social context have contextual values such as ethical, ideological and cultural values (Aikenhead, 1985).

Mendelson suggests four values which help science interact with its social context, following his conclusion that some basic scientific (constitutive) values are inadequate. These science-society values are:

a."Modesty: the arrogance of contemporary science must be replaced by modesty....

We must moderate our aims and recognize that choices are made, and then make explicit the way in which we decide what we are going to do. The necessity of conscious choice makes us face directly the social

elements involved.

b.Accessibility: implies constructing institutions which allow people in demystifying the knowledge we are dealing with, using language understood by the general public and inviting public participation, not after all the important decisions have been made, but early on when it can make a difference. Accessibility must be created also for those who have been left out by the historical evolution, of science and its' institutionalization.

c.Consideration of non violent, noncoercive and non manipulative research: the physicist is under conscious and explicit pressure not to construct substances harmful to human life. What if the same were required of all scientists? What would we not be doing now? What might we be doing?

d.Harmony with nature: as we go about gaining knowledge of nature, dominating and controlling it, we begin to consider the implications of stepping out of the natural order." (Mendelson, 1976 and Aikenhead, 1985).

As a result, when one is going to take a decision about a social issue, constitutive and contextual values must be in accordance with knowledge and testimonies related to science and technology (Aikenhead, 1983 and Thelene, 1983).

This happens through the direction these values give to the ethics which rules out decision. Value laden issues are good concerns for middle and elementary

students (Cogan, 1989; Schneider, 1989; and Allen, 1988).

Bronowski in his book "The Ascent of Man" in 1973, summarized the role of values:

> "Our actions as adults, as decision maker, as human beings, are mediated by values, which I interpret as general strategies in which we balance opposing impulses. It is not true that we run our lives by any computer scheme of problem solving. The problems of life are insoluble in this sense. Instead, we shape our conduct by finding principles to guide it. We devise ethical strategies or systems of values to ensure that what is attractive in the short term is weighed in the balance of the ultimate, long term satisfactions" (Bybee, 1979).

The implementation of technological innovations has raised questions of moral and ethical conduct of "rightness" in which ethics are viewed as human responsibility and do not rely on genes or natural selection to ensure that man will always choose the right direction (Bybee, 1979; Baker, et.al., 1975 and Strike 1988).

3.Inquiry Oriented Instruction

Inquiry process had been called for at the time of

attempts were just lip service (Yager, 1988).

STS tries to actually engage students in diverse fields of inquiry in natural and behavioral sciences, through a shift in instructional materials and teaching techniques from the impersonal factual one-right-answer factual one-right-answer to a personal factual value verification, multianswer approach. This shift includes decision making, with the primary goals for students being:

a.Identification of values in conflict.

b.Recognition of groups that would benefit or make sacrifices.

c.Selection of alternatives emphasizing the general welfare.

d.Application of reliable sources of factual claims. And

e.Prediction of results from the implementation of an alternative.

However, question-posing rather than question answering should be stressed (Baker, et. al., 1975, Hurd, 1970; Aikenhead, 1985, Hurd, 1975; Spector et.al., 1979; Allen, 1988; Tooke, 1988; Thompson, 1989; and Nziramassanga, 1989).

The role of the teacher is to accept a perplexing question or issue from students, model it and make an input portion of the session. This could be in the form of a straight two hour lecture (its' time varying according to the unit and the instruction), in the form

of lecture- discussion, or in the form of multimedia experiences. The teacher then places the students in small groups and participates in and directs their discussions and relates the presentations to one another (Allen, 1988; Lepp et.al., 1989).

Time should be allowed at the end of the sessions for small group interaction that results in synthesizing the topics (Spector, et.al., 1989).

Decision making differs from scientific inquiry in several ways. Firstly, decision making includes an additional dimension to be based on reliable and relevant knowledge. This means that data has qualitative as well as quantitative sides. Second, two or more people may form contrasting conclusions about identical facts, or one person may find several meaningful relations among data. The final choice is personal- the most satisfying one. Third, decision making is action oriented. It implies 'what do we do next?' It is one form of human adaptive behavior which is a necessary concomitant for the development of culture (Hurd, 1975).

In the decision making approach we identify the components of the problem or questions to be asked of the data, for example, let us consider overpopulation. Is too many people the central issues? Or is the problem our inability to produce and distribute enough food for all? Or perhaps, are we living too long? (Hurd, 1975).

There is no one answer to the problem, the students are faced with contrasting ideas and view points in which they must decide about the most satisfying solution according to the greatest benefit that this solution will

bring to society.

4.New Organization of Material Interdisciplinary Issues Since the format of the subject matter is the module

and not the text book, hence the organization is not the traditional psychological and logical one but it is according to the society's problems which have local relevance. The local community, including its' agricultural and physical features, industry and other resources, may provide direct resources for problems that are going to be taught and learnt (Yager, et.al., 1981).

5.High Motivation Of The Students

Involvement of students in question possing, collecting information, evaluating their own and other view points, expressing their opinions through small group organization and synthesizing new solutions all make students appreciate more and understand better what they can see, touch and smell.

This has a great effect on their feeling that they have a role in potential solutions and possible future actions which increases their motivation to a large extent (Gardner, 1979).

6.Trend Toward General Education

STS programmes tend to prepare students for life and not simply for entrance examinations of universities.

This entails the development and implementation of the general education (Gardner, 1979). General education

is concerned with the majority of students, who don't have aspirations to a scientific career.

These students need a certain basic level of understanding and functional capability in science and technology included in an interdisciplinary, more concrete and socially oriented curriculum.

The other type of students who have science career aspirations need a more mathematical, abstract and discipline based science curriculum. Both need programmes based on real life situations.

II. Comparison Among STS and Traditional Programmes

Yager (1988) in his papers discussed the STS and traditional programmes and he compared them from different points of view. The following is a list of these differences:

Traditional	STS
1. Survey of the most important concepts found in textbooks.	1. Search and identification of problems presented in the society.
2. Use of textbook activities and laboratories according to the lab manual.	2. Use of local resources (material and human) to collect information that can be used in problem solving.
3. Passive role of students in assimilating information provided	3. Active participation of students in searching for information that can be

by teacher and textbook.	used.
4. Science being contained in series of classrooms over the school year.	4. Science goes beyond the classroom to meeting room or a given educational structure.
5. Focus is on the information that is considered to be important for the students to master.	5. Focus is on the personal impact and may be started with students curiosity and concerns.
6. A view that science is what is printed as material in the textbooks and teacher lectures.	6. A view that science is not something that is going to be mastered just because it is printed in the textbooks.
7. Practice of basic process skills, of the kind necessary for evaluation.	7. A de - emphasis on the process skills, just because they represent glamorized skills of practicing scientists.
8. No awareness of careers other than occasional reference to a scientist and his/her discoveries (mostly dead).	8. There is a direction toward career awareness especially those related to science and technology and not merely those related to scientific research, medicine and engineering.

9. Students concentrate on problems identified by teachers and texts.	9. Students participate in roles of a citizenship through their attempt to resolve issues which they have identified.
10. Science being visible only in the classroom as part of the school programme.	10. Science being visible in the community and in any given institution.
11. Science is acquired as information evaluated by teachers on the degree of acquirement.	11. Science being an experience students are encouraged to have.
12. Science focuses on current explanations and understandings, little or no concern for using science beyond the classroom.	12. Science focuses upon the future and what it may be like.

As we can see, some of the points related to STS were pointed out by the early Arab-Moslem scientists and educators centuries age, like Jaber Ibn Haian (738-814C), El-Razi (854-932C), Ibn El Haitham (965-1039C), and Ibn Sina (980-1036C), who called for the scientific approach to be followed in thinking and life, which is consistent with points 6 and 10 (See page 12 and 13) (Difaa, 1979).

Ibn Haian said:

"We should know that we mention only the

characteristics of what we see, not what we learn, read, or are told, and this can be accomplished through experimentation after which we either accept or reject it."

Gibran Khalil Gibran in 1923 called the teacher to be a guide to the student, w hich is consistent with STS characteristics number 3,9 and 11 (See page 16, 17 and 18)[Gribran, 1923].

As concerns western thinking Dewey, Bobbitt and Tyler also emphasized some of the STS characteristics, for example, Bobbitt's analytical aims approach (1918) emphasized the role of education in preparing individuals to live in society, and this is consistent with point 10 that pointed to the use of science outside the classroom (Sayler et.al., 1981).

Tyler (1940) emphasized the importance of learner participation which is STS characteristic number 3.

He commented that:

"I would give much greater emphasis now to careful consideration of the implications of the curriculum in development of the active role of the student in the learning process. I would also give much greater emphasis to a comprehensive examination of the nonschool areas of student learning in developing a curriculum" (Sayler, et.al.,1981).

In addition, Dewey confirmed point 10 by commenting:

"What nutrition and production are to physiological life, education is to social life" (Sayler, et.al., 1981).

As we can see, the original ideas of some early educators have gained importance to the point where they now dominate our thinking.

STS programmes are defined as those starting with the world of the student, dealing with his real world issues and concerns. The students mostly choose the problem, and then, the problem must be investigated. This student concern comes from unusual circumstance. Some of them, reported by some students might be problems with a tap which does not turn off at school, a power failure in a school with no windows, a problem with a polluted water and hundreds of others (Yager, 1988).

STS means searching for answers and explanations, it means dynamic teaching and learning, it provides a real life context.

On the contrary, in traditional science classrooms students are expected to remember, to get the answer on quizzes, and to make correct observations in the laboratory (Yager, 1988).

Assessment of STS focused on: opinions, attitudes, knowledge, and creativity. In this research the focus will be on the opinions of secondary girl students in relation to an STS interdisciplinary unit and their academic achievement.

III. Research Studies Related to STS

Research studies which are related to STS are divided here into two types: the first deals with STS curriculum evaluation and the second deals with development of instruments for measuring students' opinions about STS relationship.

1. Studies Related To STS Curriculum Evaluation

The first research on this topic was done by Milkent(1975) with the purpose of evaluation of the chemistry curriculum to determine the degree to which it reflected the STS relationship.

The curriculum material examined was " Nuclear Energy: Origins and Consequences ". It was applied over two weeks through 10 sessions to experimental groups. It consisted of an introductory part, science and technology part, and three other parts about major scientific discoveries: X-rays, Radio-active phenomena and Nuclear fission.

In addition, there was a students' guide and a teacher's guide which included objectives, method of instruction and probable answers to the student activities.

The sample consisted of 203 students. Post-test-only control group design was used in which the experimental group received the STS material for two weeks, while the control group received the ordinary material with no STS concentration. Data were collected and two way analysis

of variance was used.

The results of Milkent's study were:

a) The curriculum material "content" affected the opinions of students positively toward STS interaction.

b) The teacher had great effect on changing students opinons tward this STS interaction.

c) The benefit of medium ability students was much more than that of low and high.

The second study was a project conducted by Kortland, et al., in the Netherlands in 1988, to investigate the effectiveness of classroom teaching with the help of teaching materials in reaching the educational objectives.

The curriculum material were called "Fuel" and "Meat". The teaching units have some common characteristics in relation to content and structure that deal with a range of topics. The sample was students in the 12-15 age groups at all ability levels of secondary education in the Netherlands. Pre test-post test design was used.

The results of the study indicate that the effectiveness of the unit Fuel is only partial. This general result does not only apply to this unit. Research on the unit Meat reveals the same pattern.

In addition, a number of curriculum- material-units were conducted and evaluated by Eijkelhof and his colleagues in a specified project in physics in the Netherlands. One of these units was entitled " Water for

Tanzania ".

Six classes were involved. Teachers and students (No: 106) filled in questionnaires and lessons were observed by the project staff members and trainee teachers.

In general, this unit was highly appreciated by teachers and students, especially by the girls.

Another unit was evaluated by the same project staff. The unit in which mechanics is taught in the context of traffic was called "Traffic". About two thirds of the students seemed to dislike the first version, mainly because they didn't know what was expected of them both in activities and in preparations for tests. The same unit became popular in the second version.

Evaluation of the unit " Ionizing radiation" showed that it was a very popular unit especially the medical parts of it with the girls. In the late evaluation study, it appeared that students had misconceptions about radiation which didn't change very much.

In another study carried out by the same project staff, students were asked about their pinions on the various previously mentioned units. 191 students filled in a questionnaire at the end of a two year physics course in senior secondary education.

The results showed that students preferred some units more than others. Popular units were those which related to daily life or specific interest areas of students, for instance the units traffic, music, weather changes (boys) and ionizing radiation (girls).

Students seemed to be less fond of units which were

either theoretical or technological, such as matter, energy, and quality, electronics and electrical machines (girls). on the other hand students responses showed more variety in answering the question: "From which two units did you learn most?" 41% of the boys found ionizing radiation very instructive, the same qualifications was given by 23% of the girls to electronics.

In general, students appreciated the physics lessons with these units. They were especially positive about the student activities and the applied character of the physics.

The latest study in this field was done by Finson and Enchos (1987) on a sample of 194 high school students in order to find out if there would be an effect of the visit of students to science and technology museums on their attitudes toward STS issues. The results of this study indicated that the positive attitude for the results toward science and technology was increased by their visits to the museums. It also indicated that the level of the class has an effect on increasing positive attitude. The lowest class (6 through 8) was the most affected. And finally, it indicated that previous experience with STS, sex, kind of school and socio-economic status of the student have no effect on the attitudes of students toward science and technology.

2.Studies related to development of instruments for measuring the opinions of students and educators about the interaction among STS.

The first study was done in the U.S.A. in 1972 by Milkent (1975). The purpose of the study was to develop a

quantitative instrument which was based on the following:

a.its items were related to the items of the "Test of Social Aspects of Science" which was developed by Korth 1968 (Milkent, 1975).

b.its items were unrelated to any specific situation in science.

c.acceptance of the item as a general true or false statement.

The instrument consists of 43 items, each item having 3 possible answers, true, false or uncertain. One mark is given to the item if the student has the right answer. The sum of the item scores constitutes the total score.

The instrument was administered to a sample of 82 secondary students. The Cronbach was calculated and found to be 78. The total scores on the evaluative instrument, that is the effect of treatment, produced a difference in favor of the experimental group.

The second study was conducted by Aikenhead et. al., (1987) in Canada.

The purpose of this study was to develop descriptive qualitative instruments (qualitative in the sense that some writing is required from the respondents and not just 'agree' or 'disagree' for example) and to learn the opinions of secondary school students before their graduation on the interaction of STS.

An instrument was developed, consisting of 46 items. Each student identifies response by saying 'agree', 'disagree', and 'can't tell', then writes the reasons for

his choice.

Data were collected from about 10800 people. The data were analyzed in a descriptive way depending on the reasons given by the students for their choices. Responses were classified in categories and given a percentage for the students which fall in each category.

General results related to contruction of the instrument were:

a. the contradictions of student opinions about some items through applying different reasons for their opinions. This led the researcher to recommend the use of descriptive instruments instead of quantitative ones since the descriptive instrument can show clearly the reasons or logic behind a certain opinion for a certain student.

b. the presence of some items that couldn't be analyzed and thus couldn't be classified or given a certain percentage, thus the student lost that percentage.

The last study in this field was done by Bybee with the help of colleagues. The purpose of this study was to survey the opinions of educators about the teaching of international issues and problems related to STS (Bybee, et.al., 1986; Bybee, 1987; Bybee et.al., 1987). Bybee developed a questionnaire suitable for use by university students, teachers, ordinary people and scientist. The three studies (Bybee and Mau 1986; Bybee and Bonster 1987; and Bybee, 1987) which used the same instrument as that earlier devised by Bybee showed that international starvation, pollution, water resources, overpopulation

and water technology are the most important problems suitable for teaching. The results also showed that STS issues must be taught to all students and at all levels. In addition, the time to be given to such issues at higher levels must be increased. These research studies also indicated the presence of some retardations in the face of teaching STS issues, including economic, personal, social and psychological ones.

It appears from the previous studies that there are two kinds of instrument, the first is quantitative and the other is qualitative. In the first one, a total score can be obtained but in the second one there is an emphasis on the opinions of students. It seems that the qualitative instrument is more capable of giving a clearer picture about the STS interaction among students since it allows the expression of opinions on the part of the student.

As regards studies in Jordan, Bakir (1988) conducted one with the title "Measuring Understanding of Community College Students to the interaction of STS". Bakir's instrument was composed of 36 items and was used to measure the understanding of the community college students toward STS relationship.

The understanding of the interaction was measured by the degree of competence which is equal to =

$$= \frac{\text{Row score (Row mean)}}{\text{Highest degree}} \times 100\%$$

This study showed that among the students, the

understanding of the interaction of technology and society was the highest, then the interaction of science, technology and society, and the interaction of science and society was the lowest and very similar to the interaction of science and technology which in turn would also be the lowest.

As can be seen, a relatively large number of STS studies have been carried and in the west. On the other hand, very little research has been done a STS topics in Jordan. Taking into consideration research done on STS in various parts of the world, the problem, the statistical methods and the results, the present study aims to investigate the effect of academic achievement and an interdisciplinary biology-geography STS pollution unit on the opinions of students toward this relationship in Jordan.

CHAPTER FOUR

DESIGN OF THE STUDY

This chapter presents the methodological aspects of the study. The major sections in this aspect are the hypotheses, the population and sample, data collection and analytical procedures.

The section on data collection deals with the procedures used in the collection of data for the study.

The section on analytical procedures deals with the operational definitions of the independent and dependent variables of the study and contains a description of the analytical techniques which were employed in the analysis of the data of the study.

Hypothesis

The purpose of this study is to test the following set of hypothesis which are concerned with the opinions of Jordanian high school girl students.

The hypotheses are:

1.Interaction effect between academic achievement and a selected biology-geography unit on the relationship among STS upon the opinions of secondary school girl students toward this relationship is not significant.

2.Effect of the academic achievement upon the opinions of secondary school girl students towards STS relationship is not significant.

3.Effect of a selected biology-geography unit on the relationship among STS upon the opinions of secondary girl students toward this relationship is not significant.

Sample

The sample used in this study was 78 Jordanian 11th grade girl students who were selected from a high school for girls in Irbid, the 2nd largest city in Jordan, during the 1st semester of the 1989-1990 academic year.

The subjects of the sample consisted of the girls science major of a single governmental high school. Girls only were chosen as indicated in chapter one- because of the difficulty of the application of a new type of unit, and because of shortage of time.

The 78 subjects were presented in two classes, one with 37, the other with 41. The random sample procedure was used to choose the experimental and the control classes (groups). The results of the study can only be generalized to the similar schools since the target school was deliberately chosen because of the faet that it was the only school among others which agreed to participate to the study.

Data Collection

The post test control group design has been adopted in this study, as was indicated in chapter 2.

The subjects were divided into two groups, the control and the experimental. They were a signed randomly to either of the two treatments: the ordinary administration of the ordinary curriculum material as it is presented in the already existed books without the concentration on STS relationship and the curriculum material manual that is designed to reflect the STS relationship. The first group was considered to be the

control and the second the experimental.

An opinion inventory (See Appendix C) was administered to both groups at the end of the programme.

The opinionnaire or the opinion inventory on the relationship between STS is an instrument to measure students opinions about the role of science and technology in society. The instrument is similar to that used by Milkent(1975) and Bakir(1988) in content and form.

The instrument consists of 37 items which are generally accepted as true or false. Students are asked to respond to the items by indicating 'agree' or 'disagree'.

The opinion inventory is scored on the basis of one point for each response considered to be the correct response.

The response is considered to be correct by comparing it with the comparable response in Milkent(1975) and Bakir's (1988) instruments and also as judged by a group of experts chosen by the researcher and which consisted of graduates specialized in the fields of engineering, mathematics, computers and education. The reliability of the instrument is .65 as found by using Kuder Richardson Formula 20.

Kuder-Richardson formula 20 was used because the instrment of the present research provides the information required by this formula; as the mean, variance, number of items, the percentage of those who answered each item correctley and the percentage of those who answered each item incorrectley.

Another reson to use Kuder-Richardson formula 20 was that because each item in the opinionnaire were scored either 0 or 1 and there were no multiple levels of responses.

When the validity of the instrument was checked by the committee, their opinions were taken about the degree of reflection in the instrument of the STS relationship presented in the unit. According to their judgements the number of the instrument items was reduced from 42 to 37, which is the final number used, in addition to adjustment of the written items.

The content of the items ranged from types measuring opinions about science as a social institution to types measuring opinions about the social consequences of science and technology, but the instrument in it's overall format measures opinions about the interaction of science, technology and society. This is referred to as the opinionnaire.

The experimental group followed a specially prepared manual of STS based material (See Appendix A). The subject is pollution and it is an interdisciplinary unit. It has been prepared by the researcher. The researcher decided for the major points and titles to be included in the unit under the title the relationship of STS, and then looked for it in different references. During her look, she faced with other important points which considered as a valuable points to be included, and so she did.

This pollution unit was treated firstly from the side of biology and its relations to society and

technology and contains the following subtitles: Same procedures of scientists, Applying a scientific discovery, Consequences of technology, Science and the public and Plastic today. The unit continued to the geography with its relation to science and technology dimension under the following subtitles: A further look at the procedures of scientists, Predicting the applications of scientific discovery, Views of David Janzen and Marie Curie, Communication among scientist, Discovery of the ozone hole, suggested solutions to the problem of pollution, Acid rain and finally Radiation. The concentration in the unit is on the STS interaction from economic, social, scientific, technological and political points of view.

At the same time the instructor received a teachers guide containing the objectives for each lesson (See Appendix B). The material is divided into eight 45 minute lessons. The guide also contains steps advising about the method of instruction recommended in instructing this STS interdisciplinary unit. The method of instruction is mostly composed of discussion on the part of the students, the instructor only guiding student in the desired direction. The method of instruction also includes some silent reading aloud while the others listen to him. Then students are directed to some exercises at the end of each lesson. Finally they discuss the unit with the whole class.

The unit also contains two activities about the role of technology, and science in society, each assigned one session in which the students are divided into 8 groups

of five or six. The subjects in each group read the activity together, start to agree on an answer to each question after discussing it. After that, one student from each group reads one question from the activity and the suggested answer for it and allows students from other groups to present their answers. Discussion follows among groups, then within groups and the final result is then reported.

The teacher's guide include possible answers to the exercises presented in the students manual, activities for the students related to the relationship between STS (not necessary related to the content of the teaching material but with the purpose of widening the students view of STS).

The group exposed to the interdisciplinary STS unit was tested on the 3rd of December 1989, after 8 lessons using the unit.

The control group which was following the usual method of instruction and the standard Jordanian "Biology" and "Society" courses was tested after the same number of classes held up to the 3rd of December 1989(1).

The date at which the two groups diverged from the standard syllabus, in other words when the experimental group started the interdisciplinary STS unit was November 20th, 1989. The opinionnaire was applied 2 weeks later after the unit had been applied.

---

(1)Any person wishing to see the standards Jordanian Biology and social sciences curriculum mary apply to the Jodanian Ministry of Education. The interdisciplinary STS unit in it's original from in Arabic may be obtained from the researcher. A copy in English is available from the Educational Sciences Department in METU.

While extension of the time of the experiment would have been advisable, it was similar to the time allowed for the application of similar experiments previously applied in the U.S.A. In fact an 8 sessions unit to be administered in a short time was planned from the beginning for practical reasons. The method and the material have been developed and can now be used again by other researchers if necessary.

Analytical Procedures

a.Operational definitions of the dependent variable.

Opinion

This dependent variable of the study was measured by the opinion inventory scores. This score represents a measure of the affective domain of the student.

Opinions were treated as a continuous variable in the analysis, and its values ranged between 13 and 32 it out of 37.

b.Operational definitions of independent variables.

1.Academic Achievement: This was measured by the mean of the overall score of the students at thee end of the 1st semester of the academic year 1989-1990, which is the same semester in which the data was collected.

2.Interdisciplinary biology-geography unit: It is a unit designed to overcome the bridges between biology and geography, as it was pointed to earlier in this chapter (Look page 5).

Analysis of Data

Two way analysis of variance and the Scheffe test were the techniques that used in the analysis of data.

Two way analysis of variance permits the simultaneous study of the effect of two types of treatment conditions. In two way analysis of variance there are two independent variables, each one is known as the treatment, and the varied conditions of each of the independent variables are known as levels of that treatment.

There should also be a dependent variable.

In the case of this study the two independent variables are: a. the academic achievement and b. the unit. There were three levels for the academic achievement: high, medium, and low. And there are two levels for the unit: unit, and no unit or programme, no programme. Thus the design is a "3x2" design. Each of he two treatments (academic achievement and the unit) represents a separate question, and a possible interaction between the two can be assessed as a third question.

The dependent variable is: the opinions of the girls secondary school students (11th grade).

Usually, the independent variables in two way analysis of variance are categorical, while the dependent variable is usually continuous.

Academic achievement and the unit are categorical variables and the opinions are continuous since it is measured by the response to the opinion inventory.

Concerning the Scheffe test, it is useful for making post hoc comparisons. It permits evaluation of any and all comparisons, independent or not, including those suggested by the outcome of the study.

The Scheffe test is applicable only in situations where a primary overall F test for the treatment has shown a significant difference.

In this study, the Scheffe test was used for the academic achievement to check to which level the significance was due after finding a significant difference for the academic achievement by using the F test.

CHAPTER FIVE

PRESENTATION OF THE FINDINGS

In this chapter, the results of the study are presented. The results were obtained by analyzing the data in the way reported in the previous chapter.

The findings concerning the main and interaction effect of academic achievement and the selected interdisciplinary Biology-Geography unit upon the opinions of 11th grade girl students are presented in three sections.

The first section concerns the interaction effect of academic achievement and the unit upon the opinions toward STS relationship of the girl students, the second section concerns the main effect of academic achievement of students upon their opinions and the third section concerns the main effect of the unit upon student opinions toward STS.

Results Concerning the Intreraction Effect of Academic Achievement and the Interdisciplinary Biology-Geography Unit

Two way analysis of variance of the data regarding test of hypothesis "1" revealed that there was no significant difference for the interaction effect of both the academic achievement and the unit upon the opinions of the 11th grade girl students $F(2,72) = 1.1$, $P>.05$ (See Table 1).

This means that academic achievement play no role in changing students opinions when studying an STS interdisciplinary unit.

Results Concerning the Main Effect of Academic Achievement

Two way analysis of variance of the data used to test hypothesis "2" indicated that there was a significant difference due to the academic achievement of students upon their opinions toward the STS relationship $F(2,72)= 14.3$, $P<.05$. (See Table 1). This means that academic achievement level has an effect on changing the opinions of students toward the STS relationship.

Because of the presence of significant difference in the three levels of academic achievement on the opinions of 11th grade girl students toward the STS relationship, the Scheffe test was used as a post hoc comparison in order to check the sources of these differences. It was found that the Scheffe result between high and medium achievement means was 7.14 (See Table 2).

This means that high academic achievement students showed a more favorable opinion toward the STS relationship.

It was found also that the calculated Scheffe result between high and low means was 25 (See Table 2) which means that again the high academic achievement students showed more favorable opinions toward the STS relationship than low mean achievement students.

The Scheffe result comparing students of medium and

low means was found to be 11.25 (See Table 2) which means that students with medium means had more unfavorable opinions toward STS than low mean students.

Results Concerning the Main Effect of the Interdisciplinary Biology Geography Pollution Unit

Two way analysis of variance of the data regarding test of hypothesis "3" revealed that the application of the interdisciplinary STS pollution unit caused a significant effect at =.05 on the opinion of the 11th grade girl students toward the STS relationship F (1,72)=11.1, P<.05 (See Table 1). This means that students who were exposed to the unit showed a favorable change of their opinions toward the STS relationship contrasts to those who were not exposed to the unit.

CHAPTER SIX

DISCUSSION, SUMMARY AND IMPLICATIONS

Discussion of the Results

This study, as was indicated before, dealt with the effect of academic achievement level and an interdisciplinary biology-geography STS pollution unit on the opinions of 11th grade girl students in Jordanian secondary schools toward the STS relationship.

The analysis showed that there was no significant difference for the interaction effect of both the academic achievement level and the unit on the opinions of students toward STS relationship.

On the other hand, academic achievement alone showed a significant difference in changing the opinions of the students toward the STS relationship and particularly at the high achievement level.

This result is consistent with the findings of another study (Milkent, 1975) which pointed to the presence of an effect of the STS curiculum material in changing the opinions of students positively toward STS, but is inconsistent with another (Finson and Enchos, 1987) which pointed to the absence of the effect of the STS experience (material and method) on changing the opinions of students toward STS" since "experience with STS" was taken as another variable (other than the visit to museum) in Finson et al study.

Analysis also indicated that the interdisciplinary STS pollution unit had a significant effect on changing the opinions of the students toward the STS relationship. This is consistent with Milkent's study (1975) conducted

in the U.S.A.

As concerns the interaction effect it was found that students with high, medium and low achievement levels who were exposed to the unit were not significantly different from each other.

At the same time, students with high, medium and low achievement levels who were not exposed to the unit also are not significantly different from each other. This may be due to the traditional curricula and instructional strategy. The teacher who is the active part in the teaching-learning process does not direct students toward the interdisciplinary approach. He/she does not reward and encourage the students for this approach of learning type of thought, thus keeping him within the limits of each discipline far remmoved from the other and from it's application in the society.

One of the reasons that teachers don't encourage students toward this approach may be that they didn't experience such a kind of curricula and instructions during their preparation. Thus a call is given for such preparation in the recommendations.

The analysis of the main effect of academic achievement upon student opinions toward STS showed a significant difference. The analysis also showed that students with a high achievement level were significantly different from the students with medium achievement. The reasons for that may be due firstly to the fact that high academic achievement students may be more interested in the subject; thus more able to cope with its requirements and therefore to change their opinions accordingly than medium academic achievement students are. Secondly, the

backgrounds of the high academic achievement students may have caused them to be better prepared for receiving and adapting to a newly applied interdisciplinary content. And thirdly, the high academic achievement students are already motivated by their good grades. This motivation gives them the chance to prove their success in every new aspect and hence they are more successful.

The above explanations are also true for medium and low achievement students when compared to each other.

As regards the analysis of the main effect of the unit, it showed a significant difference in the case of the interdisciplinary biology-geography unit.

The effect of the unit may be due to the fact that the nature of the topic which is related to daily life is closer to the students experience and hence it is easier for them to grasp. It may also be due to the presence of a new type of curriculum material. The "Pollution-interdisciplinary unit" may attract the attention of the students and act as a motive for them to respond positively to it.

Another possibility may be introduced which is the subject itself which may have greater effect than others since it is a universal issue.

One of the very important objectives of the STS approach is to prepare students for future life where they can solve their problems by transferring e classroom information to their daily life. But student were noticed to be far from his application.

The reason for that may be due to the fact that the students were accustomed to the system of "Read the text look and repeat it" method and not to material much

closer to real life situations and society, requiring thinking and decisions making. Students were not accustomed to an original type of material that is opposed to the regurgitation of a textbook style of factual accounts.

This original material invited students to examine real evidence before drawing their conclusions. The students in the experiment enjoyed the new and different approach and responded positively to it. However the fact that they could not show the same response elsewhere suggested that the way they were taught had became part of their way of act and thinking. Using this type of material for only 8 sessions was not enough to make the students accustomed to feel free to act and give their own answers and solutions in all situations.

This was the reason that caused the students to return to the traditional way of learning as soon as they had finished the unit as if it were an episode just conducted for the researcher, inspite of the fact that students liked the unit and were interested in it.

Students for example asked the teacher to continue the same unit for the whole of the semester, others asked how the unit was made up and for the references of the material that was used. Although they were given a list of the references which means that they hadn't acquired gain the habit of looking at them before. Students wished that most of their courses could be given in the same manner.

Summary of the Study

The problems of this study were three fold. The first was to test the effectiveness of the interaction of the academic achievement and the interdisciplinary STS biology-geography pollution unit on the opinions of secondary girl students in Jordan toward this relationship.

The second was to judge the effect of the academic achievement level on the opinions of students toward the STS relationship. And the third was to check whether the interdisciplinary STS biology-geography unit had an effect on the opinions of girl students toward this relationship.

Previous literature indicated that only one survey about the understanding of community college students to the STS relationship had been conducted in Jordan -in the limits of the researcher knowledge-.

Also, it was recommended at the national educational conference in Amman in 1987 that interdisciplinary subjects should be included in the curriculum. The researcher found that this type of study may help to satisfy that need.

From a practical point of view this study aimed to investigate the factors that influence students opinions about STS relationship at the 11th grade level.

From a theoretical point of view, this study tried to draw the attention of researchers to the application of the interdisciplinary type of curriculum in the east.

The sample consisted of 78 11th grade Jordanian girl students, who were distributed in two sections (classes), one containing 41 students, the other 37. The

experimental and control groups were selected randomly. The study was conducted in Irbid, the 2nd largest city in Jordan, during the 1st semester of the academic year 1989-1990.

The data was collected in the same semester in December by administering an opinion inventory which was prepared by the researcher herself. The content validity of the opinion inventory was checked by six post graduates. It was also checked by a pilot study consisting of 200 11th grade students from the science branch.

Kuder-Richardson formula 20 was used for estimating the reliability of the opinion inventory.

The data was analysed by using two way analysis of variance and the Scheffe test.

It was found that each of the two independent variables: the interdisciplinary STS biology-geography pollution unit and the academic achievement had a significant effect in the explanation of the variance of the dependent variable.

No significant difference was found due to the interaction between the two independent variables upon the dependent one.

Recommendations

The results of this study and other studies like Milkent (1975) supported the notion that conducting such an interdisciplinary unit that reflects the relationship between science, technology and society is an important step in which to direct girl secondary school students

opinions.

Furthermore, it was found that changing opinions of higher achievement level students towards the STS relationship is easier than changing lower achievement level students.

So, the following implications may be helpful.

a.Repeating the same experiment with new variables as, family background, age and/or socio-economic status may give significant interaction effect since no interaction effect was found between academic achievement and the Interdisciplinary STS pollution unit.

b.Repeating the same experiment with boys.

c.Repeating the same experiment but for different levels, say elementary preparatory community colleges and universities, taking into consideration the adjustment of the unit accordingly.

d.Repeating the same experiment by conducting other units concerned with other issue of 21st century society, or any other universal issue.

e.Extending the time of the unit for one complete academic year, keeping the same variables in the previous study.

f.Training teachers through teacher training programs to prepare STS curriculum material and to implement it in their closrooms.

g.Starting to instruct STS curricula especially for low ability students from the primary schools, continuing to elementary and secondary levels; community colleges and universities. Because it was noticed by the researcher, that the students were found to be very far from applying the information presented by the unit in

times other than the time of presenting the unit.

REFERENCES

"A Leading Experiment In Environmental Protection", Al-Arabi, No.343, 1987.

Abed-El Macqsoud, Z. Environmental and Man, Kuait, 1981.

Abraham, M; Renner, J: Grant, Rand Westbrook, S. "Priorities For Research In Science Education: A Survey". Journal of Research In Science Teaching, 19(8), 1982.

Aikenhead, C; Fleming, R. and Ryan, A. "High School Graduates Beliefs About Science Technology Society I.Methods and Issues in Monitoring Student Views." Science Education, 74(2), 1987.

Aikenhead, G. "High School Graduates Beliefs About Science-Technology-Society. III.Characteristics and Limitations of Scientific Knowledge". Science Education, 71(4), 1987.

Aikenhead, G. "Collective Decision Making in the Social Context of Science". Science Education, 69(4), 1985.

"Air Pollution in Europe and America and Wayo of it's Protection", Al-Arabi, No.344, 1987.

Allen, G. "The Present Opportunity in Education." STS Reporter, Special Issue, Nov.1988.

Allen, M. "Middle Grades Social Studies: A Modest Proposal". Social Education, 52(2), 1988.

"America: the Country of Contradictions", Al-Arabi, No.347, 1987.

Alwi, H. "The Need for Continuous Education and the Role of Information Media in it's Verification", Continuous Education, No.12, 2nd year, 1987.

Badran, A; Lufty, R. and Nather, L. Biology, Jordan, 1973.

Baker, Mand Doran, R. "From an Awareness of Scientific Data To Concerns of Mankind: Strategies for Affective Instruction in Science". Science Education, 59(4), 1975.

Bakir, H. Measurement of the Understanding of Community College Students of the Interaction Between STS". Unpublished Master Thesis, Yarmouk University, Jordan, 1987.

Bellon, J. and Handler, J. Curriculum Development and Evaluation: A Design for Improvement, USA, 1982.

Bernstein, Stanley. "Science and Society, Social Content of Science", Journal of College Science Teaching, 14, 1985.

Biological Science: A Molecular Approach, BSCS Blue Version, Fifth Edition, USA, 1985.

Bruner, J. The Process of Education, USA, 1960.

Brunsting, H; Vanderloo, F; De Vries O. "Waste Management, Environmental Education In Science", Paper on Project NME-VO, University of Utrecht, 1989.

Bussoff, L. and others. Curricula and Life Long Education, France, 1981.

Bybee, R. "Science Education and the Science-Technology-Society Theme". Science Education, 71(5), 1987.

Bybee, R. "The New Transformation of Science Education". Science Education, 61(1), 1977.

Bybee, R. "The Restoration of Confidence in Science and Technology Education". School Science and Mathematics, 85(2), 1985.

Bybee, R. and Bonnestetter, R. "What Research Says: Implementing the Science-Technology-Society Theme in Science Education: Perceptions of Science Teachers". School Science and Mathematics, 87(20), 1987.

Bybee, R. and Mau, T. "Science and Technology Related Global Problems: An Introductional Survey of Science Educators". Journal of Research in Science Teaching, 23(7), 1986.

Bybee, R; Harms, N; Ward, B and Yager, R. "Science, Society and Science Education". Scince Education 64(3), 1980.

Bybee, R. "Teaching About Science-Technology-Society (STS): Views of Science Educations in the United States". School Science and Mathematics, 87(4), 1987.

Bybee, R. "Science Education and the Emerging School Ecological Society". Science Education, 63(1),1979.

Camphell, T. and Stanley, J. Experimental and Quasi-Experimental Designs for Research, Chicago: R. and MacNally, 1960.

Casteel, J; and Yager, R. "Science as Mind Affected and Mind-Effecting Inquiry", Journal of Research in Science Teaching, Vol.4, 1966.

Cogan, J. "Citizenship for the 21st Century: Observations and Reflections". Social Education. 53(4), 1989.

Dewey, J. Democracy and Education, NewYork: Markmillan, 1916; Reprinted, NewYork: The Free Press, 1966.

Difaa, A. A Summary of Moslems' Arabic Scientific Heritage, U.S.A., 1979.

Dreyfus, A. and Jungwrith, "A Comparison of the Prompting Effect of Out of School Contexts in Certain Aspects of Thinking". European Journal of Science Education, 2.

Dubs, R. "Humanistic Biology". American Scientist, 53, 1965.

"Educatinal National Conference". El-Ray Newspaper, No.6269, Jordan. 1987.

Eijkelhof, H. and Kortland, K. "Broadening the Aims of Physics Education". Cited in: Development and Dilemmas In Science Education. The Falmer Press. 1988.

Ewer, JR and Glatorre, A Course in Basic Scientific English, Longman Group Ltd., London, 1969.

Finson, K. and Enchos, L. "Student Attitude Toward Science, Technology-Society resulting From Visitation to a Science-Technology Museum". Journal of Research In Science Teaching, 24(7), 1987.

Fleming, R. "High School Graduates Beliefs About Science-Technology-Society, II.The Interaction Among Science, Technology and Society". Science Education, 71(2), 1987.

Fleming, R. "Adolescent Reasoning In Socio-Scientific Issue". Journal of Research In Science Teaching. 1986.

Gallagher, J and Yager, R. "Perceived Problems of Science Educators for their Disciplines". Science Education, 64(5), 1980.

Gardner, M. "10 Trends in Science Education". The Science Teacher. 1979.

Gibbon, C. and Morris L. How to Design A Program Evaluation, USA, 1978.

Goad, L. Preparing Teachers For Life Long Education, Britain, 1984.

Goldsbee, R; ,translated by Alwi, A; El-Haj, H; Deecy; A; Abu Rumeileh, N. and Abed Al-Hafitb, Biology, Jordanian Arabic Language Center, Amman, 1980.

"Good and Bad Ozone" Al-Arabi, No.368, Kuait, 1989.

Good, R; Herron, D; Lawson, A. and Renner,J. "The Domain of Science Education". Science Education. 69(2), 1985.

Haffar, S. "Technology and Environment", Education, No.85, 1988.

Haikal, "Programs and Curriula for Teaching Adults and Illiterates", Continuous Education, No.12, 2nd year, 1987.

Hijazi, A. "Educational National Conference: Process, Media and Results". El-Ray Newspaper, No.6281, Jordan, 1987.

Hofstein, A. and Yager, R. "Societal Issues As Organizers for Science Education in the 80's". School Science and Mathematics, 82.

Holdson, D. "Toward a Philosophically More Valid Science Curriculum, Science Education, 72(1),1988.

Hornik, R. "Polluting China's Good Earth", Time, No.12 1987.

"Human Safety through Environmental Safety", Al-Arabi, No.369, 1989.

Hurd,P. "Science, Technology, and Society: New Goals for Interdisciplinary Science Teaching". Science Teacher, 42(2), 1975.

Hurd, P. "Scientific Enlightenment For An Age of Science". The Science Teacher, Vol. 37, 1970.

Hurd, P; Bybee, R; Kahle, J; and Yager, R. "Biology Education in Secondary Schools of the United States". The American Biology Teacher, 42(7), 1980.

Idris, M. and Shaban, R. "Plastic", General Sciences, Jordan, 1984.

"Is there a Contradiction Between Environmental Protection and Development?", Al-Arabi, No.367, 1989.

Jager and Van Der Loo, F. "Decision-Making In STS-Education", Notes from Research into Environmental Education Center for Science and Mathematics Education. Netherlands, 1988.

Johnson, S. "Assessment in Science and Technology". Studies in Science Education, 14, 1987.

Kauffman, D. Teaching the Future, USA, 1976.

Kerliger, F. Foundations of Behavioral Research, Japan, 1981.

Khalih, K. "New Trends In Curriculum Development Encompassing STS Interaction", Paper Presented in Amman Counselling Summit for the International Committee Responsible for the Teaching of Science and Technology, February, 1989.

Kirschenbaum, H. and Simon, S. "Values and the Futures Movement in Education", Cited in Learning For Tomorrow, The Role of the Future in Education. Alvin Toffler, USA, 1974.

Klopfer, L. "Teaching Physics for the 21st Century: Science and It's Cultural Context". School Science and Mathematics. , Chicago, 1967.

Kortland,K. "Environmental Education Within the Science Subjects in Secondary Education: Why, What and What for?" PAPER Presented at the Seminaries Europe Congiunto ICASEAIF, Italia, Oct. 1988.

Kromhout, R. and Good, R. "Be Ware of Societal Issues as Organizers for Science Education". School Science and Mathematics, 83.[8], 1983.

Lapp, D; Flood, J. and Thrope, L. "How-To-Do It". The American Biology Teacher, 51(2), 1989.

Layton, D; Davy, A. and Jenkins, E. "Science for Specific Social Purposes". Studies In Science Education, 13, 1986.

Lifton, W. Educating For Tomorrow, USA, 1970.

McCormic, C. "Air Pollution", National Geographic, Vol.172(2), 1987.

McCormic, C. and James M. Curriculum Evaluation In Schools, Britain, 1983.

Mendelson, E. "Values and Science: A Critical Reassessment". The Science Teacher, 43(1), 1976.

Milkent, M. "An Evaluation of Supplementary Chemistry Curriculum Materials Reflecting Relationships Between Science, Technology and Society". The University of Texas Publications, USA, 1975.

Milkent, M. "The Development of an Instrument to Measure Understanding of Relationships Between Science, Technology and Society". The University of Texas Publications, USA, 1975.

Milkent, M. "Science and Technology. Student Booklet, USA, 1975.

Milkent, M. "Science and Technology". Teacher Guide, USA 1975.

Morris, L. and Gibbon, C. Evaluators Handbook, USA. 1982.

"New Education",No.40, Year 14, 1987.

Nziramasanga, C. "Citizens for the 21st Century: The Role of Social Studies: A view from Zimbabwe", Social Education, 53(1), 1989.

OECD. Curriculum Improvement and Educational Development. Paris: OECD, Publication, 1966.

Ogden, W. and Jackson, J. "Secondary School Biology Teaching 1918-1972: Objectives as Stated in Periodical Literature". Science Education, 1987, 62(3). 1987.

Ost, D. "The Nature of Technologic Hierarchy". School Science and Mathematics, 85(8), 1985.

Pella, M; Ohearn, G. and Gale, C. "Referents to Scientific Literacy". Journal of Research in Science Teaching, 4, 1966.

Pieters, M. "Environmental Education In Regular Subjects: Innovation Through A Curriculum Development Project". Paper presented in Austria, 1988.

"Protective Shield for Life Pictures", Al-Arabi, No.344, 1987.

Rawe, M. "Reparing the Arab Educational System, from Outside", Arab Magazine for Education, 7(1), 1987.

"Recommendations of the National Conference", El-Ray Newspaper, No.65270, Jordan.

Redfield, D. "The Philosophical Basis of Modern Science", Journal of Research in Science Teaching, Vol.3, 1965.

Renner, J. "The Power of Purpose". Science Education, 66(5), 1982.

Roberts, D. Developing the Concepts of Curricular Emphasis in Science Education". School Science and Mathematics, 82(7), 1982.

Roby, K. "Origins and Significance of the Science, Technology and Society Movement". The Australian Science Teacher Journal, 27(2), 1981.

Rosenthal, D. "Trends in Science and Society Education: An Analysis of the Literature". The American Biology Teacher, 45(1), 1983.

Rumaihee, M. "May we need to learn how to think?", Al-Arabi, No.372, 1989.

Ryan, A. "High School Graduates Beliefs About Science Technology-Society. IV. The Characteristics of Scientists". Science Education, 71(4), 1987.

Sabbarini, M. "Goals and Content of the Biology Curriculum Secondary Level", Teacher Magazine, Jordan, 28(4), 1987.

Sabbarini, M. and Hammad, R. "Environment its Problems", The World of Knowledge, No.2, 1984.

Salameh, E. "Water Pollution from Sewage" Manuscript, Jordan, 1989.

Salameh, E; Saliba, E; Hashwa, F; Rimawi, O. "The Effect of Khirbet es Samrae Effluent on the Water Quality of Wadi Dhnleil and Zerka River in Jordan", Bulletin of the Water Research and Study Center. University of Jordan, Amman, 1987.

Schnieder, D. "History, Social Sciences and The Social Studies. Social Education, 53(3), 1989.

Schubert, W. Curriculum, USA, 1986.

Shwab, J. "Structure of the Discipline: Meaning and Significances". Cites in: Curriculum Design for Greenwald, G. and Others. London: Open University Press, 1975.

Snelbecker, G. "Learning Theory, Instructional Theory and Psychoeducational Design, New York, McGraw Hill, 1974.

Solomon, J. "Social Influences on the Construction of Pupils Understanding of Science". Studies in Science Education, 14, 1987.

Solomon, J. "Prompts, Cues, and Discrimination: The Utilizations of Two Separate Knowledge Systems". European Journal of Science Education, 6(3), 1984.

Solomon, J. "Learning and Evaluation: A Study of School Children Views on the Social Uses of Energy", Social Studies of Science, 15, 1985.

Solomon, J. "Science Technology and Society Courses: Tools for Thinking About Social Issues". International Journal of Science Education, 10(4), 1988.

Spector, B. and Phillips, E. "Excellence in Graduate Education for Mathematics and Science Teachers: A Schematic Approach". School Science and Mathematics, 89(1), 1989.

Strike, K. "The Ethics of Teaching". Phi Delta Kappan, Oct., 1988.

STS Reporter, 1(1), 1988.

Switzer, T. and Voss, B. "Science Education In the 80's. School Science and Mathematics, 82(7), 1982.

Tanner, D. and Tanner, L. Curriculum, Theory into Practice, USA. 1980.

Tell, A. The Development of Education in Jordan, Jordan, 1978.

The Educational Covenant Section, Ministry of Educatin and Instruction. History of Education and Instruction in Jordan, Jordan, 1980.

Thelen, L. "Values and Valuing in Science". Science Education, 67(2), 1983.

Thompson, J. "Citizens for the 21st Century: The Role of Social Studies. A View from Jamaica". Social Education, 53(4), 1989.

Thorndike, R. Applied Psychometrics, USA, 1982.

Tooke, M. "Citizens for the 21st Century: The Role of Social Studies. A View from Canada". Social Education, 52(6), 1988.

Totten, S. "Using Oral Histories to Address Social Issues in the Social Studies Classroom". Social Education, 53(2), 1989.

Tucker, J. "Social Studies for the 21st Century". Social Education, 52(3), 1988.

Westmeyer, P. "The Nature of Disciplines". Journal of Research in Science Teaching, 20(3), 1983.

Wiles, J. and Bondi, J. Curriculum Development, USA, 1984.

Wisson, J. (Translated). "Science Programmer Teaching and the Social Issues". International Culture, 5(29), 1986.

Wright, J. "2000: A Science Odussey". The Clearing House, 62(1), 1988.

Yager, R; Hofstein, A; and Lunetta, V. "Science Education Attuned To Social Issues: Challenge for the 80's". The Science Teacher, 1981.

Yager, R. "In Defense of Defining Science Education As the Science Society Interface". Science Education, 69(2), 1985.

Yager, R. "Defining the Discipline of Science Education". Science Education, 68(1), 1984.

Yager, R. "STS As a Development In Science Education". Manuscript, 1988.

Yager, R. "Instructional Outcomes Change With STS", Manuscript, 1989.

APPENDIX A

INTERDISCIPLINARY UNIT ON POLLUTION

BY

SALMA NASHEF

INTRODUCTION

The unit you are about to study is based upon two related current societal and universal issues which have major effects upon society; Air and Water Pollution.

Pollution has the meaning of: "the addition of any material to the elements of the environment".

You may be aware that science and technology have great effects on modern society and that they can produce both benefits and problems. But can you state the meaning of each of science, technology and society? Do you know the ways science and technology affect social environment? Can you differentiate between science and technology? Do you know the values scientists hold? You will find the answers to these and other questions related to science, technology and society in this unit.

There are two sections in the unit. The first 4 lessons of the unit are related to the biological nature of issues or topics related to STS, while the later 6 lessons are related to the geographical nature with the same purpose but with different directions, emphasizing the relationship between different disciplines.

Both section of the unit contain reading passages and exercises. You will be able to answer most of the questions in the exercises by referring to the reading passages, but there are a few questions which will require original answers from you.

As it is difficult to give you an exact definition of each of science, technology and society, it would be a good idea to discuss the following definitions before you

start, either of the sections the following definitions might be helpful:

Society: is a group of people who have the same values, habits, traditions ... etc. and who live with each other.

Society is made up of different kinds of people, some of whom are scientist (sociologists, natural scientists, pathologists, meteorologists and others), governors, economists, business men and women, the public and others.

Science: is a search for understanding of the natural world by using the scientific method.

Technology: involves application of knowledge in order to alter or improve the material environment (Milkent, 1975).

Science and technology are closely related. You are required to distinguish an activity to be mainly scientific or technology according to the purpose of the activity.

In general, the purpose of scientific activity is to increase an individual's understanding of natural phenomena, while the purpose of technological activity is to alter or improve the material environment. So STS issues are not concerned only with the material environment or the understanding of nature but the application of these in the social environment and the resulting effects of this application.

The above definitions and clarification will be applied in completing the following exercise.

EXERCISE ONE

Directions: classify each of the following activities as being mainly scientific or mainly technologies in nature. Write your answers in the space directly to the right of each statement.

1. Building a canal in order to provide a waterway between two cities. ----------

2. Building an irrigation system to provide water for arid regions. ----------

3. Decomposing water in order to determine its components. ----------

4. Purifying water in order to make it fit for drinking. ----------

5. Inventing a telegraph to provide a means of communication. ----------

6. Studying rocks to try to determine the composition of the earth. ----------

7. Studying the expansion of liquids to determine the relationship between volume of expansion and rise in temperature. ----------

8. Formulating the law of universal gravitation. In an attempt to explain the motion of the planets. ----------

9. Designing a rocket to enable space travel. ----------

10. Analyzing moon rock in an attempt to determine the origin of the moon. (Milkent, 1975). ----------

I.The Biology Dimension

Some Procedures of Scientists

A brief description of the procedure followed by Salameh and his colleagues recently in Jordan while investigating water and the extent of pollution in it can be used to illustrate several other aspects of the procedures which scientists follow. First, a scientist often becomes interested in a particular problem after learning of the experiments of other scientists. Next, scientists often repeat the experiments of other scientists. Finally, when a scientist feels he can make a contribution to the understanding of nature, he publishes the results of his investigations.

Sometimes, an unexpected observation of a scientists may lead to an important scientific discovery (Milkent, 1975).

Salameh and colleagues (1986) tried to document the work of Salameh and Bandel, 1982; Soub, 1981; AlSae'd, 1983; Haddad 1983; Hashwa, 1985; Khoury, 1986; Shraideh and Hashwa 1987; and other reports, by repeating the same work. They aimed to study in the laboratory the possible effects of the outflow of Khirbet es Samre (KS) on the survival of Bulinus truncates snails in the Zerqa River water.

For the survival study of B.truncates, water samples were brought from some or all of six sites along the Zerqa River course from KS to Jarash Bridge. To account for the contribution of the Zerqa River an additional sampling point was selected in Seil Zerqa, 200m upstream of the confluence points. Water samples

from these regions were taken approximately once every month during the period from March to July, 1986, and in November of the same year. The samples were collected in prewashed plastic containers and were brought to the laboratory within 3 to 4 hours of collection. They are toured below 15C for less than 24 hours, when their effects on the survival of B.truncates snails were studied (Salameh and others, 1987).

To determine the effect of the water samples on the survival of the snails, one and a half liters of each of the samples were placed in 28cm enamel dishes that were prewashed with hot water. Fifteen laboratory reared B.truncates snails (3-8 mm in shell length) were then placed in each dish along with boiled lettuce. Control snails were placed in enamel dishes containing 1.5. liters of dechlorinated tap water (DTW) and lettuce. The dishes were covered with glass plates to prevent evaporation and the escape of snails. Snails were then carefully observed to keep them completely immersed in water. After 24 hours, the dishes were examined to determine if the snails were active (moving freely, attached firmly to the surface of the dish or the lettuce, or inactive (at the bottom and unattached to the dish surface) (Salameh and other 1987). Inactive snails were then placed in clean DTW in a petri dish and observed under a binocular stereoscopic microscope to determine whether they would respond and move their tentacles or feet when touched. The dishes and the snails were then washed 4 times in DTW and the snails were places in the enamel dishes with 1.5L of DTW for an

additional period of 48 hrs. Snails that were then inactive and showed no sign of movement as determined microscopically were considered dead and their numbers were recorded.

This study was published in a bulletins of the water research and study center of the University of Jordan in November 1987.

EXERCISE TWO

Directions: Answer the following questions in the space provided.

1.List three procedures scientists often follow in addition to performing original investigations

2.Why do scientists repeat the experiment of other scientists (give as many reasons as you can).

3.List the steps Salameh followed in his investigations which led to determine percentages of water pollution.

Applying a Scientific Discovery

It sometimes happens that a scientist who makes a particular discovery is not aware of the practical applications of that discovery. On the other hand, there may be others who are not interested in how a particular discovery affects scientific knowledge but who recognize that the discovery can be put to practical use (Milkent 1975).

The discovery case of bakelite (a type of plastic which causes air and water pollution) is an example of the first type of scientific discovery.

When Bakilland discovered bakelite, he was aware that he had made an important scientific discovery but it seems that he didn't realize that his discovery would have such a great impact on society.

However the news of bakelite spread and within a short time Bakilland was famous throughout chemical industrial world. Bakelite plastic was used to make a wide variety of products, which were soon in great demand.

Opposing Views

Some scientists discovered that the ozone gas which is present in the stratosphere at a height of about 15-50 km plays a major role in preventing ultraviolet rays and other harmful rays of the sun from reaching the earth, and thus in preventing one of the sources of air pollution. Other scientists discovered that a small quantity of ultraviolet rays pass through this layer. It

is these rays which cause us to become sun burnt after being out in the sun.

Ozone when concentrated may damage the lungs, exactly as oxygen destroys the iron. Generally, if given ozone the person will die as a result of the shortage of oxygen in the lungs. Therefore ozone is a poisonous gas as well as a protective one. One of the studies of pollution in the U.S.A. indicated that polluted ozone kills about 30% of the agricultural crops which is much more than any previous percentage indicated by other studies, where the highest was 12%. This means that the loss that ozone will cause approximates to 2500-3000 million dollars for the American farmers.

In scientific discoveries which have practical applications, as for example the discovery of X rays which are now considered to be one of the pollutants, the scientist is often faced with a decision about patenting the process involved. This may cause a dilemma. On the one hand, the scientist is concerned with the extension of knowledge and according to the ethics of science he should not use his scientific discoveries for his own personal gain.

On the other hand, scientists are not usually wealthy, and the money received from patent rights may relieve a financial burden (Milkent, 1975).

Roentgen who discovered X rays saw no dilemma. When approached about obtaining a patent, Roentgen replied:

> According to the good tradition of
> German university professors , I am
> of the opinion that their discoveries

> and inventions belong to humanity and that they should not in any way be hampered by patents, licences or contracts, nor should they be controlled by any one group.

Edison made the following statement in regard to Roentgen:

> Professor Roentgen probably does not draw one dollar profit from his discovery. He belongs to those pure scientist who study for pleasure and love to delve into the secrets of nature. After they have discovered something wonderful, someone else must come to look at it from the commercial point of view. This will also be the case with Roentgen's discovery. One must see how to use it and how to profit by it commercially.

EXERCISE THREE

Directions: Answer the following questions in the space provided.

1.State one view of the purpose of a scientist discovery.

2.Why do you think farmers were the first to notice the effects of ozone?

3.What other views do scientists hold on the purpose of a scientific discovery?

4.If Roentgen was not interested in making a profit from his discovery, what was his purpose in carrying out his investigations?

5.What does Edison see as the purpose of a new discovery?

The Consequences of Technology

The application of scientific principles and processes is often beneficial to human welfare. At the same time, these applications may also produce undesirable side effects. It took workers in different industries only a short time to realize some of the benefits of their these products industries.. Not too much time were spent before these workers learnt some of the undesirable effects of their products.

One of the reasons for the great impact of industrial technology upon society was that the already existing industries didn't have to be transformed in any way to be useful. Plastic, for example, and it's products have been in existence for about forty years and many manufacturers offered these products at reasonable prices. Scientists were interested in producing different types and products of their own with the hope that of learning more about different types and ways of production.

Workers immediately saw that plastic is an invaluable product in some home uses. On the other hand, they-workers-soon found that plastic can also cause severe disease. And the public was curious. Before long, other reports about the effects of plastic industry became common.

Those exposed for prolonged periods of time to mercury used in the plastic industry those who worked with mercury in the mercury industry, and the people who lived in certain Gulfs began to notice peculiar conditions attributed to mercury poisoning. In 1953 it

was reported that in Japan's Minamata Gulf people and fishermen were suffering from a nervous disease know later on as "Minamata Disease". This cause the death of 234 people and more than 1300 people at that time were suffering from permanent nervous diseases which affected the genes.

Water analysis in Minamata Gulf indicated that the concentration of mercury in the water is very high and equal to 1.6-3.6 parts in a million while the ordinary concentration is .1 part in a million. In fishes the concentration is equal to 5-20 parts in a million while the ordinary level is .5 part in a million.

Science and the Public

Scientific topics are common in newspapers and magazines on radio and television. It is difficult for the non scientist to discriminate between claims which are backed by scientific evidence and those which are not. However, in some cases, an elementary knowledge of the scientific topic involved is all that is needed. (Milkent, 1975).

Pollution was and still is a popular topic in scientific journals, newspapers and popular magazines. Many of the articles were based upon scientific knowledge, but some of the claims involved and some of the actions proposed showed a clear lack of understanding of the possible solutions

The American "Time" magazine stated:

In 1984 the Second National Environmental Protection Conference produced a strategic plan for reversing China's ecological

decline by the year 2000. Yet Chinese experts believe the scheme is overoptimistic , since funding has been minimal, and no single ministry has been made responsible for coordinating the program. Moreover, as an article in Shangahai's World a Economic Herald complained last year, many top officials remain indifferent to the problem. Said the weekly paper:

"Without awakening the whole nation, without mobilization from top to bottom, the halting of environmental pollution cann't succeed".

In addition the Arabic "El-Arabi" magazine stated: Form ten years, the scientific evidence has continued to assure us of the damage that has happened and is still happening to the protective ozone layer from the flouarocarbones that are used in agriculture, cooling, cosmetic etcetera, and which are still produced in factories and used by the public. Various countries have agreed to limit the production of fluarcarbons, but they disagreed on which of these fluarocarbons showed be limited in their production and to what extent. They also disagreed on the level of production that should not be exceeded. This situation continued until May 1986,

when an international organization of 31 developing met in Geneva. It this conference, it was agreed to freeze production of the fluarocarbones at the 1986 level of production till 1990. They also aimed at reducing the production of fluarocarbones between 1990 and 1992 at a rate of 20%. In addition they promised to repeat the investigation of this subject as a whole in the mid 1990's.

Plastic Today

Plastic is one of the various products of industry. Plastics are used for sblood storagebottless, syringes, eye and nose drop, container, plastic tubes used in heart and chest surgery, artificial kidney systems, artificial bone joints, artificial teeth, plastic shoes, etcetera etc.

EXERCISE FOUR

Direction: Answer the following questions in the space provided.

1.a.What are some of the uses of plastic?

b.What are some of the harmful effects of the plastic industry?

2.Analyze each of the incidents mentioned in the section "Science and the Public" as to it's scientific feasibility.

a.Plastic in shoes.

b.Danger of privacy.

c.Mobilization from top to bottom.

d.Agreement to limit the production of fluorocarbons.

BIOLOGY DIMENSION'S REFERENCES

Goldsbee, R; translated by Alawi, A; El-Haj, H; Deecy, A; Abu Rumeileh, N and Abed Al-Hafith, Biology, Jordanian Arabic Language Center, Amman, 1980.

Hilal, A. "Air Pollution and It's Effect on Environment and It's role in Curricula", Yarmouk University, Irbid, 1988.

Hornik, R. "Polluting China's Good Earth", Time, No. 12, 1987.

Idris, M and Shaaban, R. "Plastic", General Sciences, AMMAN, 1984.

Salameh, E. "Water Pollution from Sewage", Manuscript, Amman, 1989.

Salameh, E; Saliba, E; Hashwa, F and Rimawi, O. "The Effect of Khirbet es Samre Effluent on the Water Quality of Wadi Dhulleil and Zerqa River, Jordan". Bulletin of the Water Research and Study Center, University of Jordan, Amman, 1987.

"Good and Bad Ozone", Al Arabi Magazine, No.368 Kwait, 1989.

"Protectives Shield for Life Pictures". Al-Arabi magazine, No. 344, 1987.

SUGGESTIONS FOR FURTHER READING
-BIOLOGY DIMENSION-

AbdelMacqsoud, Z. Environment and Man (Islamic Perspective), Kwait, 1986.

Haffar, S. Man and Problems of Environment, Qatar, 1981.

Rasheed, A and Rasheed, H. The Science of Environment, Lebanon, 1981.

Sawthick, C. The Science of Environment and the Type of Dur Environment, (Translated by Saleh, K; Dabbagh, S and Saleh, T), Mawsil University. 1984.

Shalabi, A. Environment and Curricula, Khalij Arabi Puplishers, Eygpt, 1986.

II. The Geography Dimension

Introduction

This geography dimension in the air and water pollution units has the same major purpose as that of the biology dimension which is the acquaint you with some of the relationships but science, technology and society with the emphasis on various areas of pollution in the world as a universal issues.

You will use the same definitions of society, science and technology that were used previously and the same clarification of scientific and technologic activities.

As for the term "scientist", you must not restrict the use of it to the natural scientist only, but must also include the sociologist and meteorologist.

A Further Look At The Procedures of Scientists

A scientific discovery usually stimulates scientists to further investigations as they attempt to fit a new finding into present theory or to find relationships involving the new discovery (Milkent, 1975). These investigations, whether it it for scientists in the same country or other countries if the issue is an international one, may in turn lead to observations which stimulate further studies. For example, the discovery of B.truncatus snail in Jordan water, the study of the plastic industry and other water and air pollutants

indirectly contributed to a very important attempt to prevent air and water pollution. In 1986, while Salameh was determining the quality of water in KS in Jordan, Janzen was experimenting on the protection of the environment from air pollution in Pennsylvania in the U.S.A.

Janzen's experiment contributed to investigations which would eventually lead to a revision of many aspects of the scientists view of nature and the development of techniques for the reduction of pollution. Scientist communicate through written reports, lectures, letters exchanging ideas, as well as by publishing the results of their investigations. It is even possible that a suggestion by one scientist may stimulate other scientists in the same country or other countries to experimentation. Some events leading to the protection of the environment from air pollution illustrate how these methods may lead to advances in science in different regions in the world.

Professor David Janzen has been interested in the protection of the environment and the balance of its components that is, in the decrease of pollutants for about 15 years. Ecological balance in different regions, like Pennsylvania (where he lives), Costarica, Middle America and it's west costs was being disturbed. For example on the Pacific coast of USA the hot rainy, weather has given way to hot dry weather. He observed that in the Pacific coast rains stopped completely for 5-6 months, from December to May. The area studied became devoid of its content of plants and animals which help in

the usual conditions to keep the percentages of gases and other components of air and water in balance. So farmers began get economic difficulties and were being forced to see their land.

Farmers them selves have considerable effect help too much in causing the imbalance of their region's components. They have cut down trees and other natural vegetation for fire wood pastured the land, hunted animals and continually fired land to clean it. They didn't know that their work was a crime for them, for their neighbors and environment.

Janzen studied these problems and thought that they could be solved if money were provided for the jobs and projects necessary for restoration of the land. He designed an experiment to test his hypothesis. He began to collect money. He collected about 1.3 million dollars, and started to compete to buy the damaged area of land in order to be free to carry out the projects and jobs necessary for protection. He found that the minimum area of land required for his leading environmental project was 158 square miles in Pennsylvania through 1972-1987. And the prices of the land was 200-300 dollars for one hectare.

Janzen lived in the area in a small room with a tin ceiling. He allowed some farmers to live on the project area's land, doing some agricultural work which he suggested under the condition of not carrying out any of the activities that had caused the damage to the regions in the first place.

Janzen's efforts, which started 15 years ago, were

successful, and life started to return to the soil, trees and farms. Animals which had left that region started to return to it, including 170 species of birds, 13000 kinds of in sects, 100 kinds of reptiles and 115 kinds of mammals, in addition to 700 kinds of plants.

In February 1987, Janzen reported that he was continuing to collect many and contributions and buy the land that is required for his project. Perhaps by the end of 1990, the overall life will have returned to this area because of the "Jwana Cassitt" project, and other similar projects. From his experiences Janzen was led to believe that protection of the environment and hence the reduction of the pollutants is very important, as was pointed to by the cooperation of the people of that region with Janzen in carrying out his project and their appreciation of his work.

Janzen's experiment has been reported in some magazines, as in the "Al-Arabi" magazine with the title "A Leading Experiment in Environment Protection Work".

Predicting the Applications of Scientific Discoveries

When a new discovery is announced, there usually follows a number of predictions regarding the possible applications of the discovery.

While a predicted application may be based upon experimental evidence, additional evidence may indicate that the application is not practical (Milkent, 1975).

The Curies and other scientists performed

experiments to show the physiological effects of the rays given by some radioactive elements such as radium. If the air is contaminated by such rays, animals may have painful sores on their skins or die as a result.

Sometimes these rays nay be used to cure cancer.

Some View of David Janzen

Janzen was not enthusiastic about his work just because of material benefits or self satisfaction, but because of the benefit to the public through his environmental work.

In fact Janzen expended a lot of time, money, and effort on his project. His purpose was to protect the environment, air, and water and to save different kinds of animals. That's why he chose his office in Pennsylvania University as a base where he spent his time for example in collecting worms and seeds, observing rats and from which he set out to wander among abandoned lands in different regions.

Similar Views of Marie Curie (France)

The radioactive element radium which was discovered by Marie Curie in Paris was considered as one of the causes of pollution of water and or air. (Radium also has various benefits of course)

Twenty years after the discovery of radium, Marie Curie wrote:

In agreement with me Pierre Curie

decided to take no material, profit from our discovery; in consequence we took out no patent and we have published the results of our research without reserve, as well as the processes for prepa ration of radium. Moreover, we gave interested persons all the information they requested. (Milkent, 1975).

On another occasion Marie Curie said: But we must not forget that when radium was discovered no one knew that it would prove useful in hospitals, The work was one of pure science. And this is proof that scientific work must not be considered from the point of view of the direct usefulness of it. It must be done for itself, for the beauty of science, and then there is always the chance that a scientific discovery may become like radium, a benefit for humanity.

EXERCISE FIVE

Directions: Answer the following questions in the space provided.

1.List the steps that Janzen followed in order to protect the air from pollutants.

2.List the steps* Salameh followed in investigating the degree of water pollution.

3.List two similarities in the procedures of Salameh and Janzen.

4.Is the prediction mentioned in the section "Predicting the Applications of Scientific Discoveries" based on experimental evidence?

5.In what way was Janzen's attitude toward his discovery of ways of protecting the environment similar to Roentgen's attitude toward his discovery of X rays and to Marie Curie's attitude toward her discovery of radium?

The Discovery of the Hole in the Ozone Layer

Scientists noticed through systematic observation that there was changes in the ozone layer. This is the layer which protects us from ultraviolet rays at a height of about 12-30 miles. They observed it had become thinner especially in September and October and especially over the south pole. The ozone layer was up to 50% thinner than used. The thinning through 1982-1986 is illustrated in figure 2 as it was pictured by Nimbus 7 satellite. So between 1979 and 1986, a hole was formed (the purple colour). Such a hole has also been noticed over the north pole, but to a much lesser degree.

The reasons for this thinning are not completely understood, but it may be related to the chlorine emitted by some industries which make chlorofluorocarbons. The English scientist Lovelock in 1969 found a huge amount of chlorofluorocanbons especially over the south pole. Some other theories point to nitric oxide as the cause of the changes or that the ozone is pushed upwards by the effects of other air streams from below.

Whatever the cause, thinning of the ozone layer occurs between 30-60 north latitude which will cause an increase in the temperature of the earth through the 50 coming years by about 1.5 to 4.5C. Furthermore, melting ice will increase sea levels from about 30cm to 1.5 m. It will also increase the probability of getting skin cancer.

A scientist doesn't automatically make discoveries from his observations or experiments. Prior to the discovery of the hole in the ozone layer at least

Lovelook observed huge amount of fluorocarbons which are the probable cause of the hole, but he didn't discover the hole. Other scientists observed nitric oxides which are an other probable reason for the ozone hole but they didn't discover the hole either.

Communications Among Scientists

Social scientists as well as other scientists need to communicate, this being an essential activity for scientific progress. The most common way to communicate is through published reports, but also there are a number of other ways to communicate.

The following are some examples of methds of communication:

USA suffers from a high pollution rate in air and water. Scientists are discussing the reasons and solution for pollution at conferences and seminars. In 1986, Noel Grove who writes about sociology talked on the telephone to Dr. Kenneth Kizar, was the director of state health services, about the dumping of solid wastes, since dumping of liquid. wastes had been stopped. Dr. Kizar said, "Nobody wants toxic wastes nearby, but we have a limited number of sites in which to dispose of them. Until we get additional sites, we have to base our decision on the information we gather." (Grove, 1987).

Rich Kozub, (30) who grew up in Middlesex in USA and has a degree in environmental science heard the radio crackling with reports of chemical peril: A railroad tank car holding chemicals had slipped its rails and was leaning dangerously. Fumes lingered from a point factory explosion and fire that had killed two men, helping in

causing pollution (Grove, 1987).

A private conversation took place between the social scientists Noel Grove and a pathologist Dr. Torrence Payne while he was performing an autopsy on a man who had drowned at Newburg, NewYork. The lungs when exposed, were blotchy with stiff dark spots. The social scientist said "a smoker". The pathologist replied, "Not necessarily." "Those are deposits of carbon. Virtually everyone has lungs like that after their mid 40's if they have lived in or near an urban area", in the meaning of having some sort of air pollution.

Sometimes lectures and discussions may be one kind of communication among scientists. Dr. Roger Revelle, Professor of science and public policy, once stated "Mankind is in the process of conducting a major unintentional experiment, that of feeding back into the atmosphere in a short space of geological time the fossil fuels that have slowly accumulated over the past 500 million years." Now that the chemical era has joined the age of combustion, that experiment has expanded. Almost breathlessly we await the outcome. We are our own gained pigs." (Grove, 1987).

Japan suffers from smogs, nitrogen oxides, sulphur oxide and others. Ways to reduce these or the prevent their occurrence are discussed through the communication of scientists, one method of which is the official governmental meeting which is a mark of a large scale interaction that shows the great importance of the scientist to the nation (Grove, 1987).

A 35 years old Japanese scientist said that "The

public is clamoring for cleaner air". A 30 year old man, Jun Masui, said "To make money, you need good productivity, and if the workers are feeling good, you get it, so it is cost-effective to clean up the air" (Grove, 1987).

Suggested Solutions To the Problem of Pollution: An Example of the Interaction Between Science, Technology and Society

One of the solutions to air pollution is to close some factories. Phelps Douglas of Arizona in USA is an example of a closed factory which constitutes a victory for environmental lists who had long protested the smelter's operation. (Grove, 1987)

Some natural way to overcome air pollution is that thunder-storms can gather smoke and other organic particles near the surface and pump them higher into the atmosphere as is the case in the Amazon in Brazil. The man made solution is in the use of technology, "Technology is already available to burn fuel more clean my and efficiently, and within 15 or 20 years many existing plants will be ready for retirement" Dr. Mohnen said. But can the environment wait 20 years for better technology? "Not at current emission levels" he replied, "but perhaps with conservation. A 20% reduction in fossil fuel is possible through conservation measures for automobiles and electric power users in USA" (Grove, 1987).

Reducing the emissions of sulfer dioxides by half in this century, using current technology, could required

refitting large power plants with flue-gas scrubbers. The cost has been estimated at two to seven billion dollars a year, for a total of 50 billion dollars over a decade. Who would pay for it? Would it be power plants like those of the Ohio alley, source of much of the sulfer oxides? Or should the entire country pay through an electrical usage tax, which would mean the polluter, equally in the cost? (Grove, 1987).

And what if that multibillion dollar solution is the wrong one, outdated the moment it is completed?

In Japan, people around Tokyo Gulf use oxygen masks which are provided with oxygen from machines worked by money. Another solution in Japan is to lower the taxes of the car companies who uses methods for reducing pollution like using petrol devoid of lead.

In USA also there was a recommendation to prevent people from smoking on airplanes especially on local journeys. It is recommended to use a ventilation system inside the airplane in which the air is cleaned and placed once again inside the airplane instead of mixing it with the gases inside the engine. But can this system provide clean air? May be not, since some kind of bactaria (Bacilli) will be transferred from a sick passenger to healthy ones.

In Jordan, a tree planting project started in the schools to increase the amount of oxygen in the air and reduce the amount of CO2 which is increased by the use of cars and as a result of burning in the factories. Also trees can collect dust which is a one of the pollutants.

Are we exposed to danger with each breath we take

and each industrial advance we reach. In Nepal, one possible solution is to reduce the number of cooking fires since cooking fire can fill poorly ventilated houses with heavier pollution than the worst urban smog, causing [illegible]s of respiratory disease-the Third World's [illegible] killer (Grove, 1987). But is it possible to reduce the number of cooking fires? However, the scientific information which led scientists to believe that theoretically proposed solutions to the problem of [illegible]ution are possible also led them to dout their technological feasibility.

In early 1986 a joint US Canadian report called for [illegible] industrial emission control project [illegible]ting five billion dollars. The report heartened some Canadians; others remained spectical that the US would appropriate the money in an era of tight budgets. So far it has not (Grove, 1987).

[illegible] research center in Essen-Kellwig, an American scientist is inspecting damage to trees exposed to ozone and acidic fog under controlled conditions.

Yet the air pollution picture is not totally bleak. [illegible]inning research offers some hope of improvement. In [illegible] 1986 two scientists reported a chemical process capable of eliminating nitrogen oxides from diesel exhaust gases and coal fired boilers. The hot gases, [illegible] a nontoxic chemical called cyanuric acid, break [illegible] into harmless nitrogen and water. If later [illegible] research supports the findings, a giant step could be [illegible] eliminating a major contributed to acid rain [illegible] ozone (Grove, 1987).

The pollution problems is an economical problem, since the mistakes of humane in causing it are costly. Americans spend more than ten million dollars a year on medical problems caused by outdoor pollutants. Researchers now suggest that gas and wood-burning stoves exude harmful compounds inside buildings. These indoor pollutants, along with cigarette smoke, asbestos, toxic released from building materials, and radon gas trapped by tight insulation, may exact an annual health bill of a hundred billion dollars (Grove, 1987).

The scientists realized that the pollution problem may have grave political implications. Tracing pollutants is becoming a political necessity because is no respecter of boundaries. On the acid rain issue alone Scandinavians are angry at the British, the Canadians are impatient with the United States, and the North-east blames the Midwest for dead trout and dying trees. From the accused the answer has become a familiar refrain: "You can't prove that my emissions are killing your....." (Grove, 1987).

If all the research, projects and subjects related to pollution that have been published (or it will be published) is subjected to a voluntary sensorship, this sensorship may not succeed.

EXERCISE SIX

Directions: Answer the following questions in the space provided.

1.Name two reasons why scientists in different countries of the world may not make a particular discovery even after they have performed investigations which make the discovery possible.

2.Name the different forms of communication employed by scientists in the reading passage "Communication Among Scientists".

3.Name two major technological problems which have to be overcome in order to prevent pollution.

4.Name three ways in which finding solutions to the problem of pollution affects scientists.

Solutions to the Pollution Problem

Man-made clorofluorocarbons contribute to a deepening hole in the upper atmosphere ozone observed seasonally over Antarctica.

Depletions also have been noted over the Arctic and heavily populated latitudes.

The first agreement to protect the ozone layer was made among 30 countries in 1987. It was suggested that the production of chlorofluarocarbons their use should be limited by 50% before the beginning of the 21st century.

The second agreement was made in 1988. It was conducted by the ministries of the European Community. They decided to reduce present production of fluorocarbons by 85%.

At the same time approximately, there was a conference in London conducted by Mrs. Margaret Thatcher who suggested a green policy to protect the ozone layer and the environment.

Later, President George Bush ordered that production of fluorocarbons should be stopped entirely before the year 2000 and the American government started to establish a law to get rid of all the fluoracrobons during the following 5 years.

Acid Rain

Acid rain added a new dimension to the issue of air pollution. It possed a new mystery to the environment.

Acid rain composed of sulphur oxides unites with normal rain. First recognized as a regional issue in Scandinavia acid rain, snow, and fog kill fishes and

other aquatic life and damage forests in Canada, the USA, and Western and central Europe. An estimated 200,000 square miles of forests in industrial countries are damaged by acid rain or other forms of air pollution. A problem that wafts across borders, it demands international solutions (Grove, 1987).

Dr. Chris Bernado, an American air quality expert said,

> "We are in the infancy of understanding the fuel effects on an atmosphere acidified by burning fossil fuels. In order to really understand it, we must conduct years of research" (Grove, 1987).

Radiation

Scientists in the Soviet Union's Chernobyl Nuclear Power Plant put into effect the possibility that the energy of the atom could be put to practical use. They hoped to use this energy for peaceful purposes, as for example a source of electricity. The first Soviet Union experimental power station was built in 1954, and the United Kingdom began operation of a large scale reactor power plant in 1956.

The disaster which occurred at Chernobly Nuclear Power Plant in 1986 caused the single greatest industrial release of radiation, dwarfing a previous accident at Three Mile Island in Pennsylvania. Waste disposal also poses unanswered problems.

Several nations are testing nuclear weapons. Bikini islanders can't yet return to a home contaminated by US testing. Janapene atom bomb survivors still suffer radiation effects (Grove, 1987).

REFERENCES

Aabedy, M; Kurd, A; Shami, M; Hiary, M; Abu-Mizer, J; and Nicola, K. Teacher Guide in Teaching Sociology Curricula, Amman, 1965.

ABED-El Macqsoud, Z. Environment and Man, Kuait, 1981.

Grove, N; Spiegel, T; and Bond, W. "Air: An Atmosphere of Uncertainty National Geographic, Vol. 171(4), 1987.

McCormic, C. "Air Pollution", National Geographic, Vol. 172(2), 1987.

Salameh, E. "Water Pollution", Manuscript, Amman, 1989.

"A Leading Experiment in Environmental Protection Work", Al-Arabi, No.343, 1987.

"Air pollution in Europe and America and ways of Protection From it." Al-Arabi, No.344, 1987.

"America: the Country of Contradictions", Al-Arabi, No.347, 1987.

"Good and Bad Ozone", Al-Arabi, No.368, Kuait, 1989.

"Human Safety Through Environmental Safety", Al-Arabi, No.369, 1989.

"Is there a Cnotradiction Between Environmental Protection and Development? Al-Arabi, No.367, 1989.

SUGGESTIONS FOR FURTHER READING

Abed-ElMacqsoud, Z. Environment and Man, Kuait, 1981.

Adabashif, I. Man and Environment, (Translated) Mear Puplishers, Moscow, 1985.

Mills, K. "Air Pollution", National Geographic, Vol.172, No.2, 1987.

Najem, H; Bana, A; Abed-El Macqsoud, Z. and Abu-Aiash, A. Environment and Man, Kuait University, Geography Section, 1977.

APPENDIX B

TEACHER GUIDE

TO

POLLUTION UNIT

INTRODUCTION

"Pollution" is a ten session unit design for high school students. The purpose of this unit is to present students with an opportunity to gain an understanding of some of the relationships which exist between science, technology and society.

Most Biology and Geography courses provide students with a basis for acquiring an understanding of major concepts. Students are taught how these concepts relate to each other and to the larger framework of scientific knowledge. However students are seldom presented with a basis for acquiring an understanding of how the concepts of Biology and Geography relate to specific events in society or to the general framework of society. Thus many students lack an understanding of the relationship which exist between science, technology and society.

Students may know that science and technology in the society are related, but they may not be able to distinguish scientific activities from technological activities. Most students realize that science exerts a major influence upon modern society, but they probably don't understand the relationships which exist between science and the economic, social and political forces of society.

Present day school students will be members of society long after they have stopped being students. They should be given an opportunity to learn the concepts of the biology dimension not only as they relate to

scientific knowledge but also as they relate to society. They should also be provided with a basis for acquiring an understanding of the relationships which exist between science, technology and society.

While it is difficult to give an exact definition to each of science, technology and society the following definitions might be helpful:

Society: is a group of people who have the same values, habits, traditions... et. and who live with each other. Society consist of different kinds of people, some of when are scientists (sociologists, natural scientists, pathologists, meteorologists and others), Governors, economists business men and women, the public and others.

Science: is a search for understanding of the natural world by using the scientific method.

Technology: involves application of knowledge in order to alter or improve the material environment (Milkent, 1975).

So, STS topics are not concerned only with the material environment or the understanding of nature but with the application of them in the social environment and the resulting effects of this application.

The Content of the Unit:

The material is concerned with some causes and effects of pollution. The unit contains an introductory part with two dimensions, one a biology dimension, and the other a geography dimension. Both are divided into sections which illustrate one or more relationship

between science technology and society. The content of the unit was selected to illustrate two major generalizations which are:

Science and technology interact with each other and with society.

The title of each section indicates a major theme. The content of each section has been selected to provide the necessary information about pollution or to provide an illustration of one or more relationship between science, technology and society. In addition the unit contains six exercises which are to be completed by the students at the appropriate time in the presentation of the unit. For this purpose, each student is to receive a booklet at the beginning of the unit and is to keep the booklet for the duration of the discussion of the unit.

Student Activity

The unit contains two students activities. The topics of the activities are related to the relationship between science, technology and society, but they are not directly related to the content of the sections. The activities are open - ended and their major purpose is to engage students in a discussion of the many way science and technology affect society.

The student activities are to be presented to the students at the time the activity occurs and are not included in the student booklet. Directions of the procedures to be followed in the activities and the appropriate placement of the activities are presented in

the teachers guide.

The Teacher's Guide

The successful implementation of this unit is dependent upon the teacher. The relationships which are illustrated in the sections are sometimes suitable, and it is not intended that the student should recognize these relationships after reading the sections. The questions in the exercises are intended to focus the attention of the students on certain aspects of the reading passages, and the discuss in of the passages and exercises is left to the teacher.

The teacher's guide has been written with the assumption that many teachers have attended no formal causes related to science and society and that they have had no previous experience in teaching a unit specifically related to the social aspects of science. Therefore the teacher's guide contains rather specific instructions on how to present the unit. At the same time, the teacher's guide is not intended to imply that, to be effective, the unit must be taught exactly in the manner indicated. Individual teachers may want to make adjustments which better suit their teaching style or their students.

The unit should take approximately 10 lessons to complete, each lesson is intended to be completed in one class period. Any lesson that is not completed in one class period may be completed during the following class period.

Each lesson is divided into sections with separate headings. The headings generally correspond to the headings of the reading passages or to the exercises in the student booklet. However, there are some sections pertaining to class discussion, demonstrations, or student activities which are not a part of the student booklet. Each section contains a suggested procedure for presenting that section. Some teachers may wish to discuss certain aspects of some sections more fully and may do so.

The teachers guide also contains suggested answers for the exercises in the students booklet, for the student activities, and for the discussion questions. Many of the questions are open ended and all of the possible correct answers cannot be anticipated. The teacher should accept all student answers that appear to be justified.

However, the teacher may have the students clarify their answers by asking them to cite examples.

Student evaluation is to be determined largely by the teacher Student exercises may be checked for daily grades or short quizzes may be presented at the appropriate time. The teacher's guide contains a unit test. The teachers may wish to use the test as presented or may wish to adapt the test to meet their own specifications.

LESSON ONE

Objective:

After completing this lesson the student should be able to distinguish from a list of activities those which would most likely be associated with scientific activity from those which would most likely be associated with technological activity.

Introduction

Instruct the students to silently read the introduction to the unit in class. When they have finished, you may wish to discuss the purpose of the unit for a few minutes. As a student what the purpose of the unit is. His answer should be similar to "to introduce us to some of the relationships which exist between science, technology and society".

You might ask then, "What is the difference between science and technology?" Ask several students to answer this question. You should accept the students answers without making any correlations, but you may ask them to clarify their answers by giving examples. Science and technology are often confused and the purpose of this activity should be to illustrate that some confusion does exist. You might then lead the students into the next section by saying, "Let's see if any body changes his mind after we have completed the next section".

Science and Technology

Assign one student to read aloud the section "Science and Technology". You may wish to have the students apply the definitions of science and technology by classifying a few activities such as those which follow. Ask the students to identify the purpose of the activity and to decide whether the activity is concerned with science or technology. For example:

1.Using steel and concrete to build a bridge (Purpose: to build a bridge; Classification: technological)

2.Heating water to determine it's boiling point (Purpose: to determine the boiling point of water; Classification: scientific) (Milkent, 1975).

Instruct the students to complete exercise one. They are to read each statement and classify each activity which is mentioned as being scientific or technological in nature. They are to write their answers in the space immediately to the right of each statement. Exercise one should take approximately 15 minutes to complete.

Next have the students check their answers to exercise one, Call on an individual to read the statement aloud, give his classification of the activity mentioned in the statement, and give the reason he chose that particular classification. In each case, the reason should refer to the purpose of the activity.

If, after discussing the answers to exercise one,

some of students are having difficulty in distinguishing scientific activities from technological activities, you may wish to classify the activities in the examples which follow the answers to exercise one in this guide.

If you feel that the student have had enough practice in classifying the examples given, you may wish for the students to make examples of their own and let other members of the class classify them as being scientific or technological in nature.

ANSWERS TO EXERCISE ONE

The answers to exercise one are presented below. The purpose of each activity is underlined and the classification of each activity is written to the right of each statement.

1. Building a canal in order to provide a water way between two cities — Technological

2. Building an irrigation system to provide water for arid regions — Technological

3. Decomposing water in order to determine it's components — Scientific

4. Purifying water in order to make it fit for drinking — Technological

5. Inventing a telegraph to provide a means of communication — Technological

6. Studying rocks to try to determine the composition of the earth — Scientific

7. Studying the expansion of liquids to determine the relationship between volume of expansion and rise in temperature — Scientific

8. Formulating the law of universal gravitation in an attempt to explain the motion of the planets — Scientific

9. Designing a rocket to enable space travel — Technological

10. Analyzing moon rock in an attempt to determine the origin of the moon — Scientific

(Milkent, 1975).

Additional Examples

Presented below are ten additional examples which you may wish to use with those students who had difficulty with exercise one. The purpose of each activity is underlined and the classification of each activity is present in parenthesis.

1. Making measurements to determine the properties of helium (Scientific)

2. Designing weather balloons which can be filled with helium (Technological)

3. Using weather balloons to study the properties of the atmosphere (Scientific)

4. Studying the relationship between the volume of a gas and the amount of pressure exerted upon it (Scientific)

5. Studying the expansion of metals to determine the increase in length per degree rise in temperature (Scientific)

6. Applying the knowledge of the relative rate of expansion of metals to make a thermostat (Technological)

7. Determining the relationships between the amount of sunlight received by a plant and it's rate of growth (Scientific)

LESSON TWO

Objectives:

After completing this lessons the students should be able to:

1.Name three procedures scientists often follow in addition to performing original investigations.

2.Name three reasons for the practice of one scientist repeating the experiments of another scientists.

3.List the steps in the experimental procedure followed by Salameh in his investigations of water pollution.

Demonstration or Illustration of the Plastic Industry

A demonstration of the industrial operation of plastic production will reinforce what the student has read in the section.

You may illustrate the operation of the production of plastic by means of steps on the blackboard or with the aid of an overhead projector. You may take bakelite as one source of plastic. Bakelite is used for the body (box) of radios and televisions, telephones, electric switches, knife handles, etc.

You may find the steps which follow helpful in the diagrammatic illustration of the operation of the plastic

industry.

Steps in the Production of Bakelite

1. The primary materials will be put in the reaction bowl.
   The primary materials are:
   Phenols C6H5OH and
   Formaldehyde HCHO.

2. Air will be pumped into the reaction bowl till the pressure reaches six times air pressure.

3. Tubes containing water vapour with more than 160 C temperature will be used to heat the primary material.

4. Bakelite will be produced and becomes solid taking the shape of the bowl.

5. Later the bakelite can be reheated and given the required shape.

Some Procedures of Scientists

Assign the student to read the section "Some Procedures of Scientists" silently in class. When they have finished reading this section, they may begin to answer the questions in exercise two. All of the students may not be able to complete exercise two during the remainder of the class period and those who do not finish should complete it as a homework assignment.

LESSON THREE

Objectives:

After completing this lesson the student should be able to:

1.State one view of the purpose of a scientific discovery

2.Provide an explanation of why formers were the first to notice the effects of ozone

3.State another view of the purpose of a scientific discovery.

Discussion of Answers to Exercise Two

Call on individual students to give their answers to the questions in exercise two. The discussion should take approximately 10-15 minutes.

Discussion of the Role of Chance in Scientific Discovery

Chance plays a role in scientific discoveries.

You may begin the discussion with the following question:

Do some scientists have more lucky accidents than others performing the same experiment?

By a show of hands, determine how many members of the class think that the answer to the question is yes and how many think that the answer is no. Elicit opinions

from the students regarding their choice. The teacher may ask "Why didn't any of the other scientists working with the same procedure make the same discoveries?"

The discussion should end with most of the class agreeing that luck is involved and the scientists has to realize that his unexpected observations deserve further investigation. The discussion should take approximately 10 minutes.

Applying a Scientific Discovery and the Opposing Views

The sections "Applying a Scientific Discovery" and "Opposing Views" and the answers to the questions in exercise three may be discussed by using the following procedure:

1.Call on a student to read aloud the section "Applying a Scientific Discovery" from the beginning of the section to the end of the paragraph on air and water pollution. Have the students discuss the answer to question 1. After they have reached agreement on the answer to question 1, have them write the answer in the appropriate space.

2.Call on a different student to read aloud the remainder of the section "Applying a Scientific Discovery".

3.Call on a third student to read aloud the section "Opposing Views". Have the students discuss the answer to question 3. Again, instruct the students to write the answer in the appropriate space.

Assignment

Assign the students to read the sections "Consequences of Technology", "Science and the Public", and "Plastic Today" for homework.

ANSWERS TO EXERCISE TWO

The suggested answers to exercise two are presented below. The answers presented are not the only "correct" answers, and the teacher should accept other answers if they appear to be justified.

1.List three procedures scientists often follow in addition to performing original investigations.

a.Read the reports of other scientists (They may become interested in particular problems after learning of the experiments of other scientists).
b.Repeat the experiments of other scientists.
c.Publish the results of their investigations.

2.Why do scientists repeat the experiments of other scientists? Give as many reasons as you can.

a.To check the results of other scientists.
b.To learn to procedure involved in an experiment.
c.To gain a better understanding of the results reported.
d.To obtain ideas for further investigations.
e.To repeat the experiment under other conditions.
f.To document the findings.
g.For political purposes.

3.List the steps Salameh followed in his investigations which led to the discovery of small percentages of water pollution.

a.Repeating the experiments of others.

b.Posing a question: can the same results be obtained in all water samples?

c.Planning an experiment to answer this question.

d.Testing the water samples.

e.Making an observation.

f.Investigating the observation.

ANSWERS TO EXERCISE THREE

The suggested answers to exercise three are presented below. The answers presented are not the only "correct" answers and the teacher should accept other answers if they appear to be justified.

1. State one view of the purpose of a scientific discovery:
   The extension of knowledge without any practical use.

2. Why do you think farmers were the first to notice the effects of ozone?
   Farmers are interested in their corps from an economic point of view, hence they watch their crops and notice changes quickly. In addition the life duration of crops is shorter than the life duration of other individuals like animals and human being so the effect of any kind of pollution can be seen more quickly.

3. What other view do other scientists have of the purpose of scientific discovery?
   The practical application of the discovery for the use of the society.

4. If Roentgen was not interested in making a profit from his discovery, what was his purpose in carrying out his investigations? Apparently Roentgens purpose was to increase man's understanding of nature. Edison says it

quite well, even if he is somewhat scornful: "He belongs to those pure scientists who study for pleasure and love to delve into the secrets of nature."

5. What does Edison see as the purpose of a new discovery?

Edison states: "One must see how to use it and how to profit by it commercially".

LESSON FOUR

Objectives:

At the end of this lesson the student should be able to:

1.Name three uses and two harmful effects of plastic.

2.Analyze each of the examples given in the section "Science and the Public", with regard to it's scientific feasibility.

Discussion of Answers to Exercise Four

Have the students orally answer the questions to exercise four in class. The discussion should take approximately 15 minutes.

Student Activity One

The objective of Student Activity One is to engage the students in a discussion of:

1.The effects of science and technology upon economics.

2.The effect of science and technology upon social conditions.

Divided the class into five groups of three, four, or five students each. Give each member of two of the

groups a copy of "Student Activity One, Letter 1". Give each member of the other three groups a copy of "Student Activity One, Letter 2".

Instruct the students to read their letter. When they have finished, assign each group to answer one of the questions which follow the letter. The students are to discuss their ideas with other members of their group. They may write their answers as a paragraph or as a list of statements. Allow 10-15 minutes for the group discussions.

If the students are having difficulty in answering their assigned question, you may guide them into considering some possibilities with such questions as:

How does scientific research affect technology?

How does technology affect jobs or trade with foreign countries?

How does technology affect war?

How does technology affect world peace?

How does technology contribute to social problems?

Begin discussion of the letters and the students answers by first naming the highlights of the proposed bill in letter 1. Call on one member of each group to read to question of his group and the answer the group has composed. Have other members of the class comment n the argument presented.

Follow the same procedure for letter 2 as you did for letter 1.

If the students do not finish the discussion during this class period, they may complete it at the beginning of the next class period.

Some possible answers to the questions presented in Student Activity One follow. These are not the only possible answers or even the best possible answers. The students may have some better ones.

ANSWERS TO EXERCISE FOUR

The suggested answers to exercise four are presented below. The answers presented are not the only "correct" answers, and the teacher should accept other answers if they appear to be justified.

1.a.What are some of the uses of plastic?

1.As electrical insulator

2.As a strong body box for TV and Radio

3.For knife handles as it is not affected by heat

4.For cheap shoes

5.For dolls for children

b.What are some of the harmful effects of the plastic industry.

1.It causes a pollution problems as:

a.Plastic in water damages has a negative effect on living organisms for example it kills fish.

b.Plastic may diffuse into the human body through syringes, blood storage bottles, eye and nose drop containers and plastic tubes that are used in heart, kindly chest, joint, and tooth surgery.

c.Plastic transfer through plants to the human body. Plastic diffuses to the plant from rubbish and is also transferred through surface and ground water which the plant takes in. Later humans eat the plant which

contains traces of plastic.

2.Analyze each of the incidents mentioned in the section "Science and the Public" as to its scientific feasibility.

a.Plastic in Shoes.

Plastic shoes are serviceable but at the same time the plastic ultimately becomes waste which enters water. Bactaria can't breakdown this waste, hence water pollution is caused.

In addition this industry, like most other industries, causes air pollution with it's traces of gas given off into the air.

b.Danger of Privacy.

Plastic is first produced as colored or unclouded powders, small particles or granules. These can later be converted to a thick liquid and can be given many different shapes using different methods.

c.Mobilization from top to bottom.

Cooperation among all types of society, especially scientists, help in protecting our earth from pollution by limiting the causes of different types of pollution. This is an ethical responsibility.

d.Agreement to limit the production of flouracorbons.

Limiting the production of fluoracorbons will help to repair the damage done to the ozone layer, especially

of the hole in the ozone layer over the south pole.

This agreement is an example of a methods of limiting air pollution and hence the protection of the environment.

Student Activity One

Letter 1

BAN SCIENCE!!!!!!!!!!!!!!!

PROMOTE TECHNOLOGY!!!!!!!!!!!!

Dear Citizen:

The Organization of Citizens for Technology is proposing that Congress pass a bill promoting technological activity and banning future scientific research. The highlights of this bill are:

1.Technological development will be promoted by the government.

2.All future scientific research will be banned.

The Organization of Citizens for Technology feels that you will agree that this bill would benefit Jordan in several ways. We can spend the money that is now being used for scientific research in finding way to use the scientific knowledge that has accumulated but for which no use has yet been found. Advanced technology would lead to increased industrial output and an improved economic situation.

Jordan is one of the developing countries of the world, and a more advanced technology would enhance our position in world politics. Advanced technology would also lead to improve social conditions in Jordan.

Please write to your local representative supporting our proposed bill.

Questions

1.What argument would you present against the

Organization of Citizens for Technology concerning an improved economic situation if all scientific research were banned?

2.What argument would you present against the Organization of Citizens for Technology concerning improved social conditions if all scientific research were banned?

Student Activity One

Letter 2

BAN TECHNOLOGY!!!!!!!!!!!!!

PROMOTE SCIENCE!!!!!!!!!!!!!!

Dear Citizen:

The Organization of Citizens for Science is proposing that Congress pass a bill promoting scientific research and banning future technological activity. The highlights of the bill are:

1.Scientific research will be encouraged and will be supported by the government.

2.Existing industries may continue with their operations, but all new technological activity will be banned.

The Organization of Citizens for Science feel that you will agree that this bill would benefit Jordan in several ways. Our present technology is more than adequate for us to remain economically prosperous. Jordan is one of the developing countries of the world and our present technology is such that we can maintain our position in the world. We have above average social conditions which might deteriorate if technology were allowed to continue to advance.

Please write to your local representative supporting our proposed bill.

Questions

1.What argument would you present against the

Organization of Citizens for Science concerning the future economic situation in Jordan if all new technology were banned?

2.What argument would you present against the Organization of Citizens for Science concerning future social conditions if all new technology were banned?

SOME POSSIBLE ANSWERS TO STUDENT ACTIVITY ONE, LETTER 1

1.What argument would you present against the Organization of Technology concerning an improved economic situation if all scientific research were banned?

a.Much of the present scientific knowledge may not have an identifiable practical use and therefore may be of little help in advancing technology.

b.Technological advances may require scientific research into specific areas. (Example: Designing new automobiles may require scientific research concerning fuels so that decisions can be made concerning the best fuel to use).

c.It is difficult to predict what scientific discoveries might occur if research were allowed to continue. It is possible that some of the these discoveries would help to advance technology.

d.Other countries which continue to do scientific research may develop better products than those now being produced in Jordan and foreign trade might decrease as a result of this.

e.The amount of technological advancement would be limited without scientific research providing new ideas for industry.

2.What argument would you present against the Organization of Citizens for Technology concerning improved social conditions if all scientific research were banned?

a.Present technology may produce problems which require scientific research for their solution.

b.New technology may create problems which can't be solved without scientific research.

c.Some new diseases may become prevalent which require scientific research in order to find ways of controlling them.

d.Technological advances will be limited. Population growth may lead to a reduced standard of living.

SOME POSSIBLE ANSWERS TO STUDENT ACTIVITY ONE, LETTER 2

1.What argument would you present against the Organization of Citizens for Science concerning the future economic situation in Jordan if all new technology were banned?

a.Other countries may develop technology which would make some industries in Jordan obsolete. This would affect world trade.

b.Scientific research may make a new type of technology possible, but Jordan would not be able to make practical use of this discovery while other countries would. The exports of Jordan would probably decrease.

c.Jordan might produce fewer exports and therefore have less money for imports.

d.With no new products placed on the market, trade within Jordan would probably decline.

2.What argument would you present against the organization of Citizens for Science concerning future social conditions if all new technology were banned?

a.Present technology may produce problems which require new technology for their solution.

b.People would not be likely to support scientific research if none of this research were allowed to be put to practical use.

c.People might become very unhappy if scientific research provided knowledge which would enable advances to occur, such as special equipment to cure diseases, and this knowledge was not allowed to be used.

LESSON FIVE

Objective: After completing this lesson the student should be able to:

1.List the steps Janzen followed in finding a way to protect the environment.

2.List the steps Salameh (in the biology lesson) followed in investigating the degree of water pollution.

3.Name two similarities in the procedures of Salameh and Janzen.

4.State a similarity in the attitudes of Marie Crue, Roentgen and Janzen with regard to their discoveries and observations.

A Further Look at the Procedures of Scientists

Assign a student to begin reading aloud the section "A Further look at the Procedures of Scientists". Instruct the students to stop him each time he comes to a step in Janzens experimental procedures. Instruct the students to write the steps as an answer to Question 1 of exercise 1 as they occur in the reading passage.

Predicting the Applications of Scientific Discoveries and some View of David Janzen (U.S.A.) and Marie Curie (France)

The students may read these last two sections silently. They may begin to answer questions 3-5 of exercise one if any time remains in the period. Those who don't finish exercise one should complete it as a homework assignment.

ANSWERS TO EXERCISE FIVE

The suggested answers to exercise five are presented below. The answers presented are not the only correct answers, and the teacher should accept answers if they appear to be justified.

1.List the steps Janzen followed in discovering a way to protect the environment.

a.Posing a question: Do planting and stopping damaging the land help in reducing air pollution?

b.Designing experiment to answer the question.

c.Making an expected observation.

d.Designing an investigation to answer the question.

e.Performing the investigation and finding an answer.

2.List the steps Salameh followed in discovering the low percentage of B.truncatus snails in Zerqa River Water.

a.Posing a question: Does the outflow of KS affect survival of B.truncatus in Zerqa River Water?

b.Designing experiments to answer the question.

c.Making an observation: about the movement of B.truncatus.

d.Finding an answer to the question: there is an effect of the outflow of KS on the survival of B.truncatus in Zerqa Riven Water.

e.Making a prediction: If the outflow of KS

continues, the percentage of killed B.truncatus will increase, and this means an increasing rate of water pollution.

3.List two similarities in the procedures of Janzen and Salameh

a.Each posed a question

b.Each designed experiment in a attempt to find an answer to the question.

4.Is the prediction mentioned in the section "Predicting the Applications of Scientific Discoveries" based on experimental evidence?

Yes.

5.In what way was Janzen's attitude toward his discovery of ways of protecting the environment similar to Marie Curie's attitude toward her discovery of radium.

Neither believed that they should benefit personally from a scientific discovery.

LESSON SIX

Discussion of Answers to Exercise Five

Discuss the answers to questions 3-5 of exercise five. The discussion should take approximately 10 minutes.

Student Activity Two

The objective of Student Activity Two is to engage the students in a discussion of:

1.Predicting applications of a hypothetical scientific discovery.

2.Benefits which might be derived from technological applications of a scientific discovery.

3.Problems which might evolve from technological applications of a scientific discovery.

Divide the class into five groups of approximately equal size. Give a copy of Student Activity Two to each member of the class. Instruct them to read silently the paragraph describing the hypothetical scientific discovery. Each group is to decide upon the two uses to which it would put the discovery and to record these uses on paper. After deciding upon it's two uses, each group

is to answer question 1 and 2 concerning the uses, again recording their answers on paper. Approximately 20 minutes should be allowed for the students to complete the activity. While the students are involved in group discussion, you may draw a chart on the board similar to the one below:

Group	Uses	Benefits	Problems

Designate one student to record the answers on the chart as each group indicates it's uses, benefits, and problems. There are no "right" answers, and the number of possible answers is almost unlimited. Therefore no attempt is made to present some possible students answers in this guide.

When the chart is completed, chose a few of the uses listed and ask the members of the class if they can name any additional benefits or problems which might result from the uses.

The activity should end with a brief discussion of the question: "Why is it difficult to predict the consequences of a scientific discovery?"

STUDENT ACTIVITY TWO

Some scientists believe that gravity in any part of the world is transmitted by extremely weak waves which they haven't yet been able to detect. A British astronomer and science fiction write, Arther C.Clarke, has predicted that by the year 2050, scientists will have found a way to control gravity by neutralizing its effects. Let us imagine that the control of gravity comes sooner than Clarke predicts. Suppose that in the next issue of an important journal there is an article which staff as that scientists have determined a method to detect gravitational waves and are now able to neutralize the effects of these waves (Milkent, 1975).

Directions

Discuss the possible uses of this hypothetical discovery with other members of your group and decide upon the two uses to which you would put the discovery.

After you have decided upon your two uses, answer the following questions concerning your uses. Discuss your ideas with the their members of your group and keep a record of the answers your group has decided upon (Milkent, 1975).

Questions

1.In what ways would society benefit from your

uses?

2.What problems may arise if this discovery is used in the ways you have suggested?

LESSON SEVEN

Objectives: At the end of this lesson the student should be able to:

1.List causes of pollution.

Causes of Pollution

Before the students begin the discussion of the episode Solutions to the pollution problem, they should have some background knowledge of the causes of pollution.

Call on a student to give you an observation from his/her daily life about one r more of the causes of air or water pollution. List it on the blackboard.

Ask if any other student would like to comment on this cause and it's effect. If not you can modify it by adding, or you can keep it as it is if it is a suitable answer.

Call another student to give you another cause. Write the cause of water pollution on one side of the blackboard an of air pollution on the other side. Ask the students if they have any other comments.

Use the same procedure to obtain most or all of the pollutants and their effects in general. You may receive some names for pollutants from the side of the students that you had decided nor to mention. It is okay: this is a good point for the students.

The following are the probable causes of air

pollution and its general effects to guide you in this lesson:

As (arsenic): from coal and oil furnaces, glass manufacturing; long term exposure may cause lung and kin cancer.

C6H6 (benzene): from refineries, motor vehicles; long term exposure may cause leukemia.

Cd (cadmium): from smelters, burning wastes, coal and oil furnaces; long term exposure damages kidney and lungs, weakens bones.

Cl2 (chlorine): from chemical industries; forms HCL; irritates mucus membranes.

CO (carbon-monoxide): from motor vehicles, coal and oil furnaces, smelters, steel plants, starves body of oxygen; damages hearts.

F (flouride): from smelters steel plants; high concentrations mottle children teeth.

HC (hydrocarbons): from unburned gasoline vapores; combine with nitrogen oxides in sunlight to form smogs.

HCHO (formaldehyde): from motor vehicles, chemical plants; irritates eyes, nose.

HCL (hydrogen chloride): from incinerators; irritates eyes, lungs.

HF (hydrogen fluoride): form fertilizer plants, smelters, irritates skin, eyes mucus membranes.

Hg (mercury): from coal and oil furnaces, smelters; causes tremors, behavioral problems.

HNO (nitric acid): formed from NO2; a major component of acid rain; causes respiratory diseases.

HONO (nitrous acid): formed from NO2; a major

component of acid rain; causes respiratory ailments.

H?S (hydrogen sulphide): from refineries, sewage treatment, pulp mulls; causes nausea, irritates eyes.

H2SO4 (sulphuric acid): formed in sunlight from sulphur dioxide and hydroxyl ions; causes respiratory ailments.

Mn (manganese): from steel plants, power plants; long term exposure may contribute to Parkinson's disease.

Ni (nickel): from smelters, coal and oil furnaces; high exposure may cause lung cancer (Grove, et.al, 1987).

While the causes of water pollution are:

Oil: from marines, ships, and shore industries which causes death of some types of fishes in addition to the bad smell and sight of the water.

Chlorinated hydrocarbones: like D.D.T. and others, also kill some types of fishes and also affect their proliferation.

Waste: thrown from the shores into the water. From humans, industries and radioactive elements. It causes overfertilization of some marine living organisms which affects its kind and also the smell of the water.

Wastes thrown from ships: mostly it is thrown out in international waters. Some other types of waste be put in closed containers in order to reduce its danger for example, radioactive material waste. These containers will in time be damaged and this will affect the water and hence the living organisms it.

The Discovery of the Hole in the Ozone Layer

Assign a student to read aloud the first two paragraphs of the section "The Discovery of the Hole in the Ozone Layer". After he has finished, ask the students questions like: "Where and when did the layer become thinner?

Assign a student to read aloud the third paragraph of this section. When he has finished, ask the students some questions like "What type of technology is used to get information about the hole?"

You may have the students silently read the remainder of this section, you may call on individuals to read aloud, or if no time remains in the period, you may assign it for homework.

LESSON EIGHT

Objectives: At the end of this lesson the student should be able to:

1.Name six ways in which scientists communicate with each other.

2.Give a reason for scientists not revealing the results of their research until they have published the results.

3.Name two major technological problem which had to be overcome in finding solutions for the problem of pollution.

4.State three ways in which finding solutions to pollution problems affects scientists.

Communication Among Scientists

Designate a student to read aloud this section. Instruct the members of the class that they are to watch for means of communication in the transmission of the news of pollutants and their probable solution. You may wish to list them on the board. Include the scientists involved (if possible), the location, and the means of communication. This section should take 10-15 minutes to complete.

Suggested Solution To The Problem of Pollution: An Example of Some Interactions of Science, Technology and Society

Allow the students to approximately 20 minutes to silently read this section in class. When they have finished, divide the class into groups of two or tree students and instruct them to answer the questions in exercise two.

LESSON NINE

Objective: The objective of this lesson is to engage the students in a discussion of:

1.If there is an attempt at voluntary censorship of articles related to pollution, why it will fail.

2.How world politics influenced scientists in their decision to recommend ways of preventing pollution?

Discussion of Answers to Exercise Six

Have the students discuss their answers to exercise six. The discussion should take approximately 15 minutes.

Discussion of Suggested Solutions to the Problem of Pollution: An Example of Some Interactions of Science, Technology and Society

This section is assigned for class discussion. Some questions along with some possible answers, which may be used for class discussion follow.

1.Why do you think the attempt at voluntary censorship of all articles related to pollution may fail?

a.Scientists always communicate freely with each other. The idea of censorship may be new to many scientists with the result that they refuse to accept it immediately.

b.If a scientist didn't publish the results of his investigations, some other scientists might perform similar investigations and publish the results. So the scientist who first performed the investigations would not be given credit for his findings.

c.Many scientists in many different countries are investigating causes and solutions for pollution. It will be difficult to get them all to agree not to report their results.

2.Do you think that scientists in Jordan and other countries are justified in listing the aid of the government to confront pollution.

This question calls for evaluation on the part of the students. The moral question concerning pollution has been debated ever since this issue emerged. Two possible answers to this question are presented below. Neither is more right than the other. However it is important that the students should be able to justify their answer on moral grounds.

a.Yes

Scientists are concerned with identifying the causes and possible cures of the problem. The government her to implement their recommendations. Scientific information is not the product of the country and can't be used exclusively by one country.

b.No

Governments come and go but the pollution problem remains. Scientist should organize active solutions to pollution problems which are above party politics. They

should get funding from universities, etc., so that action does not suddenly cease when power is transferred from and party to another. Furthermore a government may be influenced by money making pollution-causing big industries-detrimental to the scientists work.

ANSWERS TO EXERCISE SIX

The suggested answers to exercise six are presented below. The answers presented are not the only answers that are correct, and the teacher should accept other answers if they appear to be justified.

1.Name two reasons why scientists in different parts of the world may not make a particular discovery even after they have performed investigations which make the discovery possible.

a.They may think that a particular observation does not deserve further investigation.

b.They may not be able to explain an observation because their previous knowledge leads them to expect something else.

c.They may not have the necessary vision and imagination to see the full significance of their work.

2.Name the different forms of communication employed by scientists in the reading passage "Communication Among Scientists".

a.Letter

b.Private conversation

c.Scientific meeting

d.Telegram

e.Published report

d.Telephone (Milkent, 1975)

3.Name three ways in which the search for solutions

to overcome pollution problems can affect scientists.

a.Scientists become involved in politics

b.Scientists become important in national environmental issues.

c.Scientists become employees of the government on a large scale.

LESSON TEN

Objectives: After completing this lesson the student should be able to:

1.List at least one benefit and one undesirable consequence of the procedures used to protect the environment.

2.List three consequences of acid rain.

3.List two advantages and two disadvantages of the use of nuclear power plants.

Solutions to the Pollution Problem

Have the students silently read the section "Suggested Solutions to the Problem of Pollution: An Example of the Interaction between Science, Technology and Society" in class.

The following questions may be used to involve the students in a discussion of suggested solutions to the pollution problem. Some possible answers follow each questions. The discussion of this section should take approximately 15 minutes.

1.Are the any benefits derived from the pollution problem? If so what are they

Yes, Governments, scientists, and people in different nations start to think at approximately the

same time of ways they can prevent or lesson this problem whatever their politics, religions, attitudes, etcetera. It is a moral problem. If there were no pollution, nations would forget their joint problems, and start dealing with new sorts of problems against each other.

2.What were some of the undesirable consequences of the use of some solutions to pollution?

a.Closing factories will affect the economy, it will also affect the unemployment rate.

b.The introduction of some adjustments on car engines in order to gain complete combustion of fuel is an expensive operation so not all car owners can afford it.

Acid Rain

Have the students silently read the section. "Acid Rain" in class. This section is intended to present only a brief review of the problem of Acid Rain.

Since this section will be used as a basis for class discussion, the following questions may be used to involve the students in the discussion. Some possible answers are given after each question. The discussion of this section should take approximately 15 minutes.

What reasons can you give for attention being paid to the acid rain issue in the first place?

a.If the solution used is effective, it will be only a matter time before other countries will developed similar solution. The country with the most effective

supply of money and research to support this solution will be the most effective position.

2.What new threats to world environment will be posed by the increase in the amount of acid rain?

a.These effects are detrimental to man's environment to.

b.Nations may be affected politically as is in the case of Canada and U.S.A. and Britain.

c.Acid rain may affect plants and animals also as dying forests and lifeless lakes will upset.

d.The development of research and projects is very expensive.

3.What reasons can you give for different nations trying to reach an agreement on the limitations of acid rain?

e.The development of research and projects is very expensive.

Radiation

Assign the students to read silently the section "Radiation" this section gives only a brief review about radiation and can be used as a basis for class discussion. The discussion of this section should take approximately 15 minutes.

The following questions may be used to involve the students in a discussion of radiation. Some possible

answers are given after each question.

1.Nuclear power plants are much more expensive to build than conventional power plants. However, nuclear fuels yield many times more energy than the same amount of fossil fuels. When all factors are considered, the cost of electricity produced from the two types of plants is approximately the same. What reasons can you give for building nuclear power plants?

a.Amount of fossil fuels, such as coal and oil are limited.

Unless some other source of energy is found, we may have to depend upon nuclear energy in the future.

b.Some regions, and especially some countries, do not have access to fossil fuels.

2.Nuclear power plants do not burn fuel in the conventional sense and therefore don't produce air pollution. However, they do produce waste products which are radioactive. What are some of this disadvantages of building nuclear power plants?

a.Radioactive wastes must be disposed of. Strict safety standards are needed.

b.An accident at a nuclear power plant might endanger nearby populations and damage agricultural land.

APPENDIX C

OPINION INVENTORY

MEASURING RELATIONSHIPS

AMONG SCIENCE, TECHNOLOGY

AND SOCIETY

DEVELOPED OPINION INVENTORY MEASURING RELATIONSHIPS AMONG SCIENCE, TECHNOLOGY AND SOCIETY*

You are allowed 28 minutes to complete this inventory by responding to each of the following items with "agree" or "disagree".

Be sure that you understand the item before answering it, be as quick as possible, and let your writing be clear.

All the technologists in the world live in Jordan.

OPINION INVENTORY ON RELATIONSHIPS AMONG SCIENCE, TECHNOLOGY AND SOCIETY

1.It is difficult to predict how a newly acquired scientific knowledge will affect the society.

2.Most of the scientists are reluctant to expose or share their findings with other scientists in foreign countries because they are afraid that secret scientific information will be disclosed.

3.If all basic researches were brought to a halt, future technological activities would not be affected.

4.Scientists are expected to question findings of their own and of others.

*This instrument is very similar to Milkent's instrument in form and content.

5.The main aim of scientists is to increase man's understanding of the physical and biological world.

6.When a famous scientists makes a new discovery, other scientists accept his results without questioning.

7.Free flow of scientific knowledge among scientists is important for scientific programs.

8.Technological and scientific progress has only a small effect upon political relations among countries.

9.A scientists basic duties include that a discovery should have some practical use.

10.Scientists are often concerned that they should be given credit for their discoveries.

11.The economy of a nation has little effect on the quantity of research done by the scientists in that nation.

12.Scientists often provide the knowledge that makes new technological progress possible.

13.It is expected that a scientist will share his knowledge with other scientists instead of using it for his own personal benefit.

14.Technology has provided advancement in living

conditions, and hence the public must accept all technological progress as beneficial to social development.

15.The greatest achievement accomplishments of scientists consists of the beneficial commercial products which they have provided.

16.A lot of scientific progress became possible after technologists provided machines and tools for scientists to use.

17.Scientific information is of value only to technologists and scientists and not to the public.

18.Science and technology have been separated from politics in the pasts and this separation is expected to continue in the future.

19.One reason for scientists to publish their findings is to get credit for their discoveries.

20.Scientists often follow steadily, step by step, a definite procedure called scientific method.

21.Science is related to technology because the progress of one often leads to the progress of the other.

22.The uses of any scientific discovery can usually be determined directly after the discovery is made.

23.Since scientists in different countries speak different languages, they are interested only in the scientific work done in their own countries.

24.Political environment in a nation has it's effect upon the type of problems that can be investigated by the scientists in that nation.

25.A lot of the already existed problems in the society is the sole responsibility of scientists because they developed the knowledge which is related to the development of nuclear , air pollution ...etc.

26.Science is basically a method for inventing new devices.

27.Scientific and technologic progress often lead to changes in the economy of the society.

28.Social problems that result from technological and scientific progress are usually so minor that they have only a very small effect on society.

29.Scientists depend on engineers and other technologists to provide them with theories and laws.

30.Scientist should plan and direct their research only to the problems which presently face the society.

31.Scientists care more about the explanation of events rather than collecting information.

32.Technologists generate knowledge and explanations which scientists can use to discover new products.

33.It is not expected that scientific theories will endure in their present form.

34.Social needs during a particular period may have an effect on the type of questions that scientists will investigate.

35.Technology is a specialized branch of science dealing with mechanical objects.

36.New legislation is often necessary to control problems which result from scientific and technological advances.

37.Scientific research is always necessary to answer questions resulting from technological advances.

Table 1

Two-Way Analysis of Variance Results

Source	df*	SS**	S***	Calc. value of F
Columns	1	78	78	11.1
Rows	2	201	100.0	14.3
CxR	2	16	8	1.1
Within Cells	72	503	7	
Total	77			

---

* df : degrees of freedom
** SS : sum of squers
*** S : variance

Table 2

Schaffe Test Results

Between high and medium	7.14*
Between high and low	25*
Between medium and low	11.25*

---

*P<.05

Note: Critical Scheffe (2,75) value is 6.24.