

Learning “Microorganisms”: Science Content, Pedagogical Methods and Students’ Affective Domain

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Abstract

The learning unit “Microorganisms” developed by Khalil 2003, for 9th grade students, based on the Science, Technology, Environment, Peace and Society, (STEPS) approach is depicted and its impact on students’ attitudes toward environment and peace was investigated in Arab schools in Israel. It was hypothesized that learning the microorganisms topic, by the methods of instruction and learning used in this study would enrich the learning material of Arab middle schools, and enhance students’ interest in science, technology and awareness toward environmental preservation and peace. The approach of integration of science, technology and societal subjects can determine the impact of this curriculum on the affective domain without neglecting the scientific aspect, and may affect educational values, toward the environment, and peaceful relations among neighbors. The learning unit contained 15 chapters (learning tasks), on microorganisms’ role in nature, science research, food industry, health, and was taught in individual and cooperative learning settings, using a variety of instruction/learning methods in the classroom, laboratory and field trips. The results have shown significant improvement on students’ attitudes toward environment and peace. The outcomes indicate that the unit and the learning/instruction modes used, may serve as a method to improve students’ attitudes on the affective domain.

Keywords

STEPS, Learning Unit, Microorganisms, Affective Attitudes, Environment, Peace

1. Instruments

The Learning Unit: “Microorganisms”.

The learning unit meant to unearth the reality of an invisible world. The microorganisms are of paramount significance for the live world and man in the spheres of health, industry, biotechnology and life cycles in nature.

The learning unit consists of fifteen learning tasks sub units (Khalil, 2002a, 2002b).

“An Inquiry Journey to the Wonderful World of the Microorganisms” was written on the STEPS approach. The learning unit is based on the biology principles of the “Unifying Themes in Biology”, (Schwab, 1963: p. 31); 1) diversity of type and unity of pattern in living things; 2) the complementarity of organism and environment; and, 3) the complementarity of structure and function principle. The function of microorganisms in cycles in the nature, their role in the food chain and in the human health were emphasized along the fifteen learning tasks as the main idea, which connected the topics of the learning unit to the STEPS approach. The two new concepts of environment and peace education were added, and the recommendations made by Lazarowitz (2000) were considered, expanding the concept of STS to Science-Technology-Environment-Peace-Society (STEPS).

The learning unit was taught to ninth grade students in Arab junior high schools in the northern part of Israel.

This unit aimed to develop the students’ laboratory skills, promote their scientific thinking, enhance their problem-solving skills, their abilities to form independent attitudes, and to make proper evaluations relying on knowledge and reflection. Their engagement in teamwork nurtured their sense of cooperation, appreciation of others’ work, efforts, achievements, self-confidence, tolerance, competition and patience, required variations of teaching/ learning methods.

Of the activities included, the following were ascertained: conducting experiments (in groups), reading scientific articles individually and in groups, watching video-movies, going on a school trip, role-playing, learning in jigsaw groups and looking up information in academic sources (Khalil, 2001). A video tape containing selected films borrowed from the Educational Television accompanied the learning material, designed, taught and exposed in a way that arouses students’ excitement in terms of content and teaching styles. Practical benefits and clear links to daily life were highlighted and the learning material had within its folds societal subjects that marked the concatenation among science, technology and societal issues so the principle of Science-Technology-Society (STS) approach expanded to STEPS, E for environment and P for peace.

Since microorganisms play a dual role in the life cycles of man, plants and animals as symbiotic organisms and as factors on causing diseases, necessary precautions were taken and safety rules were followed along the practical part of the study in laboratory work and field trips.

2. Reasons for Choosing Microorganisms Topic

- Students hold prejudices, considering microorganisms (including bacteria and fungi), as harmful organisms, which is a misconception. We assumed that learning the unit on the STEPS approach would enable students to see not only the harmful impact of microorganisms but also their contribution to the life in general.
- We have daily interaction with microorganisms, through the skin, the air we breathe, the food and water we consume; therefore, it is desirable to learn about them.
- The microorganisms have an important role in our life, food, health, medicine, agriculture, environment, elements in cycles in nature and in food industry.
- Microorganisms are spread in the air, in the water, in the ground and in hard conditions too: high temperature, cold weather, high salinity, and even in environment lacking oxygen.
- Microorganisms are diseases factors. They are responsible for spoiled food, are used in scientific research, and were used in the studies when the DNA was identified as the heredity factor, and unfortunately can be used in biological war.
- Microorganisms are the ideal organisms, for a STEPS learning unit, since they offer the most opportunities, where topics in biology, chemistry, physics, technology and societal issues, can come together in a broad spectrum and studied from different points of view.

3. The Topics Taught

Antibiotic test to study the delay and death of bacteria.

Genetic engineering and microorganisms.

Microorganisms, and their function on plants, drainage and infections.

4. Modes of Learning

Reading scientific paragraphs from studies on subjects found in diverse resources, (anti-biotic and probiotic). Students watched video films on fungi, bacteria and their life in cycles.

Students learned in Jigsaw small cooperative groups about diseases caused by microorganisms and societal aspects, which have a strong relation to the environment and peace topics. These examples illustrate the subunits learning tasks as were introduced in the Teacher Guide Book (Khalil, 2002b).

The study subjects, science content knowledge, technological aspects, societal aspects and pedagogical content knowledge of the learning tasks of the 15 subunits are presented on **Table 1**.

One can see that the 15 subunits include topics, which provided students with the opportunity to learn about the biology and physiology of microorganisms and learning situations in which students had to deal with societal issues on their use in industry, research on biological war, problems of protecting the environment and good relations among neighbors in order to keep the environment and water supply from agents of diseases. It was our hypothesis that learning about microorganisms from all the STEPS point of view will have an impact on students' attitudes toward the environment and peace concepts.

Table 1. The study subjects, science content knowledge, technological aspects, societal aspects and pedagogical content knowledge of the learning tasks of the 15 subunits.

Subunit	Study subjects	Science content knowledge	Technological aspects	Societal aspects	Pedagogical content knowledge
1	Introduction to the study of microorganisms	<ul style="list-style-type: none"> - Definition of microorganisms - Classification of organisms - Characteristics of microorganisms 			<ul style="list-style-type: none"> - Classroom discussion on old concepts - Conceptual change
2	"Garden" of microorganisms	<ul style="list-style-type: none"> - Microorganism's main features and diversity - Bacteria, isolation seeding - Aerobic and anaerobic microorganisms - Seeding and growth of microorganisms on Petri dishes 	<ul style="list-style-type: none"> - Using the microscope in the laboratory work - Techniques for "gram" dyeing - Sterile methods in the laboratory work - Using the video scope 		<ul style="list-style-type: none"> - Group experimenting - Processing and presenting information - Presenting the findings - Group summary - Conducting observations - Class discussion
3	Microorganisms in food and drinks industries	<ul style="list-style-type: none"> - The role of microorganisms in food and drinks production - Fermentation - Microorganisms' optimal growth conditions 	<ul style="list-style-type: none"> - Technologies of cultures breeding for use in the food industry - Food preservation for an extended amount of time 	<ul style="list-style-type: none"> - Alcoholic drinks and their affect on man's health and the driver's sobriety - Proper diet - Food storage 	<ul style="list-style-type: none"> - Meaningful reading of a scientific article - Creative thinking - Systematic perception - Presenting knowledge - Class discussion
4	The contest of "What tastes better?"	<ul style="list-style-type: none"> - The biology of food products' preparation - Important terms and processes in food producing by microorganisms 	<ul style="list-style-type: none"> - Means for checking variables: temperature, pH - Technological methods for improving the production of food products in the industry 	<ul style="list-style-type: none"> - Economic aspects - Relations among neighbors and solving environmental issues in peaceful means - Cooperation and mutual aiding among neighbor countries for the purpose of improving economy and farming 	<ul style="list-style-type: none"> - Conducting an experiment and team work - Critical thinking - Systematic perception - Graphic presentation - Identifying problems and suggesting hypotheses - Class discussion - Inferring and conclusions
5	Bacteria in the service of the human being	<ul style="list-style-type: none"> - Microorganisms in the food industry 	<ul style="list-style-type: none"> - Chemo stat - Technological limitation in the food industry 	<ul style="list-style-type: none"> - Technologies and Food to poor countries 	<ul style="list-style-type: none"> - Systematical use of the video tape films - Logical thinking - Asking questions - Inferring and conclusions

Continued

6	The story of a food processing plant	- Food preservation - Food spoiling by microorganisms	- Food preservation techniques: sterilization, pasteurizing, freezing, drying, etc.	- Wise and proper consuming and man's health - Marketing deadline - Environment quality, pollution and fish poisoning of a lake - The location of a food factory plant - Social and economical profits from food plants	- Critical reading of a scientific article - Critical and logical thinking - Deduct ional and concluding process - Defining problems and suggesting solutions
7	A visit to a "healthy fruit" food plant	- Food preservation in practice	- Using video cameras for evidence documentation - Knowing the machines used for food processing and preservation.	- Preparation for study tours; Water, hats, hiking shoes, first aid kits and etc. - Caution while touring the machines factory, skidding, bacterial infection and more	- Optimizing the study tour - Asking questions - Locating and gathering information - Writing reports - Using video cameras
8	Plants, sewers and pollution.	- Dilemmas in choosing a food processing plant's location	- Technologies for toxic chemicals annexation - Water purification technologies.	- Social and economical interests in food plants - Environment quality: Water pollution, using unleaded gas, using purified water for agricultural purposes - Organizations and efforts for preserving the environment - Health aspects of drinking contaminated water and eating poisoned fish	- Debate and role-playing - Using presentation tools: slide projector, video, maps, etc. - Oral presentation - Presenting and analyzing findings - Gathering information - Critical and creative thinking - Systematic perception
9	Why do birth givers die?	- Hygienic dependent diseases - Controlled experiments and logical deductions - Disinfection		- Moral issues and the ethics of conducting experiments	- Team work - Critical reading of a scientific article - Critical and logical thinking
10	Antibiotic test for preventing and end life of bacteria	- Antibiotic materials and microorganisms resistance - Symbiosis - Bacterial seeding	- Microorganism experimenting tools : seeding needle, water bath, Petri dish, incubator and more - Seeding techniques		- Variable isolation and conducting controlled experiments in the lab - Graphic representation - Skills in conducting experiments - Analysis of the findings and inferring conclusions
11	Diseases caused by microorganisms	- Microorganisms causing disease: teeth caries, aids, flu, malaria and more	- Means for fighting and treating diseases agents - Pesticides techniques	Man's health: avoiding diseases: Teeth carries, aids, food poisoning and more - Social loyalty and the general benefit - Correct storage of food products and medicine - Sexual education - Economical and environmental aspects of using pesticides	- Team work (studying in groups) - Critical and meaningful reading - Analysis and presentation of findings - System perception
12	The importance of microorganisms in the elements cycles	- The importance of bacteria in food industry - Bacteria and fungi in the decomposition of organic materials - Two faced bacteria: good and bad	- Learning about technologies tools in the food industries		- Effective watching and attention to a scientific movie - Organizing and sorting information - Asking questions

Continued

13	Genetic engineering—the two sides of a coin	<ul style="list-style-type: none"> - The production of insulin using genetic engineering - Biological war 	Genetic engineering technique	<ul style="list-style-type: none"> - Aids as a societal issue - Genetic engineering harnessed for improving the social and economical society life - Genetic engineering for the benefit of mankind: industry, medicines, scientific research - Genetic engineering and biological war 	<ul style="list-style-type: none"> - Critical reading of a scientific article - Class discussion - Locating important information - Creating concepts maps - Critical thinking - System perception
14	Microorganisms in databases	Selected subjects in the microorganisms world	<ul style="list-style-type: none"> - Using computers - Familiarizing with the computerized databases 		<ul style="list-style-type: none"> - Using data sources - Obtaining and processing information - Team work - Defining problems and identifying needs - Findings presentation - Class discussion
15	Antibiotics or Probiotics	<ul style="list-style-type: none"> - Knowledge enriching in the subject of antibiotics - Probiotics 	<ul style="list-style-type: none"> - Using computers - Familiarizing with the computerized and non computerized databases 		<ul style="list-style-type: none"> - Using Data sources - Obtaining and processing information - Team work - Defining problems and identifying needs - findings presentation - class discussion

In **Table 2** the fifteen learning subunits are depicted in details on their content knowledge and their characteristics.

Table 3 presents the science content knowledge, and learning task of the 15 learning subunits performed in the classrooms, laboratory work, field trips, and visits at industries.

All the learning activities enabled students to encompass the microorganisms' topic from all the STEPS angles.

5. Teaching Science and Environment Education

Environmental education is one of the basic aspects of STS. The primary aim of environmental education is to encourage the learners to be sensitive, involved and active in their personal environment. The students will be educated towards contributing (according to their own philosophical principles) to the improvement of the quality of life in the general environment. This will depend upon the readiness of the individual to undertake the responsibility for the consequences of his/her activities, or his/her possible omissions. The concept of enlightened environment was defined as the ability to understand the forces that mold the environment and determine its quality (Zoller, 1990).

One's ability to be active is dependent upon one's understanding as to how she/he can better relate to the environment and the quality of life within it.

The purpose of the education is the assumption that being involved through the learning process on practical subjects will bring about the betterment of human existence, both on the level of the individual and the society, noted Schwab (1964). The textbooks are the primary agents in education, and are the most important source of the meeting between the teacher and the student, and the majority of class activities are carried out through their use, noted Wagner-Gershgoren and Lazarowitz (2006). Therefore, the aspiration is that the curricula material in science and technology should be integrated with societal issues and actual life problems, Lazarowitz (2000). Based on the two assumptions mentioned above the Microorganisms learning unit was developed.

6. Teaching Microorganisms on the STEPS Method, and Peace

According to Solomon (2005), education towards peace is vital, and Pearson (1990), emphasized that the role of the science teacher was to integrate societal values while teaching science content. Education towards peace is a

Table 2. Science content knowledge and chapters' characteristics.

Sub-Unit	Content knowledge	Chapters' characteristics										
		Science as a study	The unity in the Organism world	Structure and function principle	The elements cycles in nature	Benefit and harm of microorganisms	Health and hygiene	Environment perseveration	Interest and positive attitude towards science	Ethics in scientific research	STS	Integrated Science
1	Introduction to the study of microorganisms	+	+			+			+		+	+
2	A garden of microorganisms	+	+						+		+	+
3	Microorganisms and the production of food and drinks.		+	+		+	+		+		+	+
4	Contests: "what tastes better?"	+	+	+		+	+		+		+	+
5	Bacteria serving man				+	+	+		+		+	+
6	A food processing plant story					+	+	+	+		+	+
7	A visit to a food processing plant	+				+	+	+	+	+	+	+
8	Factories, sewers and pollution	+			+	+	+	+	+	+	+	+
9	Why do birth-givers die?	+				+	+		+	+	+	+
10	An antibiotic test for hindering and killing bacteria	+	+	+				+	+		+	+
11	Diseases caused by microorganisms		+	+		+	+		+		+	+
12	The importance of microorganisms in elements cycles in nature		+	+	+	+		+	+		+	+
13	Genetic engineering—"two sides of a coin"	+		+		+	+		+	+	+	+
14	Microorganisms in databases	+	+	+	+	+	+	+	+	+	+	+
15	Antibiotics or Probiotics	+		+		+	+		+	+	+	+

Table 3. Science content knowledge and learning tasks.

Sub-Unit	Content knowledge	Learning tasks										
		Conducting an experiment	Defining a problem	Finding a solution	Observation	Locating and gathering information	Processing and merging information	Creating a Table/Graph	Inferring conclusions	Oral presentation (expository)	Team Work	Class Discussion
1	Introduction to the study of microorganisms					+	+	+	+		+	+
2	A garden of microorganisms	+			+	+	+	+	+	+	+	+
3	Microorganisms and the production of food and drinks.		+	+			+		+			+
4	Contests: "what tastes better?"	+	+	+	+	+	+	+	+	+	+	+
5	Bacteria serving man				+	+	+		+			+
6	A food processing plant story					+	+		+			+
7	A visit to a food processing plant				+	+	+		+			+
8	Factories, sewers and pollution		+	+	+	+	+	+	+	+	+	+
9	Why do birth-givers die?		+	+		+	+		+		+	+
10	An antibiotic test for hindering and killing bacteria	+	+	+	+				+		+	+
11	Diseases caused by microorganisms					+	+	+	+	+	+	+
12	The importance of microorganisms in elements cycles in nature				+	+	+		+		+	+
13	Genetic engineering—"two sides of a coin"		+	+		+	+		+		+	+
14	Microorganisms in databases		+	+	+	+	+	+	+	+	+	+
15	Antibiotics or Probiotics		+	+		+	+		+		+	+

point of view, which befits the STS approach.

The task of the teacher is to teach the students ways of reasoning, and the ability to weigh one's value judgment according to principles and criteria in different domains: religion, morality, science content, and social and civic problems.

The fact is that texts are the didactical instruments for bringing about the various changes in relation to the values and methodology of the educational system in the peace process (Pappa, 1999).

Three examples of the learning tasks from the learning unit, (see sub-units 4, 5 and 6 in **Table 1**) illustrate a strong relation to the environment and peace topics. These examples illustrate the subunits learning tasks as were introduced in the Teacher Guide Book (Khalil, 2002b).

The main hypothesis in this study was that if students will learn about their environment, water supplies, the sewage systems, and how to prevent diseases, the relationships among schools' students from two villages will improve, good relations among neighbors will be developed, and as a result students' attitudes toward environment and peace will increase.

7. Research Design

Sample: The sample included 91 students: 73 (80.2%) attended 2 ninth grade regular classes: 1) village B, (N = 34, (37.4%: 53% boys and 47% girls), and 2) village A, (N = 39, (42.9%: 61% boys and 39% girls); and 18 gifted students class (19.8%; 39% boys and 61% girls). The subjects were junior high school students from Arab schools in the north part of Israel.

The two regular classes were randomly chosen from ninth grade classes of the schools, which agreed to take part in the study. The students' classes from village B and A were homogeneous in terms of academic achievements. The gifted students, who took part in the study in accordance with their desire, attended the class at a regional teacher center based on their higher academic achievement in sciences and mathematics. According to schools' principals request and the procedure used in the country, no names of schools or students involved in a study are mentioned.

Before the study began, the students learned the following biology subjects. At the 7th grade: Water and Life" by Agrest (1986). At the 8th grade: Reproduction in the Human Body, Animals and Plants, by Kahana and Marx, (1989). At 9th grade, Chapters in Genetics, by Sivan, et al. (1988) and Chapters on Nutrition in the Human Body, Animals and Plants by Sivan, et al. (1993). All the books were edited by The Ministry of Education and Culture, and are recommended in the national curriculum. None of the students learnt microorganisms in the past.

A special workshop was set up at the outset of project to train the teachers to acquire the skills in teaching and handling STEPS subjects.

8. Questionnaire for Assessing Students' Attitudes toward the Environment (QASATE)

The questionnaire "Children's Environmental Attitude and Knowledge Scale" was developed by Leeming, Dwyer and Brachen (1995).

The original questionnaire included two sections: one examined the attitudes toward the quality of the environment and the readiness to preserve the environment and the second section assessed the knowledge on the quality of the environment.

In this study, the first section on attitudes, which included 36 items, was adopted. A science educator translated the questionnaire into Arab language and examined it for content validity. The translation was validated by the use of Reverse Translation Method by a teacher who was an expert in both languages (Hebrew and Arabic). Finally, two teachers from the Arab sector validated the questionnaire for its scientific and educational content for Arab students. The teachers hold MSc. degrees, one in Biology and one in science education in Biology.

(See **Appendix 1** for QASATE).

9. Scoring Procedure

The weight of each item was scored on the LIKERT scale: from 1 to 5: entirely not correct = 1, not correct = 2; not sure = 3; correct = 4; very correct = 5. Since the items 12, 14 to 22 and 25 to 27, were formulated in a negative manner, they rated from 5 to 1. Students answered the questionnaire pre and post of the learning unit.

The Alpha Cronbach reliabilities values obtained for the questionnaire in this study were: Pre-test, .79 (N = 71). Post-Test, .73 (N = 68).

10. The Questionnaire for Assessing Students' Attitudes toward Peace (QASATP)

The questionnaire developed by Pasternack and Tzedkiyahu (1994) to investigate students' attitudes toward peace was used in this study. The items referred to the degree of belief in peace, the price willing to be paid for peace, education towards peace in school, and the role that school can play in educating toward peace. The questionnaire includes 15 questions.

In this study, the questionnaire was validated and adjusted for ninth grade classes in Arab schools. Only items relevant for the Arab students were chosen. For example, an item which enquired "as to whether education toward peace may prejudice the willingness of adolescents to join the army" was not selected. Items that were considered suitable for the Arab students were adapted in consultation with the original developers: (for example: item 7 "Is it possible that education towards peace might affect one's Jewish identity?" was changed to: "Is it possible that education toward peace might affect Palestinian identity?"

As a result, 9 of the 15 items were selected. Students' answers were scored using the LIKERT scale: full agreement = 5 to complete disagreement = 1, on the positive items, and the items 1 to 5, 9 and 10 which were negatively phrased were scaled: full agreement = 1 to complete disagreement = 5.

The Alpha Cronbach reliabilities values obtained for the questionnaire were: Pre-test, .62 (N = 85). Post-Test, .72 (N = 82).

(See **Appendix 2** for QASATP).

11. Results

Attitudes toward the environment preservation.

The mean scores of the students on attitudes toward the environment were analyzed by t-test and two way analysis of variance (ANOVA). The mean scores, standard deviations, t-test, and two way ANOVA values are displayed on **Table 4**.

The results show that the students in village "B" showed positive and significant increase in their attitudes toward the preservation of the environment after studying the learning unit. The mean scores of students' attitudes in village "A" and in the class of gifted students have increased, but the differences were not significant.

12. Attitudes toward Peace

The mean scores on the attitudes of the students toward peace were analyzed by t-test and ANOVA procedure. The mean scores, standard deviations, t-test and two way ANOVA values are displayed on **Table 5**.

The results (**Figure 1**) show a significant improvement on the attitudes of the students toward peace among the students in village "A" only. No improvement was found on attitudes toward peace in class in village "B". However, the students in the gifted class were significantly positive on their attitudes toward peace.

It seems that studying the learning unit in the STEPS mode, affected the students' attitudes toward peace. Students agreed that the educational system can affect their attitudes both in their comprehension of ideas, and the stereotypes that they held, although the differences were not significant always.

13. Discussion

The results of the research have shown an increase on students' interest, which have been expressed in their enjoyment, dedication of time to the studies and the will to continue with their studies in this subject.

Summing up, this research shows positive, desirable and successful impact on the students with regard to the issues of society, environment and peace, combined with scientific and technological subjects on the STS approach.

The improvement on students' attitudes toward societal issues, examined in this research, environmental preservation and peace related to the fact that the characteristics of the "Microorganism" study unit based on the STEPS approach included diverse and alternative ways of teaching, evaluated by means of portfolios and the integration of societal issues side by side with scientific and technological subjects.

Thus science can be learned not only for academic achievement, but for development of students' attitudes on

Table 4. Mean scores, standard deviations, t-tests and two-way ANOVA on attitudes towards environment by study groups.

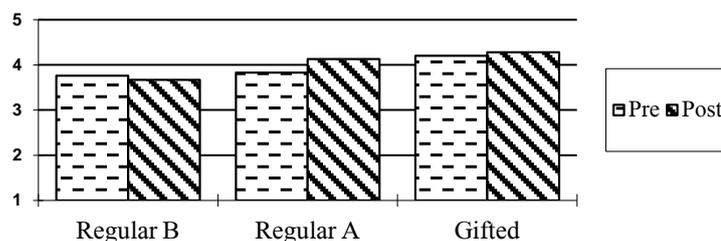
Study Group	Pre		Post		t
	X	(SD)	X	(SD)	
Regular Class "B"	3.76	(.54)	4.02	(.43)	3.26- **
Regular Class "A"	3.98	(.80)	4.15	(.55)	1.41-
Gifted Class	4.10	(.51)	4.34	(.20)	1.88-
F		1.73		2.91	F = 1.77

Note: ** $p < .01$.

Table 5. Means scores, standard deviations, t-tests and two-way ANOVA on attitudes towards peace by study groups.

Study Group	Pre		Post		t
	X	(SD)	X	(SD)	
Regular Class "B"	3.76	(.57)	3.67	(.66)	.17
Regular Class "A"	3.83	(.62)	4.13	(.54)	3.02- **
Gifted Class	4.20	(.21)	4.28	(.26)	1.16-
F		4.10*		9.15***	**F = 5.30
Scheffe		"B"-Gifted		"B"- "A", Gifted	

Note: * $p < .05$. ** $p < .01$. *** $p < .001$.

**Figure 1.** Students' attitudes toward peace.

the affective domain too.

Knowledge rather than prejudices can affect attitudes, which are conditions to behavioral changes.

14. Conclusions

The learning unit helped students to develop laboratory skills, to promote their scientific thinking, and to enhance their problem-solving skills.

In the affective domain, students were engaged in teamwork, thus nurturing their sense of cooperation, appreciation of others' work, efforts, achievements, self-confidence, tolerance, competition and patience. It was intended that students would form independent attitudes, and make proper evaluations relying on knowledge and reflection regarding the environment and peace issues, rather than on ignorance, prejudices and misconceptions. Moreover practical benefits and clear links to the daily life were emphasized in the learning material. Illuminating the interaction among science, technology and societal issues integrated with environment and peace concepts, may had an impact on human relations, according to the Science-Technology-Society (STS) approach. The learning material was designed and taught so, that it will raise students' excitement in terms of content, teaching and learning styles.

15. Recommendations

The module can be imitated in other topics including science and technology subjects integrated with societal issues that are relevant to the daily life of junior and high schools, thus meeting the students' needs as presented in Yager, R. E. & Hofstein, A. (1986). "Features of a Quality Curriculum".

16. In Addition

The learning unit “Microorganisms” was translated into Hebrew and the copies of the front cover of the Arab and Hebrew editions with their translation in English, is presented on **Appendix 3**.

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Appendix 1—Questionnaire on Attitudes toward Environment

Technion-Israel Institute of Technology

The Department of Technology and Science Education

Dear students: We will be very grateful to you for answering the following questionnaire.

Thank you very much:

Name: _____ Class: _____ School: _____ Date: _____

The following items relate to the “Microorganisms” learning unit. Please read each item and mark+ in the appropriate place, which reflects your evaluation.

	Item	Strongly Agree	Mildly Agree	Mildly Disagree	Strongly Disagree
1	I would be willing to stop buying some products to save animals' lives.				
2	I would not give \$15 of my own money to help preserve the environment.				
3	I have talked with my parents about how to help with environmental problems.				
4	I have asked others what I can do to help reduce pollution.				
5	I have written someone about a pollution problem.				
6	I do not let a water faucet run when it is not necessary.				
7	I am frightened to think people don't care about the environment.				
8	I get angry about the damage pollution does to the environment.				
9	It makes me happy when people recycle used bottles, cans and paper.				
10	I get angry when I think about companies testing products on animals				
11	It makes me happy to see people trying to save energy.				
12	I am not worried about running out of water.				
13	I do not worry about environmental problems.				
14	I get upset when I think of the things people throw away that could be recycled.				
15	It frightens me to think of how much energy is wasted.				
16	It upsets me when I see people use too much water.				

Appendix 2—Questionnaire on Attitudes toward Peace

Technion-Israel Institute of Technology

The Department of Technology and Science Education

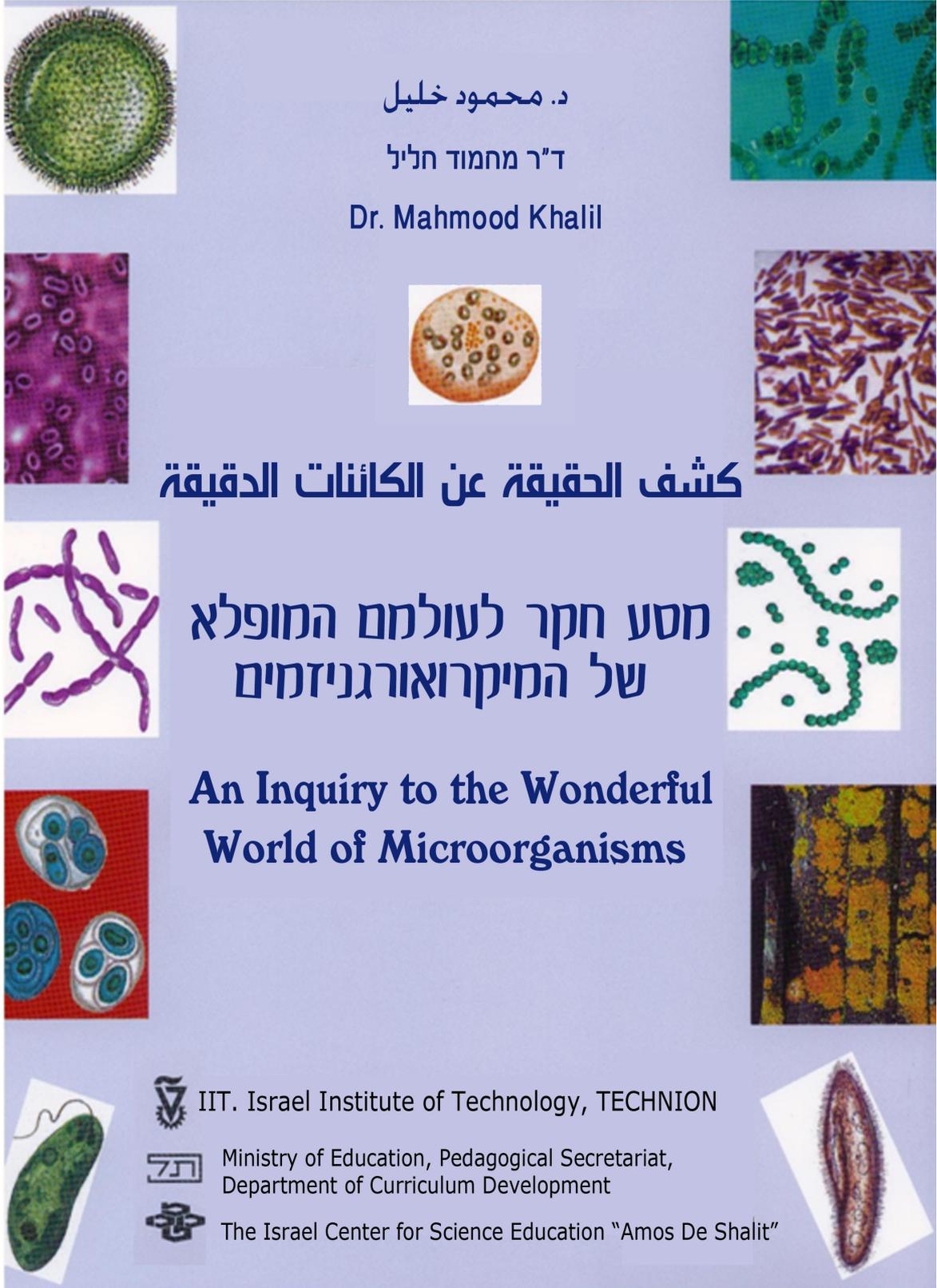
Dear students: We will be very grateful to you for answering the following questionnaire.
Thank you very much

Name: _____ Class: _____ School: _____ Date: _____

Please circle the item on the a, b, c or d, that reflects your stand. You can choose only one letter.

- 1) Do you believe there will be peace between Israel and Palestinians in the near future?
a. I absolutely believe b. I believe c. I am not sure d. I do not believe e. I absolutely do not believe
- 2) Are you pro or against the principle: Peace for land?
a. I strongly agree b. I agree c. I am not sure d. I disagree e. I strongly disagree
- 3) Is the education system able to influence the youth attitudes toward different issues related to the political process?
a. Of course it could b. It could c. I am not sure it could d. It could not e. Of course it could not
- 4) Is it the Education system responsibility to change the youth perception of the Jewish as an enemy?
a. Of course yes b. Yes c. I am not sure d. No e. Of course not
- 5) Is it the Education system responsibility to change negative stereotypes about the Jewish people?
a. Of course yes b. Yes c. I am not sure d. No e. Of course not
- 6) There are those who claim that it is not the education system's responsibility to deal with education for peace. Do you agree with this statement?
a. I strongly agree b. I agree c. I am not sure d. I disagree e. I strongly disagree
- 7) Will the education for peace hurt the Palestinian identity?
a. Very sure b. Sure c. Not a lot d. A little e. Absolutely not
- 8) Do you approve the meetings with the Jewish youth as a part of your studies in the school?
a. I will absolutely agree b. I will agree c. I am not sure d. I will not agree
e. I absolutely will not agree
- 9) Are you interested with the issue of education for peace?
a. I am very interested b. I am interested c. I am not sure it is interesting me d. I am not interested
e. It does not interesting me at all

Appendix 3



ד. محمود خليل
ד"ר מחמוד חליל
Dr. Mahmood Khalil

كشف الحقيقة عن الكائنات الدقيقة

מסע חקר לעולמם המופלא
של המיקרואורגניזמים

An Inquiry to the Wonderful
World of Microorganisms

 IIT. Israel Institute of Technology, TECHNION
 Ministry of Education, Pedagogical Secretariat,
Department of Curriculum Development
 The Israel Center for Science Education "Amos De Shalit"

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