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AN INTERDISCIPLINARY MODEL FOR TEACHING THE TOPIC "FOODS": A CONTRIBUTION TO MODERN CHEMICAL EDUCATION

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ABSTRACT: Modern chemical education aims at teaching based on critical thinking, problem solving and decision-making that may be developed through an interdisciplinary approach. An interdisciplinary model for teaching the topic "foods" is suggested. The goal of the suggested approach is for students to develop their evaluative thinking in order to adopt a responsible behaviour towards health. The proposed model consists of four main steps: i) programming/planning of the teaching strategy; ii) orientation/participation of the students in the procedure; iii) treatment of the subject and presentation of the work produced; and iv) evaluation (group and self-evaluation) of the work. The application of our project confirms that the main objective of our model, that is the promotion of HOCS learning, has been achieved since the students learned to *distinguish* and to *decide* about *choosing* foods which are not harmful for their health, to *evaluate* advertisements about foods and to *distinguish/decide* about the misleading ones, to *express* their ideas on health aspects and *critically discuss* them, to *compare* various dietary products and to *evaluate* them. Our project's pedagogic value is reflected on the fact that during its application students participating in the teamwork developed skills and behavioral attitudes such as cooperation, communication, involvement, adjustability, action, mutual support and acceptance of the individuality of each member of the team that will be important for them as citizens. [*Chem. Educ. Res. Pract.*: 2004, *5*, 143-155]

KEY WORDS: *interdisciplinary model, LOCS/HOCS; foods; nutrition; modern chemical education; evaluation (work) sheets*

INTRODUCTION

In 390 AD Hippocrates said: "Let food be your medicine and medicine be your food". In 1960 the twice Nobel Prize winner Linus Pauling proposed the terms "orthomolecular nutrition" ("ortho": Greek for "right"). He believed that most diseases would be eradicated by supplying the body with the right molecules (Holford, 1992).

A number of studies have proved the existence of a connection between optimum vitamin and mineral intake and well being (Holford, 1992). Vitamins and minerals work together. For example, for the movement of a muscle sufficient "fuel" is needed i.e. carbohydrate and oxygen along with vitamins B_1, B_2, B_3, B_5, C, iron, calcium and magnesium.

The most important role of minerals, like many vitamins, is that they act as co-factors for enzymes. Three factors determine the safety of minerals: a) the amount, b) the form, and c) the balance with other minerals in the diet.

Calcium, magnesium, phosphorus, potassium and sodium, needed in relatively large amounts every day, are called the "macro" minerals. Iron, zinc, copper, chromium, manganese and selenium are the "micro" minerals but are also essential for health. Other "trace" minerals, like molybdenum, boron, vanadium and germanium, have yet to be proved to be essential (Holford, 1992).

Research based on a multi-nutrient approach recognizes the interaction between nutrients and has led to the most promising results in improving people's energy balance, longevity, fertility, mental performance and resistance to diseases (Holford, 1992).

Foods are closely related to environmental chemistry, since the quality of the environment affects the quality of foods. This close relationship is shown by the chemical mechanisms that are connected with the introduction of the various compounds, and especially of the toxic ones, into nature and especially into the food chain. The phenomena of the bioaccumulation/introduction of pollutants from the environment/water-air-earth into the organisms/foods, and of the increase of the concentration of toxic substances in the upper levels of the food chain, have been studied greatly since the discovery of the case of Minamata Bay of Japan (enrichment of fish with mercury), during the fifties. The general conclusion is that it is not possible to produce healthy and safe foods in an environment that is polluted, i.e. near industrial areas and with processes that include toxic compounds i.e. pesticides.

In summary, the close relationship between Foods and Environmental Chemistry is included in the following effects: (a) effect of the pollution of air-water-earth on plants-animals-foods and consequently on human health. (b) effect of fertilizers and pesticides on plants-animals-foods and consequently on human health.

In this report, we concentrate on a teaching model applying an interdisciplinary approach to the topic "foods", since any environmental problem is an interdisciplinary problem (Calascibetta et al., 2000; Tabbutt, 2000) and food/nutrition is an environmental issue, related to environmental sustainability. The model for teaching is directed at the high school level, and assumes that the students have been taught general chemistry and biology at an introductory level.

A PROPOSED INTERDISCIPLINARY MODEL FOR TEACHING THE TOPIC "FOODS"

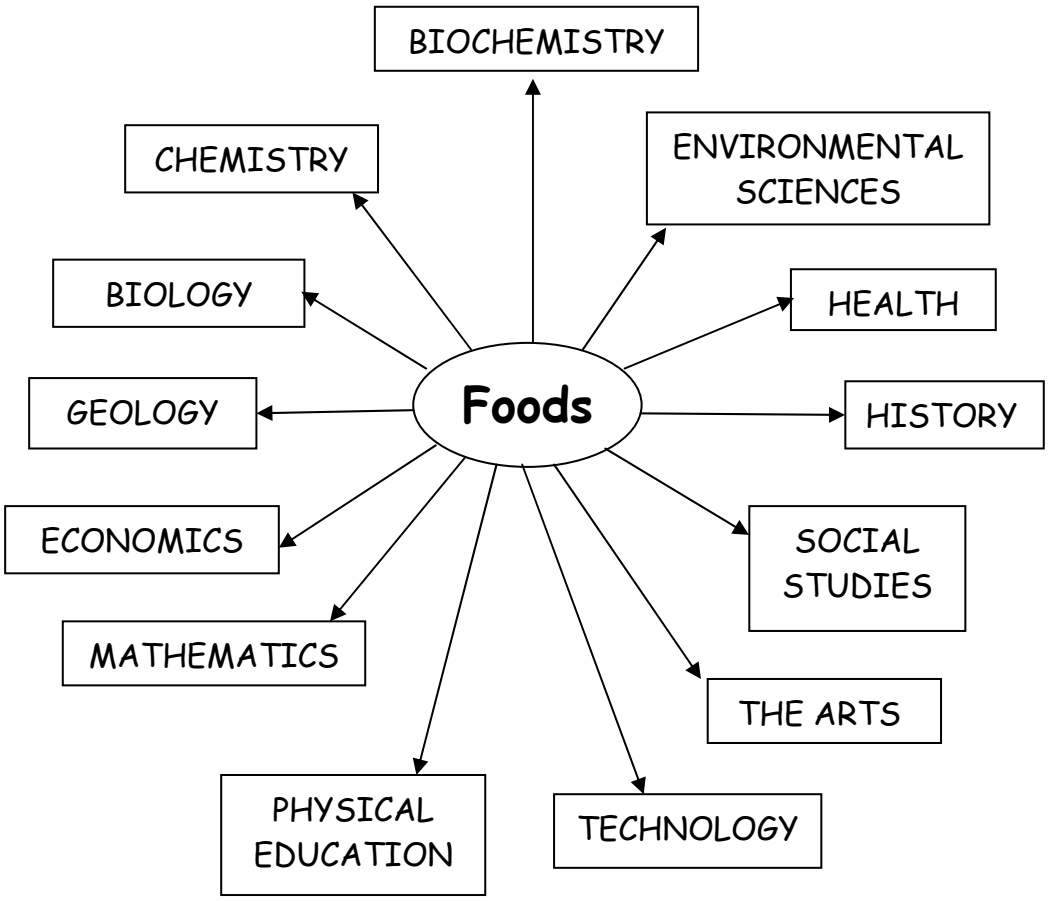
An interdisciplinary approach to the subject "foods" has been chosen because food is a real, complex issue relevant to society (Scholz & Tietze, 1999) and because Science-Technology-Environment-Society (STES)-oriented chemical education requires, amongst others: (a) inter/trans-disciplinarity as a core element in chemistry teaching since interdisciplinary courses and programs may help in facilitating or enhancing the transfer of higher-order cognitive skills – HOCS; and (b) conceptualization, by students, of basic inter/cross-disciplinary concepts: "*... A major purpose of science, technology, environment, society (STES) education is the development of the students' reasoning, critical thinking, evaluative thinking and decision-making capabilities in the context of both the specific content and processes of science and the reality-based S-T-E-S interfaces, for so they can be effective citizens*" (Zoller, 2000).

Our model consists of four main steps:

I. programming and planning of the teaching strategy;
II. students' orientation and participation in the decided procedure;
III. treatment and evaluation of the collected data and presentation of the students' work;
IV. evaluation of the students' work.

I. Programming and planning of the teaching strategy

a) The nutritional value of foods is pointed out.
b) The main disciplines that will be involved in the study of the topic are selected, for example as in Scheme 1. The criteria must be their usefulness, necessity, their teachability and, finally, their potential for stimulating the students' contribution to the subject.
c) Table 1 shows, for each discipline, the class activities and the teaching strategies, that will be helpful to teacher and students.
d) Teaching resources are collated and evaluated and the programming is determined (see Time Schedule at the end of the proposed model).
e) The means of evaluating the work is selected.



SCHEME 1. *Interdisciplinary/cross-thematic framework with "foods" as the central subject.*

TABLE 1. *Disciplines, class activities and teaching strategies involved in an interdisciplinary model for teaching the subject "foods".*

Disciplines	**Class activities and teaching strategies**
Physical Sciences Chemistry, Biochemistry, Biology, Geology	Experimentation: i.e. food analysis using the Kjeldahl method for the proteins. Research projects. Energy, combustion, exothermic reactions. Vitamins, minerals, proteins, carbohydrates, fatty acids. Food digestion. The role of enzymes in metabolism. Fertilizers.
Social Studies – History	Historical evolution of ways of preparing foods in different societies. Study of the evolution of fertilizers. Writing letters to suitable organizations asking for their policies on: a) the protection of the consumer from low quality food, and b) environmental pollution related to food. Collection of articles from newspapers and magazines related to foods. Homework dealing with: a) the nutritional habits of…, and b) the attitude of people towards food product advertisements. Study of jobs related to foods. Study of the scientific impact on the industrial evolution of foods, e.g. refining, genetic modification and industrial modification of foods. Curricula vitae of famous scientists who have worked on foods, fertilizers… Foods and civilization. How the Second World War affected the change in production of foods. History of the food industry.
Health Training – Physical Education	Study of the health problems caused by malnutrition. Investigation of the effect of nutrition on behavior/criminality (Holford, 1992). "We are what we eat" (food affects health, behavior, intelligence). Metal ions and diseases…
Mathematics	Calculations of the calorie content of foods and comparison of the results. Graphical representations and evaluation of the results… Drawing to scale… Application of laws, for example the Arrhenius law, to procedures applied to foods and critical comparison of the results e.g. thermal procedures and conservation of foods, as in Petrou, Roulia & Tampouris (2002); students can critically compare the conservation time of the various foods at normal temperature; they can also compare the conservation time of a food inside and outside a refrigerator.
Economics	Supply, demand and prices of foods. Correlation between price and quality. Methods of marketing. New foods and economic benefits. Food based companies.
Technology	Investigation of the effect of technology: a) on the pollution of the environment due to foods…, and b) on the evolution of food production, storage, packaging, transportation… Materials and technology. Packaging of foods. Colouring of foods. Conservation of foods. Additives and antioxidants in foods…
The Arts	Artworks of well-known artists related to foods. Study of paintings advertising foods.
Environmental Sciences	Topics related to environment, ecosystem, pollution, agriculture, soil, and water and hydrology. Examples of how the climate and the soil composition affect the production and content of various foods…
Visits and invitations related to the field	Visits outside the teaching timetable to: a) food companies and representatives, and b) Schools of Chemistry, Biochemistry, Food Chemistry…Invitation of representatives of: a) Ministries of Health, Commerce…, and b) organizations for the protection of the consumer…

II. Students' orientation and participation in the decided procedure

This step includes:

a) information for the students on the topic and discussion of its basic aspects. attraction of the students' interest;
b) question asking by students and description/discussion on their ideas about the selected topic and the programme (the so-called "brainstorming") (Theophilidis, 1997; Mavropoulos, 2002);
c) division of the students into groups, and selection by each group of a discipline to work on (according to Table 1).

Activities chosen by the students in the applied "food" project

Applying our project to a 20-student class (aged 16) in a high school, we divided them in five groups of four students each. Each group of students suggested various ideas about the topic and they finally chose the following topics to work on, as listed below in Table 2:

TABLE 2. *Activities chosen by the students in the applied "food" project.*

Group	Activity
1	Food quality-nutrition and health: "We are what we eat".
2	Effect of the climate and soil composition on the development of various plants-foods.
3	Foods in art, literature and poetry.
4	Advertisements promoting foods. The role of advertisements. Collection of articles from newspapers and magazines related to food and nutrition.
5	Mediterranean Diet.*

*"The Mediterranean Diet: Greek approach" is given at the end of this report as an illustrative example of a homework assignment-class activity.

III. Treatment and evaluation of the collected data and presentation of the students' work

In this step:

1) Data is collected, selected and evaluated by the collaborating students in relation to the programmed activities, with their conclusions. Specifically:

a) The first group collaborated (in collecting/selecting and treatment of the information) with the biology and chemistry teachers of the school.
b) The second group worked with the high school teachers of geography and chemistry.
c) The third group was guided by the teachers of arts, literature and music.
d) The fourth group collaborated with the teachers of social studies.
e) The fifth group was advised /guided by the school doctor.
f) The collaboration within all five groups was mutually successful. Teachers as well as students approved of their common work (see below Table 4 "student comments" and Table 5 "Survey responses").

2) Presentation of the students' work.

IV. Evaluation of the students' work

Evaluation of the students' work and abilities was conducted during all the stages of the project, in "real world" contexts (authentic assessments). Self-evaluation was also required as well as completion of worksheets (Hamphreys, Ellis, & Post, 1981). Completed worksheets refer to:

1. related subjects of the curriculum e.g., chemistry, biology, geology;
2. activity plans (aims, methods, materials, procedure, evaluation);
3. sources used for the interdisciplinary approach (books, papers, internet, videotapes)

Finally, the teacher evaluated the work of each group. A report (worksheet/diary containing reports) of the meetings of each group with the teacher was also kept.

Group evaluation and self-evaluation was conducted by filling, before starting to work on their chosen topics, worksheets that contained such questions as: a) what do the students know about the topic "foods"? and b) what do they need to know about this topic? After the full completion of the procedure. a third question had to be answered: c) what did the students learn about the topic? Table 3 summarises all the students' answers. The percentages that appear after each answer in Table 3 show the percentage of students that gave the corresponding answer, e.g. 40% of the students (that is, eight students out of the twenty) answered "that they know the composition of various foods, and that they undergo decomposition." The maximum percentage for an horizontal line could be 300%, and this could happen if all students (i.e. 100%) gave the answers that appear in that one horizontal line.

From the students' answers (Table 3) we conclude that a high percentage (40%) of the students knew about problems associated with foods, since these are frequently presented by television, radio, newspapers, magazines etc. 50% of the students wanted to know how to cope with food related problems. 40% wanted to know what is essential for them to eat and what to avoid. The majority (70%), ultimately, learned what they wanted to know.

Worksheets for the evaluation of each group's work were provided and the members of each group were asked (for the most part, the answers positive):

a) if they had exchanged ideas or not;
b) if all members of the group had participated or not;
c) if they had strictly (focused) maintained their goals or not;
d) if they used their time effectively/if they kept their time schedule or not.

For self-evaluation, each student was asked to respond to the following worksheet questions:

a) what they had learned about the topic "foods";
b) what they had produce for the topic "foods", that is, which activity they chose and what they produced working for this activity, i.e. report, graphical representations and conclusions drawn from them, collection of various advertisements and criticism of them, etc.;
c) what they had read about it;
d) what they had written about it;
e) if they collaborated with others;
f) if they liked or disliked the approach;
g) if they wanted to know more (and what) about the topic;
h) if they had any other comments to add.

TABLE 3. *Student evaluation.*

What I know about the topic "foods"	**What I want to know about the topic "foods"**	**What I learned about the topic "foods"**
I know the composition of various foods and that they undergo decomposition: 40%	I want to know how to behave as a consumer. 10%	I learned about harmful and dangerous foods*. 10%
I know the categories of food components; I know very few things about digestion. 30%	I want to know about the quality, the safety and the properties of foods. 30%	I learned about contaminated /infected foods; about the preparation and the packaging of foods. 30%
I know from newspapers, magazines and from television information series about some problems related to foods. 40%	I want to understand the role of foods in the human organism. 30%	I learned many more things than I expected. 30%
	I want to know the components of basic foods, the composition of foods and the correct consumption of them, (diet). 30%	I learned about basic categories of foods; what they offer and their importance to our health. 40%
	I want to know the source(s) of the problems that are related to foods; about their consequences and the ways to face them. I want to know about the problems that we face in our everyday life. 50%	I did not learn what I wanted to learn, but only superficially about some food contamination. I learned a few things about adulteration and about its consequences for our health. 30%

*One of the students answered that he became frightened because of the existence of problematic foods! Each student's answer, being composite, could be accommodated in more than one of the above classifications.

Finally, the participants were asked to respond to the question: "have all parts of the "food" project worked out as planned?" 40% of the students answered positively and 60% answered negatively. From the self-evaluation results, it can be concluded that the students learned many important things such as the existence of expiring dates in packed foods: they learned useful things about their health, such as the beneficial effects of the Mediterranean Diet on health (see the Appendix); they learned about works of artists related to foods; they wrote acceptable reports on their work on the chosen subject(s); they read articles from various journals; they enjoyed collaborating with their classmates; they enjoyed the approach to the subject; they would like this same approach to be applied to other courses as well; and they realized that the role of the advertisements may be deceptive. Specific student comments about their work on the subject are given in Table 4.

The analysis of the self-evaluation worksheets indicates that the students learned:

- to *evaluate* advertisements and to *distinguish* between the misleading and honest ones;
- to *decide* about *selecting/choosing* foods not detrimental to their health;
- to *express* their ideas on health aspects and *critically discuss* them;
- to *compare* various dietary products and to *evaluate* them.
- ….

TABLE 4. *Student comments.*

• I enjoyed the collaboration with my classmates • I learned many interesting things. From now on I will be careful about what I eat. • It was an interesting experience. This is how lessons should be taught at school. • Whenever I buy packed food or chocolates I will read the labels and I will look for the expiry dates. • I will try not to be deceived by advertisements. • I learned about works of painters and writers who have commented on the subject "foods" in their works and found them very interesting. • I regret that for so long I did not know so many useful things about my own health.

All of the above suggests that our project promotes HOCS learning, in terms of *evaluating, distinguishing, deciding, selecting/choosing, expressing, critically discussing, comparing*, that is, the main objective of our model is achieved.

The following programme was applied:

- One teaching hour was devoted to introductory remarks and a brainstorming session.
- One teaching hour was needed for the formation of students groups and the planning of each group's activities.
- One teaching hour was allocated for the supervision of the work and for answering the students' questions.
- In total, seven hours (mean value of the time devoted by all groups), outside the time-frame of classroom activities, were required: three hours for working on the Internet (e.g. to research bibliographies in journals and newspapers); two hours to assemble the work, i.e. for putting together the various elements); and two hours for writing the final report.
- Three teaching hours were used for the presentation of the students' work.

The application of the suggested model in schools demands flexible timetables as well as the availability to students of the necessary resources for data collection, access to libraries, tools for data treatment/evaluation/comparison, possibilities for visits to factories, organisations, etc.

After all stages of the project were completed and final reports had been submitted, graded and returned to them, all twenty students who participated in the program were surveyed, regarding their impressions of the "food" project, The results are given in Table 5. It is seen that, even though only 40% of the students considered the project to be challenging (Question 1), half of the students found the project more interesting than typical chemistry courses (Question 2). The structure of the project required collaboration between the students, and that was enjoyed by 40% of the studetns (Question 3), while only 20% said that there was no collaboration between them. The majority of the students (70%) said that they discussed chemistry with other classmates during the "food" project more than they would have done during other classroom assignments (Question 4). In addition, the course instructors noted an increase in instructor-student interaction. All written comments about the "food" project were positive, while only one student complained about having problems in his collaboration with one of his classmates concerning his poor performance. An overwhelming majority (80%) of the students recommended the application of such an interdisciplinary model for some other chemistry subjects (Question 5b), whereas a minority (20%) recommended an interdisciplinary

TABLE 5. *Survey responses.*

Questions	Strongly agree	Agree	Indifferent	Disagree	Strongly disagree
1. I was challenged by the "food" project	10%	30%	30%	30%	0
2. The "food" project was more interesting than typical chemistry classroom assignments	10%	40%	20%	20%	10%
3. I enjoyed collaborating with my classmates and my instructor	0	40%	40%	20%	0
4. I discussed chemistry with other classmates during the "food" project more than during other classroom assignments	30%	40%	0	30%	0
5. I would recommend: a) an interdisciplinary model for all subjects in chemistry	0	20%	20%	20%	40%
b) an interdisciplinary model for some chemistry subjects	10%	70%	10%	10%	0
c) the interdisciplinary model should not be applied in chemistry	10%	10%	20%	20%	40%

model for all subjects in chemistry (Question 5a). Finally, a minority (20%) suggested the interdisciplinary model should not be applied in chemistry (Question 5c).

DISCUSSION

The topic "foods" may serve for students as an illustration of how physical sciences interact. Their decision-making, critical and evaluative thinking capabilities and skills can be potentially developed via the interdisciplinary teaching of this topic. Indeed, such an approach is in accord with "*the superordinate goal of the current reform in science and chemical education worldwide [which] is the induction of a switch from the currently dominating lower-order cognitive skills (LOCS)/algorithmic teaching to higher order cognitive skills (HOCS)/evaluative thinking and, ultimately, learning*" (Zoller, 1993; Zoller, Lubezky, Nakhle, Tessier & Dori, 1995; Zoller & Tsaparlis, 1997; Tsaparlis & Zoller, 2003).

With our proposed interdisciplinary model for teaching the topic "foods" to high school students, our goals were:

- to teach the students how to *extract* the relevant information they need about foods from the different disciplines that are presented to them through this interdisciplinary approach;
- to *compare* and *evaluate* this information;
- to *distinguish* and to *decide* about the validity of it;
- to *choose* the useful information;
- to *express* it and *critically discuss* it.

In this way, the students learnt to act efficiently under a variety of difficult circumstances, which might prove useful in their dealing with everyday life problems in the future.

The interdisciplinary/cross-thematic approach is of great pedagogic importance with many pedagogic advantages, as has already been established in the literature (Hampreys, Ellis & Post, 1981; Jacobs, 1989; The Royal Society, 1996; Theophilidis, 1997;

Mavropoulos, Papanikolaou & Psallidas, 2001; Brown, 2002; Mavropoulos, 2002). Some of the advantages are discussed below.

We propose the teaching at a high school level of the topic "foods", by considering it from an interdisciplinary, multidimentional perspective, and targeting at HOCS learning. This would result in the knowledge becoming more uniform, that is, it would provide a holistic view of knowledge. The interdisciplinary approach aims at "….. bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study. It involves the student's body, thoughts, senses, feelings and intuition and it provides a greater understanding than could be obtained by examining the parts separately" (Shoemaker, 1989). The bits and pieces of information, when put together, will lead to an understanding in context. That is, an interdisciplinary approach immerses students in an environment full of the complexities of real life. This in turn leads to a greater ability to make connections and to solve problems (Kovalik & Olsen, 1994). For instance, we found that students learned to think of minerals not only as raw materials for industry but also as factors closely associated with everyday activities, even with life itself, affecting human health by acting either separately or synergistically. Interdisciplinarity promotes "conceptualization of fundamental unifying concepts" and this should be the focus of the learning process in chemical education (Zoller, 2000). Moreover, a relevant study (Lawton, 1994) showed that students from schools applying an interdisciplinary approach achieved higher scores on standardized tests than peers who had studied single-discipline subjects.

The pedagogic advantages of our applied model are summarized as follows:

- Teaching time is saved, because unnecessary repetitions of the same topic in different courses are avoided, making it possible for students to learn additional topics or areas of knowledge which otherwise would not have been taught due to lack of time (Mavropoulos, 2001).
- The interdisciplinary approach of the topic "foods", as proposed here, can also be applied by trading journals, for textbooks, project materials for worksheets and for lectures (Kovalik & Olsen, 1994). A wide variety of "sources of knowledge", such as books, leaflets, journals, magazines, internet, video tapes and CDs, applicable within the teaching/learning of any science or non-science discipline, can be employed. Also visits to food companies and institutions, concerned with foods and food quality standards can be included in the course.

The teaching model proposed here is a "single subject integration" (Ross & Olsen, 1993) that presents the content of one subject as it appears in real life, thus requiring students to apply skills within a fully meaningful context.

CONCLUSIONS

General conclusions

Students responded positively to the "food" project experience and both students and teachers recommended the application of an interdisciplinary model for certain chemistry subjects. The project fulfilled the educational goal that requires students to think critically and to collaborate. Some of the students noticed foods in supermarkets that had past their expiry dates. They also noticed the beneficial results of the Mediterranean diet on people's health. The students tried to find reasons for the beneficial effects of this diet, as well as of foods that are low in, or free of, preservatives and are rich in vitamins and minerals.

Demand on the instructors for guidance increased during this project, and this accounted for more instructors' time; the benefit was an increased instructor/student interaction. On the other hand, the students worked in groups, which gave many benefits such as the development of skills and behavioral attitudes as described below in "Conclusions on the pedagogic value of our project", and was enjoyed by them. Based on students' and teachers' response after the first application of the "food project", we hope to incorporate the "food project" and similar projects into the curriculum of our high schools in the future.

Conclusions on the pedagogic value of our project

During the application of our interdisciplinary teaching model we realized that:

A) Students participating in the teamwork developed skills, actions and behavioral attitudes such as cooperation, communication, involvement, adjustability, mutual support and acceptance of the individuality of each member of the team that will be important for them as citizens. Moreover they learned to organize their work; they were taught to use all available sources to find data, keep notes and finally, to interpret, evaluate and use the information they gathered, adding their own comments and acquiring the satisfaction of making their own individual contribution to the project. All the above are associated with asking questions, solving problems, making decisions, thinking critically, that is to say thinking evaluatively. Students were thus encouraged to take the initiative, be creative and to develop a critical mind. The actual results suggest that "critical evaluative thinking" has been achieved. This is shown in Table 4 (Student comments) and is also concluded from the homework assignments-class activities of all groups. An illustrative example, "The Mediterranean Diet: Greek approach" is given at the end of this report (Appendix), where in section C: "Application of the Mediterranean Diet" the "critical evaluative thinking" dominates.

B) Students became more interested and motivated to learn, through the interdisciplinary approach of the topic "foods", because they better understood the close relationship (cross-links, relations) between the knowledge they obtained at school and their needs in everyday life. Students found such an everyday life topic interesting and this could affect their decisions on making further studies.

C) Finally, the students became aware and sensitive to food-related social and health problems. They exercised their abilities in participation, collaboration and communication, as well as their overall involvement and their research attitude. Their interest in learning was increased as it is concluded from the "Survey responses" (Table 5**,** Answers to Questions 2 and 4) because it involved them in the problems of everyday life.

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APPENDIX

THE MEDITERRANEAN DIET: GREEK APPROACH

A) Characteristics

1. High consumption of olive oil (mono-unsaturated fatty acids), vegetables, herbs, fruits, cereals/ bread, legumes.
2. Low consumption of meat and meat products.
3. Moderate consumption of milk and dairy products.
4. Limited consumption of ethanol/wine.

B) Beneficial role of the traditional Mediterranean Diet on health or: Why should we follow this diet?

1. It is known, from mortality data of the World Health Organization (WHO), that "something is going well" with the health of those following the Mediterranean Diet.
2. Explanation (Biochemistry/Medicine): It has been shown by various studies that the substitution of the saturated fatty acids by the mono-unsaturated ones, such as olive oil, along with the consumption of fruits, cereals and vegetables, provides a high degree of protection against a wide spectrum of diseases.
3. Decrease of the blood levels of LDL (harmful cholesterol) and triglycerides.
4. Decrease of the danger for developing intestine, breast and prostate cancer.
5. Prevention of the cardiovascular diseases and of ageing.

It must be also pointed out that the great variety of foods that are used/included in the Mediterranean Diet, minimize the possibility of developing a deficiency in any given nutrient.

C) Application of the Mediterranean Diet

1. Critical and correct evaluation of the advertisements about the composition and the nutritional value of the various foods that are included in the Mediterranean Diet. Rejection of the misleading claims after critical evaluation.
2. Critical and correct evaluation and choice of foods which are not harmful for health and which fulfil the above characteristics of the Mediterranean Diet (see A). Correct decision-making.
3. Comparison of the various dietary products with respect to their composition and nutritional value and evaluation of them.
4. Expression of ideas on health aspects related to the application of the Diet. Discussion of the health aspects related to the Diet and explanation of them. Evaluation of the positive effects that are associated with this Diet.

REFERENCES

Brown, E. (2002). Interdisciplinary research: A student's perspective. *Journal of Chemical Education*, *79*, 13-14.

Calascibetta, F., Campanella, L., Favero, G., & Nicoletti, L. (2000). An aquarium as a means for the interdisciplinary teaching of chemistry. *Journal of Chemical Education*, *77*, 1311-1313.

Carper, J. (1997). *Stop ageing now*. London: Thorsons.

Hamphreys, A., Ellis, A., & Post, T. (1981). *Interdisciplinary approaches to curriculum*. Merril.

Holford, P. (1992). *Optimum nutrition*, ION Press, London.

Jacobs, H. (1989). *Interdisciplinary curriculum*. ASCD.

Kovalik, S. & Olsen, K. (1994). *ITI: The model integrated thematic instruction,* 3rd edn. Kent, Washington: Books for Educators, ED 374894.

Lawton, E. (1994). *Integrating curriculum: A slow but positive process*. Schools in the Middle, EJ 492890.

Mavropoulos, A.S. (2001). How physical sciences interact. A teaching approach to the physical sciences. An interdisciplinary teaching planning of the topic "Bonds" (in Greek). *11th Educational Seminar in Chemistry,* p. 60. Athens: Association of Greek Chemists.

Mavropoulos, A.S., Papanikolaou Ch., & Psallidas, A. (2001). How the physical sciences interact: An interdisciplinary educational approach (in Greek). 9th Panhellenic Conference in Physics, *Developments, Trends, Achievements and Teaching of Physics*. Chios, Greece: Association of Greek Physicists.

Mavropoulos, A.S. (2002). Cross-thematic/interdisciplinary approach of physical sciences (in Greek). In 1st Panhellenic Conference of the (Greek) Association of Science Education, *The teaching of physical sciences in the society of information*. Proceedings (in press).

Petrou, A.L., Roulia M., & Tampouris K. (2002). The use of the Arrhenius equation in the study of deterioration and of cooking of foods-Some scientific and pedagogic aspects. *Chemistry Education: Research and Practice, 3,* 87-97. [http://www.uoi.gr/cerp]

Ross, A. & Olsen, K. (1993). *The way we were… the way we can be: A vision for the middle school through integrated thematic instruction,* 2nd edn. Kent, Washington: Books for Educators, ED 371906.

Scholtz, R.W. & Tietze, O. (1999). *Integrating knowledge with case studies*. London: Sage.

Shoemaker, B. (1989). *Integrative education. A curriculum for the twenty-first century.* Oregon School Study Council Bulletin, ED 311602.

Tabbutt, F. D. (2000). Water: A powerful theme for an interdisciplinary course. *Journal of Chemical Education*, *77*, 1594-1601.

The Royal Society (1996). *Interdisciplinarity – Transport and the environment*.

Theophilidis, Ch. (1997). *Cross-thematic approach of teaching* (in Greek). Athens: Gregoris Publications.

Tsaparlis, G. & Zoller, U. (2003). Evaluation of higher- vs. lower-order cognitive skills-type examinations in chemistry: Implications for university in-class assessment and examinations. *University Chemistry Education, 7(2)* 50-57. [http://www.rsc.org.uchemed]

Watts, D.L. (1997). *Trace elements and other essential nutrients* (2nd Writer's B-L-O-C-K- edition). U.S.A.

Zoller, U. (1993). Are lecture and learning compatible?: Maybe for LOCS: Unlikely for HOCS. *Journal of Chemical Education*, *70*, 195-197.

Zoller, U., Nakhleh, M.B., Dori, J., Lubezky, A., & Tessier, B. (1995). Success on algorithmic and LOCS vs. conceptual exam questions. *Journal of Chemical Education*, *72*, 987-989.

Zoller, U. & Tsaparlis, G. (1997). Higher-order and lower-order-cognitive skills: The case of chemistry. *Research in Science Education*, *27*, 117-130.

Zoller, U. (2000). Interdisciplinary systemic HOCS development – The key for meaningful STES oriented chemical education. *Chemistry Education: Research and Practice*, *1*, 189-200. [http://www.uoi.gr/cerp]