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RESEARCH REPORT

Greek Students' Science-related Interests and Experiences: Gender differences and correlations

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This paper explores the science-related interests and out-of-school experiences of 583 ninth-grade Greek students. The instrument of data collection consisted of a questionnaire including items on science-related topics that could be of interest to students and on everyday, out-of-school, science-related experiences. Factor analysis yielded six distinct fields of interest and five types of science-related experiences. Significant gender differences emerge: girls are more interested in topics related to human biology, health, and fitness, and are more familiar with using instruments and devices, seeking information about nature, and doing cuisine and handicraft; while boys are more interested in science, technology, and their social dimension, and the threatening aspects of science and technology, and tend to engage more in manual work and computer use. The results of this study indicate that there is a need for the Greek science curriculum to become more appealing to students, by integrating topics and experiences that are interesting and relevant to them.

Introduction

Among the issues of primary concern in science education are the declining students' interest in science (Dawson, 2000; Economic and Social Research Council, 2004; Gardner, 1985; Gough, 2002; Sjøberg, 2002), and the poor achievement of students in international scientific literacy tests in a number of countries, including Greece (Eurobarometer, 1993; OECD, 2002, 2004; OECD/UNESCO-UIS, 2003). These issues seem to be inter-related, since the students' interests and attitudes towards science affect their achievement (Häussler & Hoffmann, 2000; Schibeci & Riley, 1986; Siegel & Ranney, 2003), as well as their course and future

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career choices (Dawson). Moreover, interest in science is related with out-of-school, science-related experiences (Dimopoulos & Smyrnaiou, 2005), and affective factors (Joyce & Farenga, 1999).

Factors Affecting Students' Interest in Science

One of the reasons considered important in students' loss of interest in science as a school subject is that they regard it as irrelevant and therefore not useful in everyday life (McSharry & Jones, 2002; Siegel & Ranney, 2003). In the view of students, there is a considerable mismatch between science-in-society and science-in-school. Osborne and Collins (2001) used a qualitative approach to explore the experiences, views and beliefs of pupils related to the value of school science, the application of science to everyday life, and their visions of school science in the future. They conducted group interviews with 144 16-year-old pupils in England. Particular aspects of school science that are reported as unattractive to students include the lack of discussion of topics of interest, the absence of opportunities for creative expression, the alienation of science from society, and the fragmentation of science in different, isolated subjects, which fails to provide students with a coherent picture.

In an extended study, Haussler and Hoffmann (2000) investigated students' experience of the physics curriculum and their interest in physics (both in general and as a school subject) in order to develop a curriculum that would improve the students' physics-related self-concept. They carried out a longitudinal questionnaire and a cross-sectional questionnaire study with a total sample of about 8,000 German students aged 11–16. They concluded that the students' diminishing interest can be attributed, at least partly, to the fact that the science curricula emphasize the academic, highly intellectual character of science, presenting it in a decontextualized way, as an objective, and value-free succession of facts to be learnt, or in contexts that do not meet the students' interests. Other researchers have reached similar conclusions in respect to science as taught in school (Gibson & Chase, 2002; Gough, 2002; Kelly, 2000; Millar & Osborne, 1998; Osborne & Collins, 2001; Osborne, Simon, & Collins, 2003; Ryder, 2002; Sjøberg, 2002).

In contrast, science-in-society (i.e., science as it is presented and perceived by the general public) is highly contextualized: it involves complex, controversial, tentative, and topical issues. Moreover, it is cross-disciplinary, human-centred, and has a strong social dimension, involving the internal mechanisms of knowledge production, moral, political, and religious values, or conflicting interests of different groups (Bauer, 1994; Dimopoulos & Koulaidis, 2003; Driver, Leach, Millar, & Scott, 1996).

Furthermore, there is evidence in the literature that students' interest and involvement in science is not homogeneous: it varies according to different factors, among which are science subjects, or specific science topics, science-related activities and gender. What is more, these factors seem to be strongly inter-related and therefore cannot be considered in isolation.

Gender as a Critical Factor

As far as different science subjects are concerned, chemistry seems to be the subject that lacks appeal and relevance for students in general. The features of physics and chemistry found interesting to both girls and boys are those that involve concrete, observable, and manipulable entities, and the activities that involve experimentation and investigation (Osborne & Collins, 2001).

However, if gender is taken into account, there are significant differences regarding interest and intention to engage in science activities and careers (Joyce & Farenga, 1999; Mattern & Schau, 2002; Morgan, Isaac, & Sansone, 2001; Neathery, 1997; Sjøberg, 2002).

Dawson (2000) investigated the interest of 203 South Australian Year 7 students concerning different science topics and activities taught in school. The questionnaire used comprised Likert-type items covering a variety of scientific areas and science activities. His outcomes confirm that boys are more likely to be interested in science than girls, a conclusion drawn from a diversity of earlier and later studies (Catsambis, 1995; Evans, Schweingruber, & Stevenson, 2002; Gardner, 1975; Tamir, 1991; Weinburgh, 1995). Moreover, boys tend to be more willing to participate in physical science activities (Joyce & Farenga, 1999; Kahle & Lakes, 1983). Such differences widen as students move from elementary to secondary school (Jones, Howe, & Rua, 2000; Osborne et al., 2003). They also pertain in different countries and maintain over time. Both Tamir, who studied a sample of 544 10th-grade students in different types of schools in Israel, and Joyce and Farenga, who examined 111 American students aged 9–13 using questionnaires with Likert-type questions concerning science-related attitudes, informal experiences, and interest, concluded that school physics is the least appealing subject to girls, who exhibit a marked preference to biology. Ten years after Tamir, using a qualitative approach, Osborne and Collins (2001) confirmed the same tendency in England.

In a questionnaire survey, Jones et al. (2000) studied the interests, attitudes, and experiences related to science in 437 sixth-grade American students, from different areas and socio-cultural backgrounds. The students were asked to report on the frequency of their involvement in science-related experiences, and whether or not they are interested in different science topics. The authors suggest that males are appealed by topics such as atomic bombs, atoms, computers, and technology (e.g., the application of mechanics on cars and flight), and they often report using tools and instruments (such as batteries, electric toys, or microscopes). Girls are mainly interested in topics related to biology (such as animal communication, healthy diet), or in topics with an aesthetic dimension (e.g., rainbows), while their typical out-of-school, science-related experiences include bread-making, observing birds and stars, knitting, or planting seeds. Moreover, the girls' scientific interests and experiences often have a powerful affective interpersonal dimension; that is, they are strongly influenced by the presence of other people who they love and admire. Similar findings have been reported by other researchers using quantitative (Sjøberg & Imsen, 1988) or qualitative approaches (Baker & Leary, 1995; Osborne & Collins, 2001).

However, there is a considerable overlap in the interests of boys and girls: what is interesting for girls tends to be interesting for boys, but not necessarily vice versa. In particular, both sexes regard topics related to human biology (such as health, diet and exercise, the effects of drug use, diseases and cures), or to "space" and the solar system, as stimulating and relevant (Osborne & Collins 2001).

Revising Science Curricula in order to Enhance Interest in Science

Despite the declining interest in science and the differentiations according to different subjects and to gender, students' scientific attitudes and beliefs about the relevance of science may change: positive attitudes and increase of interest toward science have been found to be enhanced through inquiry-based (Fraser, 1980; Freedman, 1997; Gibson & Chase, 2002; Kelly, 2000) and issue-oriented instruction (Choi & Cho, 2002; Gough, 2002; Hofstein, Aikenhead, & Riquarts, 1988; Siegel & Ranney, 2003). Moreover, involvement in out-of-school informal science activities (such as museum visits, after school discussions, or television watching) has proved to be strongly associated with a commitment to science and science learning and a positive perception of the relevance of science (Tamir, 1990, 1991). Informal science activities also promote scientific reasoning abilities among students (Gerber, Cavallo, & Marek, 2001; Kelly), contributing to the development of more scientifically literate adults.

The studies reported suggest that in order to enhance students' interest in science, the topics taught at school should be carefully chosen. A revised science curriculum should emphasize those topics that are of interest to the students, and encourage activities that are familiar and readily adopted by them. Furthermore, a revised curriculum should present science as equally appropriate for girls and boys, and aim at fostering the girls' interest and involvement in science (Jones et al., 2000; Sjøberg & Imsen, 1988), since they seem to be more uninterested and discouraged to actively engage in science courses and activities than boys. At the same time, adapting the science curriculum so as to meet girls' interests should also be advantageous for boys, given that the girls' fields of interest tend to have an appeal for boys as well.

Rationale, Objectives and Context of the Study

Since the lack of relevance of the science curriculum affects learning and interest negatively, determining the specific factors that are related to the relevance of both contents and contexts of school science should provide a basis for informed discussions on how to improve curricula and enhance the students' interest and involvement in science.

Science-related interests and experiences of Greek students and the relevant gender differences have not been studied in the context of any large-scale survey so far. Such an exploration could reveal factors with thematic coherence in regard to what aspects of science the Greek students are interested in learning about, to what activities they engage in more readily, and possible gender differentiations in respect

to these factors. Moreover, science-related interests and experiences are considered as correlated, yet their correlations have not been thoroughly explored by previous studies reporting relevant research at an international level. Therefore, the results of the present study could contribute to the selection of appropriate directions for curriculum reform, as well as open new perspectives in analysing data of this type.

In an attempt to address those issues, this paper aims at determining the aspects of science that are of relevance for Greek secondary students in order to formulate suggestions for the improvement of science curricula in terms of content and school-based activities. In particular, the objectives of the present study include identifying the fields of interest related to scientific topics in Greek students; identifying the types of out-of-school, science-related activities these students are most frequently engaged in; exploring the possible gender differences in accordance with science interests and experiences; and exploring the possible correlations between the students' interests and out-of-school activities.

The data presented in the present study were collected in the course of the Relevance of Science Education (ROSE) project. ROSE is an international comparative project with about 40 participating countries,[1] which explores the factors affecting learning and interest of secondary students (age 15/16) in science and technology.

Method

The sample consisted of 583 ninth-grade students (approximately 15 years old), attending 27 different schools in different parts of the country. The students were attending the last year of the Greek "Gymnasium" (lower secondary school); that is, concluding their compulsory education. One class of students was randomly selected from each school for participating in the survey. The schools were randomly selected so as to form a representative sample of the different types of "Gymnasia".

The aim of the project was briefly presented to each class. The questionnaire was distributed to the classes by their teacher, assisted by a researcher, and the students were given sufficient time (about 40–50 min) for its completion.

The questionnaire comprised different parts, including a part with items concerning topics that the students should be interested in learning about, and a part with items on students' science-related, out-of-school experiences (Schreiner & Sjøberg, 2004). The data presented and discussed in the present study originate from these two parts of the questionnaire.

The part of the questionnaire referring to "things to learn about" comprised 108 items in total and involved a variety of topics referring to different scientific areas, namely Astrophysics and Universe, Earth Science, Human Biology, Zoology, Botany, Chemicals, Light, Colours and Radiation, Sounds, Energy and Electricity, and Technology. The topics were embedded in different contexts such as Environmental Protection, Everyday Relevance, Science, Technology and Society, Nature of Science, or Spectacular Phenomena (Schreiner & Sjøberg, 2004). Typical items included in this part were: "How babies grow and mature", "The use of satellites for communications and other purposes", "Why we can see the rainbow", "How

computers work", or "How scientific ideas sometimes challenge religion, authority and tradition".

The part of the questionnaire concerning the students' out-of-school experiences constituted an inventory of a large variety of activities, which were not strictly related to specific scientific areas but might affect learning science at school. This part comprised 61 items. Typical items belonging to this part of the instrument involved: "Visiting a science centre, or a science museum", "Mending a bicycle", "Collecting edible berries, fruit, mushrooms, or plants", "Recording on video, DVD, or tape recorder", "Trying to find the star constellations in the sky", "Searching information on the Internet", or "Using a mobile phone".

The items comprised in the two parts of the instrument discussed in this study were scored according to a four-point Likert scale indicating the degree of interest in the case of the first, or the frequency of involvement in the case of the second. The coding of the students' answers assigned values from 1 to 4 to designate low to high interest (1 for "*I am not interested at all*", 4 for "*I am very interested*") or low to high frequency of involvement in different activities (1 for "*never*", 4 for "*frequently*") correspondingly.

Since ROSE is an exploratory project, the validity and reliability of the research cannot be entirely guaranteed by the instrument used, but have to be judged on the basis of the information it produces and the conclusions drawn from it. Nonetheless, in order to enhance the instrument's validity, care was taken to produce useful and meaningful questions and items, worded simply and unambiguously. These features were tested and confirmed throughout the process of questionnaire development by the input from students, teachers, and researchers who were asked to complete it. Likewise, in an attempt to ensure the instrument's reliability, a large and representative variety of items relevant to each variable has been included, so as to describe science-related interest and out-of-school experience as widely as possible (for more information on the instrument design, see Schreiner & Sjøberg, 2004).

The instrument used for data coding and analysis was the SPSS package.

For the purposes of the present study, 27 items of the first part of the instrument (concerning topics that the students might be interested in learning about) that were scored low by the students (i.e., those for which the mean score was below 2.5) were excluded. Likewise, 16 items from the second part of the questionnaire (referring to out-of-school experiences) with a mean score below 2 were not taken into account in the present analysis, since these scores indicated that the majority of the students had probably no (or minimal) relevant prior experience. Therefore, the analysis presented in this paper involves 81 items concerning topics of interest and 45 items concerning science-related experiences.

Results

The data obtained from each of the two parts were subjected to factor analysis with varimax rotation. Factor loadings below 0.40 were excluded from the model. The factors extracted were further subjected to analysis of variance (ANOVA) tests, in

order to explore possible differences in interest and experiences according to gender. For those factors in which significant gender differences were revealed in favour of boys, ANOVA was further used within each factor in order to determine the specific items that contribute to the significance of the difference. Moreover, the existence of correlations between the factors related to interest and those related to experiences was examined, using the Pearson correlation coefficient (r).

Interest in Learning Science

The data reflected a high interest of the Greek students in learning about topics that are related to health and fitness. Eleven of the 15 top-rated items refer to these topics. The topics for which the highest interest was reported are presented in Table 1.

Table 1. Topics about which the Greek students report the highest interest in learning

Topic	Mean score
How to exercise to keep the body fit and strong	3.65
Cancer, what we know and how we can treat it	3.60
Sexually transmitted diseases and how to be protected against them	3.59
How different narcotics might affect the body	3.47
What we know about HIV/AIDS and how to control it	3.45
What to eat to keep healthy and fit	3.44
How my body grows and matures	3.44
What can be done to ensure clean air and safe drinking water	3.41
Sex and reproduction	3.38
How to perform first-aid and use basic medical equipment	3.37
Phenomena that scientists still cannot explain	3,33
How to control epidemics and diseases	3.32
How alcohol and tobacco might affect the body	3.31
Earthquakes and volcanoes	3.29
How computers work	3.28

Factor analysis in this part of the questionnaire resulted in six factors henceforth referred to as "themes", with an eigenvalue above 1 that accounted for 40.95% of the variance. These factors concerned the following:

1. Science, technology, and their social dimension. This theme involves 16 items referring to energy and the environment (electricity, pollution, the greenhouse effect, renewable resources), food safety and production, techno-scientific inventions and discoveries, science and society (including scientific knowledge production and the interactions of science with religion and tradition), and disease prevention (Cronbach's alpha = 0.87).
2. Astronomy, space and the sky. This theme included topics such as stars, planets and the universe, space travel and telecommunications, the mysteries of outer space, navigation, and questions of meteorology (hurricanes, tornados). This factor includes 12 items (Cronbach's alpha = 0.85).

3. Human biology, health and fitness. This theme involves 17 items concerning epidemics and diseases (cancer, HIV/AIDS), the effect of addictive substances (drugs, alcohol, tobacco) on the human body, birth, growth and heredity, first aid, nutrition and fitness, and radiation dangers of widely used electronic devices such as mobile phones, or computers (Cronbach's alpha = 0.84).
4. Plants and animals. This included nine items related to topics such as plants and animals in the students' area, endangered and extinct species, plants and animals with particular properties (Cronbach's alpha = 0.77).
5. Light, sound, their perception and reproduction. This included eight items regarding the mechanisms of sight and hearing, how everyday electronic equipment works (radio, television, DVD, mobile phone), and the perception of spectacular phenomena such as rainbows, the colour of the sky, or twinkling stars (Cronbach's alpha = 0.77).
6. Threatening aspects of science and technology. Examples were atomic bombs, electric shocks, or biological and chemical weapons. In total, five items were related to this theme (Cronbach's alpha = 0.80)

These themes, along with their reliability levels, the number of items integrated in them, their mean scores, and the relevant gender differences, are presented in Table 2.

Table 2. Factor analysis of items related to students' interests

Factor	Reliability (Cronbach's alpha)	Number of items		Mean score	% of explained variance
1. Science, technology and their social dimension	0.87	16	Girls	2.82	
			Boys	2.75	
			Total	2.89*	19.42
2. Astronomy, space and the sky	0.85	12	Girls	2.97	
			Boys	2.94	
			Total	2.99	6.90
3. Human biology, health and fitness	0.84	17	Girls	3.31	
			Boys	3.42**	
			Total	3.18	4.09
4. Plants and animals	0.77	9	Girls	2.88	
			Boys	2.84	
			Total	2.92	3.95
5. Light, sound, their perception and reproduction	0.77	8	Girls	2.92	
			Boys	2.89	
			Total	2.95	3.51
6. Threatening aspects of Science and Technology	0.80	5	Girls	2.74	
			Boys	2.48	
			Total	3.02**	3.07

* $p < .05$, ** $p < .01$.

Greek students are primarily interested in "Human biology, health and fitness", since the relevant items were given the highest interest scores in relation to any other theme (total mean score, 3.31). Other themes of high interest include "Astronomy, space and the sky" (total mean score, 2.97), "Light, sound, their perception and reproduction" (total mean score, 2.92), and "Plants and animals" (total mean score, 2.88). On the other hand, the themes referring to "Science, technology and their social dimension" and to the "Threatening aspects of science and technology" constitute the themes with the lowest interest reported by the students (total mean scores, 2.82 and 2.73, respectively).

As far as gender is concerned, some stereotypic differences regarding interest between girls and boys were identified: girls are significantly more interested than boys in topics related to "Human biology, health and fitness" [$F(1, 502) = 33.59$, $p < .001$], while boys are significantly more interested than girls in learning about "Threatening aspects of science and technology" [$F(1, 561) = 69.67$, $p < .001$] and "Science, technology and their social dimension" [$F(1, 504) = 5.68$, $p = .018$].

Regarding the themes of "Science, technology and their social dimension" and "Threatening aspects of science and technology", which seem to be marginalized in the students' (and especially the girls') interests, an ANOVA test was performed in order to isolate those topics within the two themes in which girls are at least as interested as boys. These topics are presented in Table 3 and are connected with environmental issues, food production and safety, epistemological and philosophical aspects of science, and the human body and health. What these topics have in common is that they are embedded in contexts relating to personal and everyday relevance (i.e., the improvement of living conditions, human body, and health), and/or the inter-relations between science, technology, and society.

On the other hand, topics related to "Science, technology and their social dimension" about which significant gender differences were identified in favour of boys include electric energy production and domestic use, the effect of electricity on the development of the society, energy conservation and alternative resources, very

Table 3. Topics related to "Science, technology and their social dimension" and "Threatening aspects of science and technology" with equivalent appeal to girls and boys

Topic	Mean score
What can be done to ensure clean air and safe drinking water	3.41
Inventions and discoveries that have changed the world	3.16
Risks and benefits of food additives	2.89
The ozone layer and how it may be affected by humans	2.79
Why religion and science sometimes are in conflict	2.75
How scientific ideas sometimes challenge religion, authority and tradition	2.67
The effect of strong electric shocks and lightning on the human body	2.66
How technology helps us to handle waste, garbage and sewage	2.65
Medicinal use of plants	2.62
How different sorts of food are produced, conserved and stored	2.59

recent inventions and discoveries in science and technology, and the greenhouse effect. The topics related to the theme of the "Threatening aspects of science and technology" in which boys are significantly more interested than girls concern explosive chemicals, atomic bombs, and biological and chemical weapons.

Apart from the gender-related differences, there are various themes in which girls' and boys' interests converge; that is, for which no significant gender differences were recorded in the Greek data. These themes concern "Astronomy, space and the sky", "Light, sound, their perception and reproduction", and "Plants and animals", about which a relatively high interest has been recorded by both males and females. Although other researchers have reported similar overlaps in male and female science-related interests (Osborne & Collins, 2001), these seem to be more extensive in the Greek population.

Are the Students' Interests Reflected in the National Curriculum?

According to the Greek national curriculum, in the course of the three grades of the Gymnasium, physics, chemistry, biology, geography, and informatics are taught as independent, isolated subjects. The total time spent in the relevant courses is 408 teaching periods of approximately 45 min duration (Ministry of National Education and Religious Affairs, 2001). However, the curriculum does not seem to reflect the students' interests in science. With the exception of three topics ("How computers work", "How my body grows and matures", and "Earthquakes and volcanoes"), the issues that they consider as most interesting are under-represented in the curriculum (Smyrnaiou & Dimopoulos, 2005). The examples presented in Table 4 refer to the total number of 45-min teaching periods and the corresponding percentages of the total teaching periods devoted to the topics reported as the most interesting by the Greek students (see Table 1) in the course of the three grades of the Gymnasium. These examples are indicative of the gap between the students' interests and the school-science content. Moreover, since these topics are particularly preferred by the girls, it might be the case that the thematology introduced by the Greek curriculum favours the boys' participation, widening gender-related differentiations even more.

Out-of-school, Science-related Learning Experiences

The most popular out-of-school experiences reported by the Greek students involve a variety of activities mainly related to using electronic devices, or instruments (eight of the top 10 reported activities), as well as using a computer, collecting information about nature, and so on. The experiences, about which the highest frequencies of involvement were reported, are presented in Table 5.

The data concerning out-of-school, science-related experiences were subjected to factor analysis, which yielded five distinct types of experiences with an eigenvalue above 1 that accounted for 40.31% of the variance. These factors concerned the following:

Table 4. Teaching periods and percentage of the total teaching time devoted by the Greek Gymnasium to the items reported as the most interesting by the students

Topic	Teaching periods devoted	Percentage of total time
How to exercise to keep the body fit and strong	3	0.74
Cancer, what we know and how we can treat it	0.5	0.12
Sexually transmitted diseases and how to be protected against them	0.5	0.12
How different narcotics might affect the body	1	0.25
What we know about HIV/AIDS and how to control it	0.5	0.12
What to eat to keep healthy and fit	3	0.74
How my body grows and matures	27	6.62
What can be done to ensure clean air and safe drinking water	1	0.25
Sex and reproduction	0	0
How to perform first-aid and use basic medical equipment	0	0
Phenomena that scientists still cannot explain	0	0
How to control epidemics and diseases	6	1.47
How alcohol and tobacco might affect the body	3	0.74
Earthquakes and volcanoes	14	3.43
How computers work	28	6.86

1. Manual work, including 11 activities such as using tools, operating electric appliances, and mending or constructing things (Cronbach's alpha = 0.83).
2. Using instruments and technological devices such as cameras, mobile phones, thermometers, rulers, and stopwatches. This factor included seven items (Cronbach's alpha = 0.73)

Table 5. Out-of-school experiences reported by students as the most frequent

Out-of-school experience	Mean score
Using a mobile phone	3.67
Sending or receiving an SMS (text message on mobile phone)	3.59
Using a camera	3.55
Playing computer games	3.44
Using a measuring ruler, tape or stick	3.39
Recording on video, DVD or tape recorder	3.28
Measuring the temperature with a thermometer	3.27
Collecting different stones or shells	3.16
Using a stopwatch	3.12
Searching the Internet for information	3.11
Opening a device (radio, watch, computer, telephone, etc.) to find out how it works	3.06
Using a dictionary, encyclopaedia, etc., on a computer	3.05
Cleaning and bandaging a wound	3.04
Taking medicines to prevent or cure illness or infection	3.04
Seeing an X-ray of a part of my body	3.02

3. Seeking information about nature. This type of experiences involved nine activities such as visiting museums, science centres, or zoos, reading science books and magazines, watching science programmes or films, collecting stones and cells, and observing the constellations in the sky (Cronbach's alpha = 0.69).
4. Using a computer for searching for information, communicating, writing, or entertainment. This factor involved six items (Cronbach's alpha = 0.78).
5. Cuisine and handicraft, including four activities concerning cooking, collecting edible fruit or mushrooms, knitting, and weaving (Cronbach's alpha = 0.66).

These factors, their reliability levels, the number of items included in each of them, their mean scores, and the relevant gender differences are presented in Table 6.

The out-of-school experiences reported by the students as more frequently practiced are related with "Using instruments and technological devices" (total mean score, 3.38), followed by "Using a computer" (total mean score, 2.97). Quite often, the students report "Seeking information about nature" through experiences such as observing constellations in the sky, visiting museums and science centres, reading, or watching science programmes (total mean score, 2.64), and "Being involved in cuisine and handicraft" (total mean score, 2.58), while they engage in "Manual work" less frequently (total mean score, 2.45). However, practical or informal learning activities such as these are seldom incorporated in science teaching.

It is worth noting that all the factors related to out-of-school, science-related experiences reveal significant gender differences. Thus, girls engage significantly more often in "Using instruments and technological devices" [$F(1, 556) = 4.56$, $p < .05$],

Table 6. Factor analysis of items related to students' out-of-school experiences

Factor	Reliability (Cronbach's alpha)	Number of items		Mean score	% of explained variance
1. Manual work	0.83	11	Total	2.45	17.38
			Girls	2.11	
			Boys	2.83**	
2. Using instruments and technological devices	0.73	7	Total	3.38	7.51
			Girls	3.43*	
			Boys	3.33	
3. Seeking information about nature	0.69	9	Total	2.64	6.90
			Girls	2.70*	
			Boys	2.58	
4. Using a computer	0.78	6	Total	2.97	4.47
			Girls	2.88	
			Boys	3.07**	
5. Cuisine and handicraft	0.66	4	Total	2.58	4.05
			Girls	2.82**	
			Boys	2.30	

* $p < .05$, ** $p < .01$.

doing "Cuisine and handicraft" [$F(1, 546) = 53.21$, $p < .001$], and "Seeking information about nature" [$F(1, 538) = 5.61$, $p < .05$]. On the other hand, boys report "Using a computer" [$F(1, 543) = 7.88$, $p < .01$] and "Doing manual work" [$F(1, 530) = 156.00$, $p < .001$] significantly more frequently than girls.

Therefore, as far as gender differences in science-related experiences are concerned, a "double" picture emerges. Interestingly, the girls report "Using instruments and electronic devices" (especially mobile phones) and "Seeking information about nature" significantly more frequently than boys. These findings picture a difference from traditional gender differentiations as reported by earlier studies (Kahle & Lakes, 1983), especially in terms of instrument and device use. At the same time, gender-stereotypic images are apparent in other types of experiences in accordance with previously reported outcomes referring to other countries (Sjøberg & Imsen, 1988). Thus, activities related to "Cuisine and handicraft" remain typical "female practices", while experiences related to "Computer use" and "Manual work" seem to primarily favour boys' participation.

An ANOVA test was carried out within the items that compose the two types of experiences that are more familiar to boys than to girls (i.e., "Manual work" and "Computer use"), in order to map the specific activities that do or do not contribute to the significance of the gender differences reported. Significant gender differences have been revealed for each and every experience related to "Manual work" (constructions, modelling, mending things, connecting electric appliances, etc). On the other hand, there are computer-related experiences about which no significant differences have been recorded between girls and boys. These experiences are presented in Table 7 and involve searching the Internet for information, using a word processor, or using other software for educational or recreational purposes. The practices relating to computer use in which boys significantly outscore girls involve downloading music from the Internet and sending and receiving emails.

Table 7. Experiences related to computer use with equivalent appeal to girls and boys

Topic	Mean score
Played computer games	3.44
Searched the Internet for information	3.11
Used a dictionary, encyclopaedia, etc., on a computer	3.05
Used a word processor on the computer	2.89

Correlations between Topics of Interest and Out-of-school Experiences

Five significant correlations were identified between the topics of students' interest and their out-of-school experiences. Specifically, experiences of "Seeking information about nature" have been found to be positively correlated with interest in learning about "Science, technology and their social dimension" [$r(474) = 0.475$, $p < .01$], "Plants and animals" [$r(512) = 0.417$, $p < .01$], "Astronomy, space and the sky" [$r(492) = 0.394$, $p < 0.01$], and "Human biology, health and fitness" [$r(472) =$

0.300, $p < .01$]. Moreover, the students who frequently use instruments and technological devices also tend to report an interest in issues related to "Human biology, health and fitness" [$r(483) = 0.347$, $p < .01$].

Implications

The results presented in the previous section suggest that there is a considerable mismatch between the students' areas of interest and activity on the one hand, and the science teaching on the other. They also indicate that there are considerable differences between girls and boys, both in respect to interest and experiences. Therefore, in the following paragraphs some recommendations will be considered for improving school science. These recommendations should be read as hypotheses open to consideration, which merit further investigation in order to be confirmed, rather than as definite directions to follow for a successful teaching.

Focusing on Students' Interests

There is considerable common ground in the Greek girls' and boys' interests in which a future curriculum reform could invest in order to support the students' interest in science and, at the same time, reduce relevant gender differences.

Thus, it is suggested that if the science curriculum is enriched with topics related to "Human biology, health and fitness", "Astronomy, space and the sky", "Light, sound, their perception and reproduction", and "Plants and animals", interest in science could also be enhanced. Moreover, an increased emphasis on these themes might be especially beneficial for girls, while this should be the case for boys as well (Dawson, 2000; Häusler & Hoffmann, 2002; Sjøberg & Imsen, 1988).

Moreover, it seems that an integration of science subjects, rather than their treatment as autonomous bodies of knowledge, and an adoption of an issue-oriented approach could render the science curriculum more culturally and socially relevant and more appealing to secondary students. Similar suggestions have been formulated by other authors (Aikenhead, 1994; Bybee, 1997; Dimopoulos & Koulaidis, 2003; Häussler & Hoffmann, 2000; Irwin & Wynne, 1996; McSharry & Jones, 2002; Osborne et al., 2003; Osborne & Collins, 2001; Rennie & Stocklmayer, 2003; Ryder, 2002; Sjøberg, 2002; Tamir, 1991). In particular, the marked preference of the Greek students to human biology, health, and fitness indicates that, if the relevant topics are integrated with physical and chemical knowledge with an emphasis on their moral and social aspects, then the lack of interest in physics and chemistry could be compensated.

As an example of the aforementioned arguments, the themes of "Science, technology and their social dimension" and "Threatening aspects of science and technology" can be considered. These themes are the least appealing to the Greek student population, while significant gender differences were identified in favour of boys about both of them. What these themes have in common is that the topics integrated in them generally lack a personal or social dimension. However, since one cannot

undervalue the importance of such themes in becoming scientifically literate, these should be negotiated through the specific topics that are reported as more interesting and in which girls are at least as interested as boys.

Therefore, "Science, technology and their social dimension" and "Threatening aspects of science and technology" could be presented in contexts that seem to be of (at least) equal interest for girls and for boys, or integrated with other topics in contexts with personal or social relevance, or with an affective dimension. Specifically, it is expected that if topics such as energy production and use, the greenhouse effect, or atomic, biological, and chemical weapons are not presented as scientific "facts", but along with their moral, political, and social implications, they will be faced as more relevant and equally appropriate for girls and boys.

Adjusting Science Teaching to Students' Experiences

Meaningful teaching should also build on the learners' experiences. Therefore, determining the types of activities in which the students are typically involved can provide indications for improvements in science teaching.

The outcomes of this study indicate that integrating experiences related to the use of instruments and electronic devices and to the search of information about nature in science teaching would bring science lessons closer to practices that are familiar to the students. In addition, it could provide useful links between the school science content and scientific and technological applications, and emphasize the social importance and the interpersonal character of science, hence stimulating interest in both girls and boys (Morgan et al., 2001; Osborne et al., 2003).

Besides, if the gender-related differences are taken into consideration, the outcomes presented in this study suggest that the integration of activities related to the use of instruments and electronic devices, the search of information about nature, and cuisine and handicraft in the science classroom could enhance the relevance of science, especially for girls, and therefore their confidence and participation in the science classes.

Likewise, certain aspects of computer use (i.e., searching the Internet for information, or using a word processor or other software) that are equally practiced by males and females might also be beneficial for increasing the relevance of school science, and reinforcing all students' interest, confidence, and participation.

The combination of popular practices adopted by the students in their out-of-school activities with topics they have reported a willingness to learn about could further strengthen their interest in and commitment to school science. More specifically, the correlations identified between popular out-of-school Greek students' experiences, and the topics they consider as interesting, imply the following:

1. Activities related to seeking information about nature (i.e., observing, collecting and classifying, visiting zoos, science museums and science centres, reading books and magazines, and watching science programmes or films) are positively correlated with a variety of themes that are of interest to the students. Thus,

encouraging students to seek, collect, and process information on "Science, technology and their social dimension", "Plants and animals", "Space and astronomy", or "Human biology and health" might increase the relevance of the science lessons. Indicative examples of combinations of such experiences and topics of interest could include reading books, or newspaper and magazine articles on the possible disease causes and methods of their prevention; watching television programmes on environmental problems (air pollution, ozone depletion, or water security); visiting a zoo and talking to experts in order to learn more about different animal species; visiting a planetarium to learn about the solar system, galaxies and the universe, or rockets, satellites and space exploration; or identifying and classifying different ingredients and substances used for food production, by reading the analyses on food packages, in order to make decisions on their nutritional value and the safety of alimentary habits.

2. Topics related to human biology, health, and fitness could be combined with the use of instruments and technological devices. Relevant suggestions could include seeking information about the possible risks of mobile phone and computer use and applying it to learn how to use mobile phones and computers with security; searching the Internet for information on severe health problems (such as cancer, HIV/AIDS, or other sexually transmitted diseases), issues of nutrition, diet, and fitness, or how different addictive substances affect the body; using basic medical equipment for measuring body temperature, or blood pressure, or practicing simple techniques used in first-aid; using electronic equipment (e.g., video, cameras, projectors) or relevant educational software in order to collect and display information on growth and bodily functions; or using a word processor in order to write reports on interesting biology topics about which they have collected information.

Additionally, experiences that are not of equal appeal to girls and boys could be combined with topics of general interest in order to counterbalance differences and enhance interest and participation, especially among girls. Such a combination could be an activity of exchanging reports on a health topic, which is a theme of particular interest for all students, especially for girls. These reports could be produced on the computer and sent by email (an activity significantly less favoured by girls) to their peers or to students of other schools or regions.

Science education should aim at fostering an appreciation and understanding of science, by taking into account those aspects that are valued by the students in their everyday lives, and in a variety of contexts. In this paper the science-related topics of interest and types of experiences of Greek students have been mapped, the significant gender differences have been outlined, and the principal correlations have been explored. The data presented in this paper indicate that there is a considerable gap between the Greek students' science-related interests and experiences, and science as taught at school. Their analysis has allowed the formulation of suggestions for the improvement of science teaching, so as to meet the students' needs. Thus, in terms of content, along with uncontested, pre-established knowledge, topical science

issues should constitute an important part of contemporary curricula with an emphasis to human biology and health and to the personal and social aspects of scientific and technological achievements. Moreover, it has been claimed that science practice at school could benefit by the inclusion of practical and informal learning activities, and by the use of computers. Appropriate combinations of topics and activities have arisen that could also increase the relevance of school science and contribute to the development of a scientifically literate citizenship. All the recommendations outlined constitute tentative conditions for a curriculum reform and merit further exploration as research assumptions.

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