CHAPTER 3

The e-Hermes project

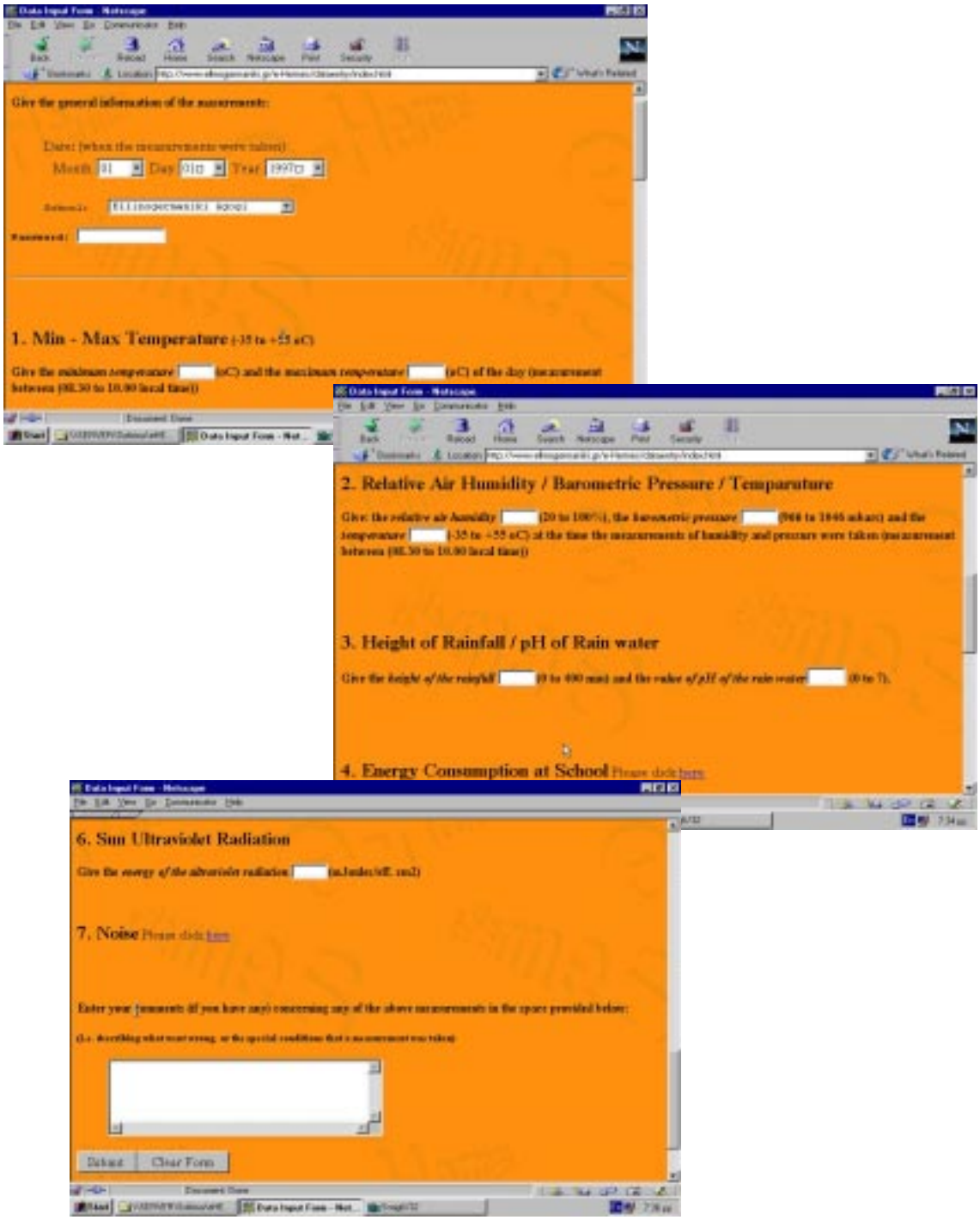
3.1 Description of the e-Hermes project

The e-HERMES project [Savas et al., 1998; Apostolakis et al., 1998] lasted for two years. The proposal was submitted to the European Union for approval in January 1997 in the framework of the call for Transnational Co-operation Projects of the SOCRATES program. Its approval was officially announced to the partners of the co-operation in August 1997 and its implementation started in September of the same year. The expected total cost of the project comes up to 358kEURO, 50% of which was covered by the European Union.

The main purpose of the project was the introduction of ODL into secondary education. The proposed introduction has to be based on the development of a framework, which has to follow the necessary pedagogical and scientific principles, which in every case should support an innovative approach to the educational process. Furthermore defining and forming the methodology that should be followed in the introduction of new technologies to everyday teaching, was also an objective of the co-operation. The e-HERMES collaboration (see paragraph 3.2) - University Institutions and schools - was able to cover the theoretical as well as the practical approach of the suggested application.

The work-plan of the project is presented in Appendix I. It includes a detailed description of the preparatory activities (planning of evaluation methodology, production of educational material, collection of information about previous ODL projects), the probe run, the final run, the evaluation and finally the dissemination of the results. In order to maximize the search outcome an input form was induced to the project's Web site allowing everyone involved in an ODL project to submit information. The form was constructed in a way that allows a lot of search capabilities to the database that is being formed. The full list of the ODL projects is presented in Appendix II. The environment related quantities which had to be measured were determined by exchanging several e-mails through the developed mailing list among the partners and by evaluating students' remarks and opinions and the results of comparison of environmental curricula of the participating countries. Meteorological quantities such as temperature, rainfall, barometric pressure, energy consumption, etc. were decided to be measured during the probe (test) run of the project. It has to be noted that only the three participating schools

contributed to the data collection during the probe run, while the number of schools which submit data during the final run was risen to 13. During the e-HERMES project's final run, which lasted for seven months, students from the participating schools collected environmental data on the selected parameters. Then, with the help of their teachers, they entered their data in an electronic tool (e-tool). The e-tool consists of an entry form (see below) in which the students submit the results of their measurements. The user interface is designed under two main aspects:

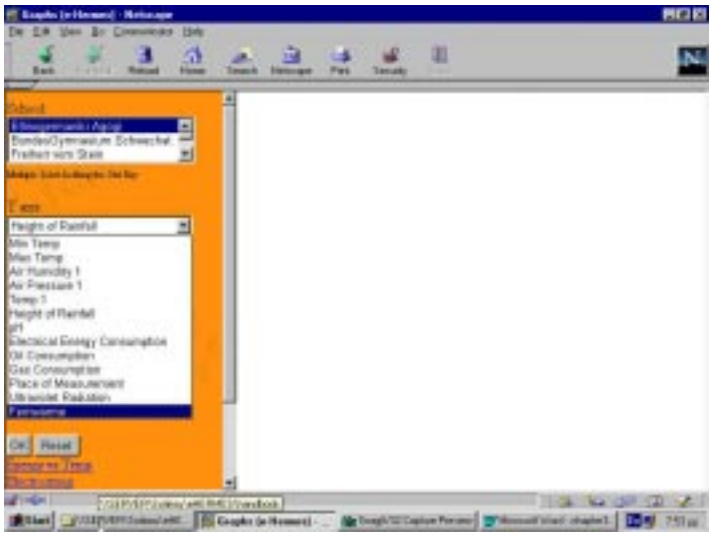


a) the possibility for a graphical representation of the measurements either as a function of time, or as a function of other environmental parameters

b) the possibility to compare their own measurements with those of their virtual classmates from the other participating schools.

The e-tool was developed with two main objectives:

- To guarantee full freedom of students in choosing the form of plots (selection of any time period, selection of schools to be compared, etc). Although a variety of selections is available, the structure of the selection page remains simple allowing even younger students to call for simple graphs (see below).



- To address clear educational needs such as familiarization with error theory, methodology of plot construction/ interpretation and determination of which quantities depend on each other. Finding out which graphs can lead to a meaningful result is an important students' task.

Three main pedagogical principles underlie the e-Hermes project:

1. learning should be a collaborative experience: The project is based on the creation of a "virtual classroom", which means that every possible aspect of a conventional classroom is simulated. In a real classroom students' collaboration and interaction is one of the most essential characteristics of success of the didactical approach [Jonassen, 1995].

2. learning is the outcome of formulating questions, making research, investigating and sharing results: The advantages of familiarizing students with scientific methodology in comparison to simply transmitting knowledge are obvious [Newton, 1988; Sandford, 1988; Hodson, 1992]. Scientific inquiry is not merely simulated within the framework of a single classroom but becomes a complete process starting from experimentation and reaching out to every aspect of modern scientific inquiry: Collection of data, formulation of hypothesis, analysis of data, extraction of results, communication of the results through electronic newsgroups specifically designed for the project, presentation and publication of results in a refereed Journal, E.S.E.M., European Students Environmental Magazine (see paragraph 3.3).

3. participation enhances learning: It is widely held that increased students participation stimulates interest [Gangoli, 1995; Todt, 1993; Lechner, 1992]. Thus the participation of the students at all steps of the e-Hermes project was safeguarded. Students not only set their own research targets based on their own data but even had the possibility to comment on the project and influence the continuous redesign/ upgrade of the e-tool.

After comparing the data, a discussion followed. This discussion was related to the variation of the measurements, which differ from the expected ones. The measurements in various areas and causes of these differences were also discussed. Communication took place through the Web based Bulletin Board, as well as through videoconferences.

The evaluation of the project's implementation was performed by researchers of the participating Universities. The evaluation involving three distinct conscious stages of quality assurance [Lancier et al., 1997]: Before (Design); during (Implementation) and after (Outcomes - Conclusions). Quality in the design stage is related to the specification of the learning content and activities on the basis of the analyzed needs of the learners including the presentation of these content and activities in the project. Quality in the implementation stage implies providing a positive affective atmosphere and a supportive environment in which the realization of the design is monitored and adapted flexibly to the evolving needs of the learners. Finally the quality of the outcomes can be evaluated in terms of the gains in competence and awareness in relation both to the resources and conditions concerned and in terms of the satisfaction of the stakeholders involved. The evaluation method and the results from the implementation of the project are analytically presented in paragraph 3.4.

One of the main goals of the co-operation was to embed the activities of the project to the curriculum of participating schools, so as to ensure its successful implementation. In general this target has been achieved (see paragraph 3.5).

3.2 The European co-operation

In the case of the e-HERMES project, the co-operation was formed by six partners from three European countries, the Pedagogical Department of the University of Athens and Ellinogermaniki Agogi from Greece, the Theoretical Physics Department of the University of Vienna and the BG Schwechat high-school from Austria and the Physics Teaching Department of the University of Frankfurt and Freiherr vom Stein Schule high-school from Germany. During the final run of the project 10 more schools participate to the data acquisition procedure as well as to the data analysis.

Ellinogermaniki Agogi was the coordinator of the project. Ellinogermaniki Agogi is an educational institution with a well-educated staff, as well as a sufficient technical background which enabled the school to overcome the responsibilities of this role. Coordination and administration, as it has been shown in practice, fully occupied at least one person in almost every phase of the project, for the monitoring of the activities and the financial aspects of the program respectively.

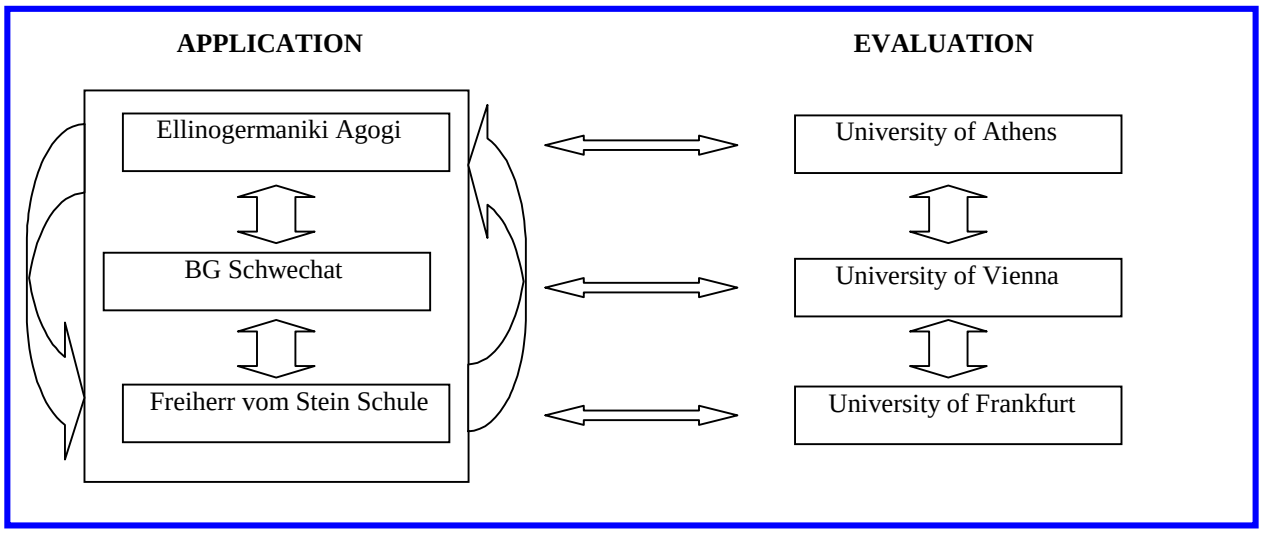


Figure 3.2.1: *The co-operation that elaborated the implementation of the e-HERMES project.*

The formation of the co-operation is graphically represented in figure 3.2.1. The application took place in the three schools. Both students and teachers participating in the program had been constantly communicating with their virtual classmates and fellow teachers in other countries respectively, mainly through e-mail and videoconferences. Scientific staff of participating Universities was closely attending the pilot implementation in the schools, to ensure it followed the predefined pedagogical framework and to evaluate the suggested procedure and its results.

A short profile of each participating institution is presented below:

☑ Ellinogermaniki Agogi [http://www.ellinogermaniki.gr]

Ellinogermaniki Agogi is an educational organization of private law, officially recognized from the state. It covers every degree of education from nursery to upper secondary. It is a pilot school emphasizing in foreign languages teaching, application of new technologies, extensive use of the laboratory in natural sciences teaching and research in education long before Greece joined the EU. On account of these projects there is a close co-operation between the school and the Pedagogical Department of the University of Athens, which participated in the present project. By translation the name of the school corresponds to Greek German Education, which determines the emphasis given to teaching the German language. Ellinogermaniki Agogi is the only Greek school, which teaches the German language intensively even from nursery school. The English language is also taught from the fourth grade of primary school and on. Operating for 37 years in the educational sector, 1500 students and personnel of 250 people (155 scientific and 95 administrative), it is one of the greatest educational institutions in Greece. It owns two fully equipped school campuses, with special classrooms for information technology, music, painting, physics, chemistry, biology, a library, projection room, theatre, sports hall and an indoor swimming pool. Through these means and facilities, the school provides its students the opportunity to get involved in various civil and social activities, reinforcing the level of education they get. Ellinogermaniki Agogi was the first Greek

school to use ODL in secondary level education in 1993. Then it started a program to create the first Internet web site of a Greek school as well as dial-up center, providing students and teachers the opportunity to cooperate, with schools from many different countries abroad by direct communication from school or even from their home, through their modem devices. Already through the COMENIUS PROJECT-ACTION 1 the school cooperates in two projects that very much use the spirit of ODL. The participation of Ellinogermaniki Agogi in EU funded programs is only recent. The school used to fund itself its educational programs, many of which were possible owing to its very good relations with Universities in Greece and abroad. In the last four years Ellinogermaniki Agogi has taken, besides the SOCRATES COMENIUS ACTION I and III programs, in the FIREES program, to a funded program of personnel education and also in the ATHENA program (as Coordinator), part of the LINGUA D and in NETDAYS EUROPE 98 (as Coordinator). The dedication of EA to ODL use and the advances of information and communication technology in the field of education, is proved by the following facts:

- Creation of Internet permanent connection and dialup center in 1993.
- Students' e-mail exchange projects for various subjects with other schools.
- Foundation of a specialized (AIAS S.A.) agency providing communication services, whose goal is to provide a more sufficient organization of its technological background.
- Starting of a specialized (EPINOIA G.P.) agency, acting, amongst others, in producing innovative educational material, conventional and electronic.

The Ellinogermaniki Agogi personnel whose task is the application and spread of ODL can be divided in two categories: one is the specialized personnel whose job is information technology and technical support of educational activities (5 persons), the other are those educators who are responsible for ODL's application (the full-time equivalent being that of 5 persons). The specialized body AIAS S.A. also occupies 6 persons (full-time equivalent).

☑ Freiherr vom Stein Schule

Freiherr vom Stein School was founded in 1907 under the name of "Kaiser – Wilhelm – Gymnasium". A University preparatory curriculum is offered to students from grade 5 to 13 and school education ends with the Abitur, which is comparable to the Swiss "Matura", the British "A-level" and the US-American "High School Diploma". Freiherr-vom-Stein School is a public educational institution financed by the Federal State of Hessen. At present 920 students are educated by 72 teachers. The course of studies emphasizes on both natural sciences and languages: In addition to the traditional subjects such as mathematics, physics, biology, chemistry, both computer science and environmental studies are being offered (the school owns a small solar energy plant, a well-equipped computer science room and an audio-visual room complete with computer and video equipment including an ISDN-line). It is one of the very first schools in the Federal State of Hessen where computer science has been taught since 1979, using an early on-line-connection to the U.S.A. Foreign Language instruction is offered for English, French, Spanish, Italian and Latin, supported by long-standing exchange partnerships with Paramus High School in New Jersey, U.S.A., Lycee Edouard Herriot in Lycon France, and Instituto Aldo Capitini in

Perugia, Italy. The school has had an Internet connection for the last 2 years; implementation of ODL has been possible since the beginning of 1997 through the acquisition of high-potential computers, which are administered by the computer science department. At present another computer science teaching room is under preparation and will enable 8 to 10 to grade students acquire basic computer knowledge and to study the appropriate use of present-day computer technology.

☑ Bundesgymnasium und Bundesrealgymnasium Schwechat

The Austrian partner school is a large school in secondary education with 860 students. It offers two branches of education:

1) Realgymnasium: emphasis on science subjects with intensive teaching curriculum in mathematics, physics, chemistry, biology, geometry.
2) Gymnasium: lingual branch with a wide variety of language teaching (Latin, Greek, French, Italian, and Spain)

The school has a modern infrastructure with special classrooms for information technology (2), physics (2), biology, chemistry, music (2). At present it employs 70 teachers, 3 of which have a technical background in telematics application. BG Schwechat was one of the first Austrian Schools in secondary education connected to the Internet. Students used this opportunity in various projects where the Net was used as a medium for communication with schools of different countries in Europe and the USA.

☑ University of Athens / Pedagogical Department / Department for science, technology and environment

The laboratory permanently employs 15 people as academic / scientific personnel and 6 more in part time (full time equivalent). It trains 250 University students, 25 postgraduate students and 150 teachers. Several members of the scientific personnel are dealing with the application of telematics in education (the full time equivalent is approximately 4 persons). The pedagogical department constitutes one of the substantial institutions in Greece in pedagogic research. It engages in the preparation of the students and their training in the science instruction methodology. Its research field covers new technology application in education as well as curriculum planning. Its infrastructure as well as its scientific personnel places it among the most important research centers in Greece in new technology and telematic application in education. The Department has well-established international links. It participates in EU programs such as the 2nd Communication Support Framework (Operational Program for Educational and Initial Training, Tertiary Education Sub-program 3), the FIREES (DG XI) project and other projects of the Greek Ministry of Education, particularly funded by the E.U.

☑ University of Vienna / Working group for Physics Education at the Institut for theoretical Physics

The working group for Physics education employs 3 persons in the level of scientific / academic personnel, 2 doctoral students and 5 post graduate students. Its activity covers the Education of Physics teachers students, continued Education of Physics

Teachers, interdisciplinary Aspects in Science Education, a post graduate course for science teachers (a two year interdisciplinary course with special concern of environmental aspects and modern pedagogic), action research for teachers (teachers research their teaching). The leader of the working group Prof. Dr. Kuhnelt Helmut is a founding member of a working group for multimedia in physics education, and of Austro-German working group (1982) for computers in physics teaching. Organizer of international conferences on physics teaching (Klagenfurt 1986, Altmuester: Interdisciplinary Aspects in Physics Education 1989), Editor Proceedings Girep 1990 Conference in Torum (PL), Member Scientific Committee of Girep 96 in Ljubljana. (GIREP = Groupe International de Rechercheurs d' Enseignement de Physique). He is chairman of the Teachers Branch of the Austrian Physical Society, Chairman of Association for the Advancement of Physics and Chemistry Teaching (Austria), member of American Association of Physics Teachers. His European connection include among others the co-operation within STOMP project of the University of Surrey together with other European institutions as Universite de Paris (Jussieu, Prod. Rebmann), Universite de Lille (Prof. Vindevoghel), University of Padua (Prof. Borghi).

☑ University of Frankfurt /Institut for Didactic of Physics

The Institut for Didactic of Physics is part of the Physics Department of the Johann Wolfgang Geothe University, Frankfurt am Main. About 25.000 students study in Frankfurt, about 800 of whom are currently students at the Physics Department. The aim of the Institute of Didactics of Physics is the education of the students who want to become Physics teachers in both Physics and Physics Instruction methodology for all school levels. Special research topics are:

- Didactics of Quantum Physics
- Didactics of fluid dynamics and no-linear dynamics
- The concept of waves and fields
- Girls in Physics education

Joint lectures are provided together with the Department of Biology in order to promote school projects, which integrate many subjects besides Physic. Moreover joint lectures are provided together with the section of history of natural science and the Department of Philosophy. Special interest is directed to astronomy in Physics education. Elementary Astronomy without technical instruments is as important in this topic as cosmology. The co-operation with the European Association for Astronomy Education (EAAE) provides many contacts to other European Universities and science institutions. As a consequence of these contacts a new research topic arises in "Learning in the International Context" where the Internet stands in the center as the new communication tool. Besides the goal of learning across the borders of European states there is a special focus on learning on integrated projects across the borders of school subjects where all natural science subjects should be integrated as well as more subjects such as history, geography, social science and many others.

3.3 Implementation of the project

The objective of e-Hermes project, apart from the promotion of environmental concern and transnational co-operation in secondary education, is to introduce scientific methodology into the classroom through the use of ODL techniques.

Contemporary science teaching methods treat students as if they were young researchers. Thus a science subject should simulate the activities and the character of a research laboratory in the classroom. The need for the wide application of this research laboratory simulation imposes the application on a scientific subject that lies beyond the narrow scientific limits and constitutes a contextual subject. A subject that overcomes the limited area of a school subject and is able to embrace all subjects and interests. Environmental study was chosen, fitting to the description above, because it can be implemented to many different cognitive subjects.

Environmental study, like every other contemporary scientific research topic, can at the same time go beyond both any narrow school limits and state limits. The transnational character of scientific research has not been applicable to science teaching until today. So even if international – transnational co-operation has affected the way we think about science, it has not affected the way we teach science. Concluding we may consider embedding scientific research methodology in the educational practice presupposing:

- Selection of a contextual scientific subject
- Adoption of transnational character

The stages of a scientific research can be summarized as follows:

1) Statement of the problem.
2) Statement of the purpose.
3) Statement of the need.
4) Statement of hypothesis.
5) Data acquisition – procedure.
6) Statement of assumptions.
7) Statement of limitations.
8) Graphical Representation.
9) Definitions.
10) Conclusions.

11) Proposals for future steps.

Nevertheless, since the environmental research that should be conducted by students is usually a long-term research, while the duration of the project is strictly determined, the above sequence was changed to the following scheme:

1) Data acquisition

2) Data analysis

3) Conduction of research.

This creates a further responsibility to the scientific group, as the quantities the students will consider studying have to be determined in advance, as well as the methods to measure, register and represent them.

3.3.1 Data acquisition

The physical quantities, which the students had to measure during the project's run were:

1) Maximum, minimum value of the daily temperature

2) Relative humidity

3) Atmospheric pressure

4) Height of rainfall

5) pH value of the rain-water

6) Electrical consumption in the school

7) Oil consumption in the school

8) Gas consumption in the school

9) Teleheating

10) Noise

11) UV (ultraviolet) radiation

12) Electromagnetic radiation emitted from different devices (e.g. TV, PC)

Physical quantities 1-9 and 11 were measured on a daily basis, because even their daily variations may be important for the study. Quantities 10 and 12 were measured only once, because no variations of their values were expected during the project's run. The choice of the physical quantities that the students measured was

made with the following criteria:

1. the physical quantities should be related to environmental studies and they should cover a great range of factors that affect the environment,

2. measurements should be made with instruments that the students themselves could set up and calibrate. In addition the physical laws that rule the operation of the measuring instruments should be known to the students in order not to confront them as “black boxes”,

3. The purchase cost of the instruments should not be prohibitive to schools.

The instruments needed for measuring these quantities are presented in the table 3.1.

3.3.1.1 Frequency of the measurements

As mentioned, some physical quantities had to be measured on a daily basis as they show daily variations. On the other hand other measurements are taken only once, since no variation of the measured quantity was expected through the run of the project. These two different measurement frequencies determine two different ways of activating students through the data acquisition. In this paragraph the data acquisition procedure is described in detail for each set of measurements.

Table 3.1: *Instruments used and the measurement frequency of the physical quantities*

Quantity	**Instrument**	**Measurement frequency**
Temperature (max, min)	*Elec. thermometer (max, min)*	*Daily*
Relative humidity	*Hydrometer (∅ 95)*	*Daily*
Atmospheric pressure	*Barometer (∅ 95)*	*Daily*
Height of rainfall	*Home-made device*	*Daily*
pH	*pH meter (Hanna Checker)*	*Daily*
Electrical consumption	-	*Daily*
Oil consumption	-	*Daily*
Gas consumption	-	*Daily*
Teleheating	-	*Daily*
Noise	*dB meter 2730*	*Once*
UV radiation	*Solar blind detector S/N4873*	*Daily*
E/M radiation	*E- and H-field meters*	*Once*

1. <u>Daily data acquisition</u>

Quantities were divided in the following groups:

1. *Maximum / minimum temperature*

Average temperature (calculated)
Humidity
Pressure

The measuring devices for the above mentioned quantities were set inside a meteorological case which was placed in the schoolyard of each of the participating schools.

2. *UV radiation*

The UV counter was placed in a different position in order to be continuously exposed to direct sunlight. Students of this group had to be able to understand the quantities that were measured, as well as their units.

3. *Height of rainfall - pH measurement*

This measurement was taken only in rainy days. Students had to understand the physical meaning of the measured quantity taking into account all the conditions their measurement has to fulfill in order to get a reliable result, so as to take pH measurements of the collected quantity of the rain-water.

4. *Measurement of electrical power consumption.*

5. *Measurement of oil consumption*

The oil level in the school's fuel tank was measured.

6. *Measurement of gas consumption – teleheating.*

In all cases students had been registering their measurements in the logbook of the group and then entered them in the e-tool. These work groups functioned during both the phases of the project, that is the probe run and the final run. The composition of the groups remained stable throughout the project. After the implementation, the following remarks had been made:

Remarks - Discussion

There were some difficulties met in the formation of the working groups.

☛ Students had to be strongly motivated to work during the school breaks in the data taking procedure every day. The teacher responsible for the measurements played a decisive role in this point, as he/she had to inspire students, to make them understand how important their role was for the project. So the teacher had to:

1. explain to the students the idea of the project in detail.

2. explain to the students the importance of their role in it, as they are a part of a whole mechanism of data taking where their contribution is crucial.

3. make the students understand the significance of the quantities they had to measure and think of how many important subjects they would be able to approach, if they had these measurements available from many different areas. Of course they first had to understand the meaning of the quantities measured, the units and instruments used.

☛ It has to be admitted that forming these groups of responsible "young" scientists was a difficult task and this was a reason for not changing their composition throughout the two years.

☛ Some groups of course encountered special problems. For instance the UV radiation measurement group, as well as the rainfall height measurement group, were escorted by the teacher responsible for the measurements for safety reasons, because of the location of the measuring instruments (terrace). A similar problem was encountered in measuring oil consumption (by measuring the oil level in the fuel tank).

2. Measurements taken once

Measurements taken once were organized in the form of group essays written by one or more students. These studies are published in the Student Environmental project of E.S.E.M.

Due to its nature, this co-operative study could be embedded in the curriculum of a science or technology class, providing a great motivation. In this case, composing the groups is easier due to the motivation and the fact that the procedure was annual. These group essays call for greater participation on behalf of a teacher responsible for them, more than mere supervision of the measurement procedure. Thus, the teacher had to:

a) provide the scientific background for the quantity that the students were going to measure (for instance noise, electric field, magnetic field), namely its definition, the units used for its measurement, its effect on human life.

b) explain about the instruments that would be used and how they operate.

c) discuss with the students how to perform the measurement. For instance, they had to discuss exactly where and when to measure noise, as well as why to do so. In which places and via which apparatus should electrical and magnetic field is measured.

d) discuss the variants that may possibly affect their measurements. For instance, measurements in the co-operative study on sound were taken in places representing the average conditions met in a wider area. To measure the noise in a teaching classroom during a subject, one has to choose neither the most "quiet" nor the most "noisy" class, but more preferably a class and a subject that correspond to the average noise made in school classroom during a subject. In most cases more than one measurement was taken and the average was used as a reference value. Similarly, while measuring the electric and magnetic field standard distance

(reference distance) between the measuring instrument and the apparatus should be agreed a, so as to make all measurements, as well the measurements taken by groups from different countries, comparable. Meanwhile the conditions under which the measurements were taken had also to be reported in detail. So to measure electric field in the are where a computer monitor was, one should choose neither a monitor of the last decade nor a LCD monitor. We should choose a type of monitor widely used.

e) discuss possible ways so that the measured quantity would be fully understood. For instance, in the case of measuring the noise, representative sounds were recorded.

f) supervise the keeping of a logbook with measurements and remarks. These logbooks were published in the E.S.E.M.

g) provide the needed bibliography for the students.

Remarks - Discussion

After elaborating these group essays during the probe and the final run, the following remarks have to be made about the implementation of the project:

- The role of the teacher who is responsible for the group essays is a very demanding one and it is different from the role of the teacher who is responsible for the measurements.

- The procedure of formulating these work groups is easier but presupposes more work from both student and teacher, so it would it better to have an effect on the student's grade.

- Problems are of course also encountered in presuppositions a, c, d and e while composing a group essay, which delay its composition. Choosing an average class, or an average subject, or an average apparatus, is not always an easy task.

- The fact that the observer affects the system (quantum mechanics principles) is a special problem in measuring sound, since the presence of the student measuring the noise in a classroom will increase the level of the noise.

- Special pressure has to be exerted on students to keep a logbook. This obligation seems very dull; nevertheless it is imposed by pedagogical needs, since it is an important scientific procedure even for "actual researchers". Discussion about the importance of the logbook, may help the teacher persuade the students to keep one.

3.3.1.2 Measuring instruments

The first factor characterizing the quantity measured throughout the project, that is measurement frequency, was explained in the previous paragraph. We saw it has an important influence on the structure and the run of the project, defining student workgroups participating in data collecting during the implementation phase of the project. In this paragraph we will focus on an equally important factor – the use of measuring instruments.

Since measurements are to be taken by the students, with little or no help from the teacher responsible for the measurements, two presuppositions must be met:

1. Instruments must be easy to use by the students.

2. Students must fully understand what they measure and how they are measuring it

The first presupposition had been taken into consideration in the first e-Hermes project stage, while scientific teams of the participating institutions made the selection of the instruments. The second presupposition is also of high importance. The main idea was to prevent students from treating the instruments they were using as black boxes, from which they just could read the measurements. Such an approach could be proven pedagogically harmful. Younger students are able to understand the concepts of temperature, thermometer and Celsius degrees, nevertheless only older students should perform the measurements of rainfall height and rain acidity (pH), and even older ones the measurements of E/M field and of UV radiation. A more analytical description of the instruments used is presented below:

✎ Temperature measurement - thermometer – (°C)

Temperature is easily recognized as a natural quantity by high school students. Even from a very early age in their everyday life students learn about thermometers and how to “read” temperature through them, as well as the meaning of the Celsius scale.

✎ Atmospheric pressure measurement - barometer – (mmHg)

Atmospheric pressure is a quantity that high school students learn in their everyday life (weather forecast), and in various school subjects (Geography, Physics). The barometer is also an easy to use instrument, often found in houses. Furthermore, the pressure unit is explained in second grade physics, so students may understand it thoroughly.

✎ Relative humidity measurement - hygrometer - (%)

Humidity is a quantity with the same pedagogical characteristics as temperature. It is easily recognized, as students are able to feel it. The instrument is also easy to use, while its units (really not existing) - % percentage – are easily explained to students.

✎ Electrical consumption measurement / teleheating - counter – (kWh)

Students know a lot about the electrical consumption and the Energy Company counters through their everyday life.

✎ Gas consumption measurement – gas counter – (m^3)

The gas consumption counter is easy to use and to be read by the students. Also the concept of volume (cubic meters) is taught to the students at an early stage.

✎ Oil consumption measurement – level of tank – (m^3)

To measure oil consumption students had to measure the oil level with a spear and then, given the other two dimensions of the tank, they could easily calculate volume of the oil left. Then by a simple subtraction the quantity of the oil consumed can be calculated. It is clearly understood that even the youngest of the students are able to perform the measurements. Nevertheless it would be better for safety reasons to prefer the participation of older students.

✎ Noise measurement - decibel-meter – (dB)

To measure noise level the decibel-meter was used. dB is the sound level unit. The difficulty met in this procedure is due to the fact that sound is not studied thoroughly in high school Physics. Nevertheless it is easily understood as a quantity, as it is known from everyday experience. Although decibel-meter function is not so obvious to students, still there is no alternative. For this purpose it was decided to record at the same time sound specimens from different places of the school and to enter them in the e-tool, so as students to have a clear perception of the concept of noise in these places. At the same time, dB unit may easily be explained through examples. Students undertaking noise measurements were encouraged to measure several everyday noises, so as to become familiar with the quantity.

✎ UV radiation measurement - UV-meter - (Watt/cm^2)

Even though it is met in everyday life, the UV radiation is an even more difficult quantity to be measured. Everybody knows that the sun is providing energy to earth in a rate over some surface. Students know why our skin needs protection from the sun during summer days. By transforming the unit from Watt to Joule for each 24h period, even younger students (second grade) are able to approach the subject. The problem of the measuring instrument and the way it works still remains (in a greater degree), still no alternative was available, while this quantity was necessary for the environmental research made by the students.

✎ Electric / magnetic field measurement

The concepts of the electric and the magnetic field are introduced in the high school curriculum with great delay. So it was decided that only a group consisted of older students should be responsible for the electric and magnetic field measurements. The task is getting even more difficult due to the fact that even if these students are

familiar with the units of these quantities (Volt (V) and Tesla (T) respectively), they still find difficult to understand the operation of the instrument. In an effort to familiarize the students with the electronic devices a kit was brought and constructed component by component by the students on a printed circuit. This was a genuine work during the run of the project.

3.3.2 Data registering

As mentioned before, different groups collect measurements and deliver them to a teacher responsible for them. Still these measurements must be entered into the especially developed e-tool, in order to be available to students in discussing the diagrams in a transnational level. Another students group was formed to materialize this procedure, aiming in playing the role of an interface between the e-tool and students who collect measurements. The students who formed this group had to be able to use the computer.

This group under the surveillance of the teacher responsible for the measurements was gathered once a week to enter in the electronic tool measurements collected during the previous week. One of this group's roles was to undertake the use of the e-tool, as well as the Bulletin Board during the subject. That is they undertake e-tool use into the classroom, as well as sending messages that their fellow students had written and reading answering messages from their virtual classmates.

3.3.3 Conduction of research

An educational project has to provide to every student the possibility to behave according to his own way of understanding the world that derives from his own perception of reality. Each student after having realized a problem will have to solve it on his/her own. Even better the problem will have to be revealed by the student himself/herself. In this way, students learn how to study and not only memorize knowledge, which in anyway in today's society of information are numerous and constantly changeable.

The immediate need for education to turn towards a new way of registering, collecting, filling and use of actual information derives from the above. Basically it should focus on the way that research is conducted.

The e-Hermes project is believed to have answered to this need in the best possible way, since it succeeded in introducing students that were participating to it, into the rationale of:

1. Research,

2. Transitional co-operation of environmental issues.

The implementation of e-Hermes project in the classroom took place in the following steps (thematic units):

UNIT 1: Presentation of the project – Presentation of virtual classmates

- *In this unit the teacher explains the research procedure, promoting discussion amongst students as questions are formed. Environmental issues are discussed.*

- *Means that could be used to reduce spreading (geographically or in other sense) of an environmental problem are discussed.*

- *"How do scientific magazines, even newspapers treat an international subject?" The need for "correspondents" – "cooperators"*

.

- *Students are asked to identify the characteristics they would their European partners to have.*

- *Discussion of the communication methodology, the procedure through which these classmates cooperate.*

- *The Internet is presented as a mean of communication (text - picture - sound - real time).*

- *Subjects about virtual classroom are presented.*

- *Presentation of virtual classmates - Materialization of the first communication with the help of the measurement registering group.*

- *The first contributions in the Bulletin Board from the students. The first videoconference.*

- *Preparation for the first publication of the E.S.E.M.*

UNIT 2: Presentation of research methodology

- *The scientific methodology of research is presented, which includes:*

a) *Definition of the problem*

b) *Data collection*

c) *Data analysis*

d) *Conclusions.*

All these steps are materialized from the researcher in parallel, offering possibilities for constant reconsideration and evaluation of the initial statement of the problem.

- *The structure of the final written essay is presented, which is the result of a scientific research methodology and should include:*

a) Research topic

b) Statement of the problem

c) Statement of the purpose of the research

d) Statement of hypothesis

e) Statement of assumptions

f) Statement of limitations and determination of the important parameters that could affect the results

g) Detailed description of the followed procedure

h) Conclusions

i) Proposals for future research on the same or on relative topics

j) Presentation of the bibliography in which the followed procedure was based.

- *The usefulness of every paragraph in the structure of the written essay is discussed.*

UNIT 3: Choice of possible research subjects in the classroom

- *A discussion is held amongst students and their proposals for probable research subjects are taken into consideration.*

- *The ability to conduct the research topic is analyzed, based on:*

- *Data availability*

- *Equipment needed*

- *Material demands*

- *Time and financial limitations.*

- *Choice by every group of students of the subject which is going to be studied.*

- *Discussion on the contextually of the subject, as well as its relationship with other school subjects.*

- *Contact with teachers of other subjects.*

UNIT 4: Definition of the research title in the Virtual classroom

- *Through discussion Bulletin Boards and videoconferences, the research topic is selected by the virtual classroom, from those that have already been discussed in class.*

- *Virtual class discusses the point to which the topic utilizes information sources. The topic is enriched by trying to increase this utilization point of the information sources.*

- *Formation of the exact research title in the virtual classroom. This title should have the following characteristics:*

- To be short and precise. There is a limit in the number of words (15 words maximum)

- To include all the points that the research will cover and all the variables that it will be studied (i.e. temperature, atmospheric pressure, etc.)

- To present the research limits, i.e. what was studied and what was not.

- *Presentation of the title in the Bulletin Board as "the question of the month" in order to be discussed by virtual classmates.*

UNIT 5: Presentation of data in the Classroom – Use of the e-tool

- *The measurements relevant to the topic, as well as the relevant issues with the diagrams are presented through e-tool from the team of the children that are dealing with the project.*

- *Classroom discussion on the diagrams and possible request for more diagrams.*

- *The observations are noted, by the team in charge, and are entered in the Bulletin Board under "the question of the month".*

- *Arrangement of videoconference date through the Bulletin Board.*

UNIT 6: Discussion of information in the virtual classroom

- *All the information discussed in the virtual classroom, either through Bulletin Board or videoconference.*
- *Suggestions for improvement.*
- *Remarks relevant to the research methodology are presented.*
- *Comparative questions are being developed, providing useful and important information.*

Example: *It is important for the research that the students have exact information of the location of each school participating in the data taking as the results are different if the school is located in the suburbs, near a forest, in an industrial area, near an airport, etc. These data, which can not be counted and measured from the beginning of the research, are very important and they have to be taken in consideration in the formation of the conclusions of the research. The answers were also unexpected, since these questions had not been formatted from the beginning, but were created through discussion in the virtual classroom in this teaching unit. The answers and all information were registered in the Bulletin Board under the question of the month.*

UNIT 7: Organization of research in the classroom

- *Discussion of the aim of the research, i.e. the reasons for which the researcher has conducted the research. Simultaneously, the aims, which the research aims to satisfy through problem solving procedure, are analyzed.*
- *Discussion of the social needs that the research serves. The usefulness of the research that is realized in the social environment is analyzed.*
- *Students are called to discuss the reasons for which the particular investigation improves the existing situation in the section that it refers.*
- *The need for extensive bibliography research is noted. Discussion on what students expect that their research will add to what they already know.*
- *Formation of the research hypothesis, i.e. the main axis of the whole research procedure. The hypothesis refers to the variable to be studied as well as to the relation between the parameters to be studied.*
- *Appearance in the e-tool of diagrams from the data that verify or reject the hypothesis. Discussion of the results. Statistical analysis.*

- *The parameters that were considered as affecting the research results are analyzed. All these parameters will have to be described precisely, since they can seriously affect the depth and the validity of the research.*

- *Restraints of the research are analyzed. These restraints may consist in some of the coefficients:*

1. The number of the diagrams that were used for the verification/rejection of the hypothesis.

2. The duration of the measurements, since if the measurements last for a long period then the validity of the research results is increased.

3. The way of analyzing experimental measurements.

4. These coefficients define the point to which the particular research can be generalized to other cases.

UNIT 8: Organization of research in the Virtual classroom

- *Introduction of unit 7 conclusions in the Bulletin Board under the following structure:*

- Description of the research procedure. Step by step description of the procedure followed by the research team and, if possible, make use of flow charts. In his way virtual classmates learn about the way the research was organized, so that they may repeat the procedure and then evaluate the validity of the research.

- Presentation of the research purpose.

- Presentation of the social needs the research fulfills.

- Presentation of research hypothesis.

- Analysis of the parameters assumed not to have any influence on the research results.

- Description of the limitations of the research results.

- *Scheduling of an on-line discussion in the virtual classroom about the organization of the research and its results.*

UNIT 9: Draw of conclusions

- *On line discussion in virtual classroom through videoconference about the presentation of results.*

- *Drawing of conclusions.*

- *Generalization of the conclusions of their research. For this purpose, students precisely describe the results in which the research concluded paying attention to the following:*

- *Not to use technical terms, so, as non-experts can easily understand them.*

- *To be relevant to the primary hypothesis of the research, in order for the reader to easily understand in which parts the hypothesis was verified, in which it was rejected and in which it remains under discussion.*

- *To clearly state the points, that were not possible to be studied during the present research and why.*

- *Presentation of the results in the Bulletin Board under the question of the month.*

UNIT 10: Formation of suggestions for future research

- *On line discussion in virtual classroom through chatting or videoconference on the general conclusions in order to form suggestions for the solving/improvement of the current situation/possible immediate or future environmental problem.*

- *Formation of suggestions for future research. Based on the research results, the researcher will propose areas, that he believes have to be further researched in the future. These suggestions have to be summarized in the research results and are closely related to the topic that was studied. Simultaneously, they will have to express the need that the researcher felt, as conducting the research, to finish it, but he couldn't, either due to time limitation or due to practical reasons (lack of measurements).*

- *Presentation of the suggestions on the Bulletin Board under the question of the month.*

UNIT 11: Announcement of the results – Publication

- *Writing of the essay by the students, under the guidance of the teacher responsible, following the structure:*

1. *Title.*

2. *Statement of the Problem.*
3. *Statement of the Purpose of the research*
4. *Statement of Hypothesis of the research*
5. *Detailed description of methodology and procedure followed*
6. *Statement of limitations of the research*
7. *Presentation of the results*
8. *Proposals for future research*
9. *Presentation of the bibliography used during the research.*
- *Publication of the research in the E.S.E.M. in conventional and electronic form.*

With the completion of this research, units 4-11 are repeated, under a different topic, until all the subjects, that were posed by the students and had been selected to be discussed, are covered. At this point the implementation of the e-Hermes project in the classroom ends. In the following paragraph a detailed description of E.S.E.M. is presented, including very useful examples of good practice during the implementation of the research methodology in the classroom.

E.S.E.M. (European Students Environmental Magazine) was a bimonthly, student edition. Seven issues were published during the two phases of the project's run (probe run and final run). The magazine was aiming in acting as a means of acquaintance for the students of a bilateral virtual classroom and then to be used as the means of expressing and registering of the results, conclusions and notifications relevant to environmental data. E.S.E.M was also operating as a means of exchanging students' views and beliefs on everyday topics.

The magazine was presented in two forms, firstly as a conventional edition (Hardcopy) and secondly in an electronic form in the e-Hermes Web site, in the following address: http://www.ellinogermaniki.gr/e-Hermes/ehesem.htm.

The advantage of the conventional edition was that it is easier to use, as it seems to be easier for the students to use. On the other hand the high quality, full colored Web pages of the electronic edition were used in order to attract students. Students' interest was also captured by the possibilities that the network offers.

The following steps were followed till the edition of each issue of the E.S.E.M.:

1. Students formed groups. Each group presented the methodology followed, the measurements, the results and finally the conclusions that were drawn. Students presented their work in electronic form (with the use of Microsoft Word). The teacher would then read, correct and if necessary add comments and remarks.

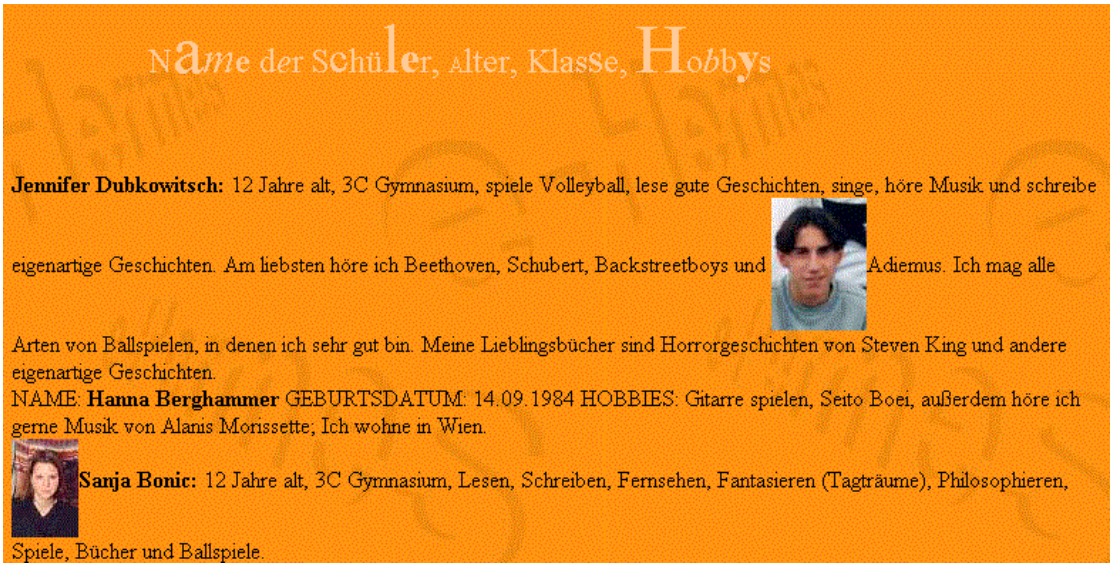
2. The teacher would read all the students' texts and would plan the structure of the magazine to be published.

3. Preparation of the hardcopy edition. The secretarial support was very important to this point as the use of advanced software is needed, e.g. Corel Draw, Power Point, in order the final result to be of the best possible quality. The final form of the magazine was the responsibility of an editor with experience in the field of educational publications (EPINOIA G.P.). Each issue was printed and sent to all the schools that participated in the final run of the project (13 schools all over Europe) as well as to the participating departments of Universities for further evaluation.

4. Preparation of the electronic edition. The electronic issues of E.S.E.M were realized by the students themselves in order to get familiar with the Internet tools. The secretarial support was also necessary to this task as advanced drawing software packages had to be used.

E.S.E.M. content – Examples: A series of examples, followed by selected pictures from the seven issues of E.S.E.M. are presented in the following:

1. *In the first issue information about the three participating schools and their students were presented. As the project proceeds, reports describing the new schools are presented in the next issues in the following way:*



more...*VIRTUAL* **Classmates,** more...**friends**!

Sezgi Uygur

My name is Sezgi Uygur and I attend the 9th grade in Sankt Georgs College. I was born in Isparta, a city near Antalya. I've got a sister,who is 14 years old. My parents work as designer. I play the saxophone and attend a music school for 2 years. My favorite musician is Paul Desmond. Besides that, I enjoy listening to jazz music and folkloric dances. And I like to play volleyball and table tennis, swimming.

Gulru Ozakman

My name is Gulru Ozakman. I was born in Eskisehir and I'm now 16 years old. I live in Istanbul and attend the 9th grade in St. George's College. I like skiing and swimming. My mother is barrister and my father is professor at the university. I want to participate in this project, because I want to have new friends.

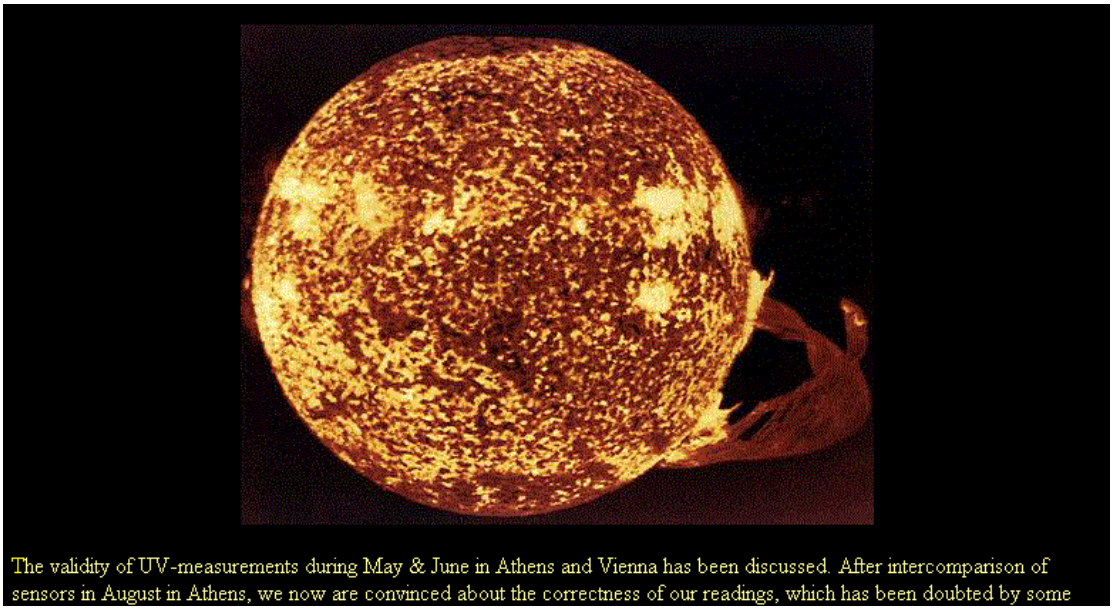
2. *In the second issue, texts and pictures were published describing sizes measured during the project, the data taking procedure (e.g. decription of the devices used, their calibration), the location where the measurements had been taken.*

clear results and exact measuring data.
The instruments were calibrated by Prof. Binder. He adjusted the hygrometer by putting a wet towel around the instrument. After this procedure, this instrument should show 100% humidity, but this wasn`t the case. Because of this false result he had to recalibrate the instrument. Finally, we are now able to provide you with satisfying results.
We have developed a certain system for registering the measured data. In the early morning and at noon the class monitors check the station. There are always two class monitors active to ensure that the data are acquired correctly every day. That`s a good way to make sure you don`t fall ill.
We are very delighted to have the opportunity to take part in this project. It isn`t a really hard job, but it`s a pleasure for us to work together with schools from other countries.
As far as the next year is concerned, we would be really happy if we could join this project again. We think, that it is a very good idea to let pupils from

New measuring equipment...

Many new and very interesting measuring equipment have been acquired for the e-Hermes project. First of all the UV sun radiation instrument. It is a relatively very expensive device manufactured in the USA. It is capable of measuring energy of the sun UV radiation relative to surface (in Joules/cm2). It can also integrate over a period of time (in Watts/cm2). The measuring procedure chosen was the first one. That means that the instrument has to stay outside in the open subjected to all kinds of dangers to the instruments' smooth operation: sun, dust, wind, bugs etc. For that reason protection measures had to be taken. So two boxes were made to minimise the outdoor hazards.
The first one…

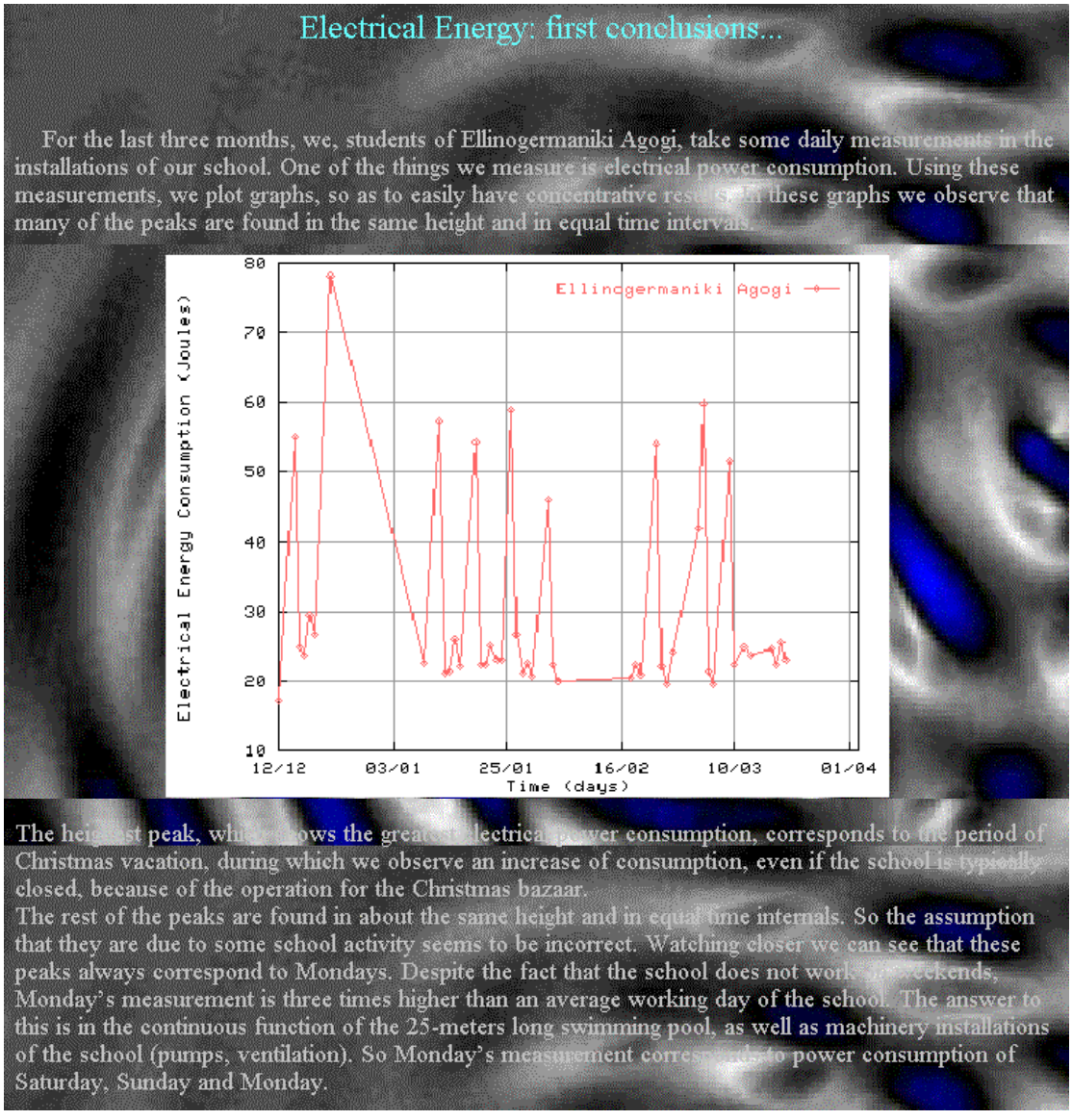
3. *Teachers' articles presenting related topics and the principals of the research methodology were published in order to introduce students to the new approach.*

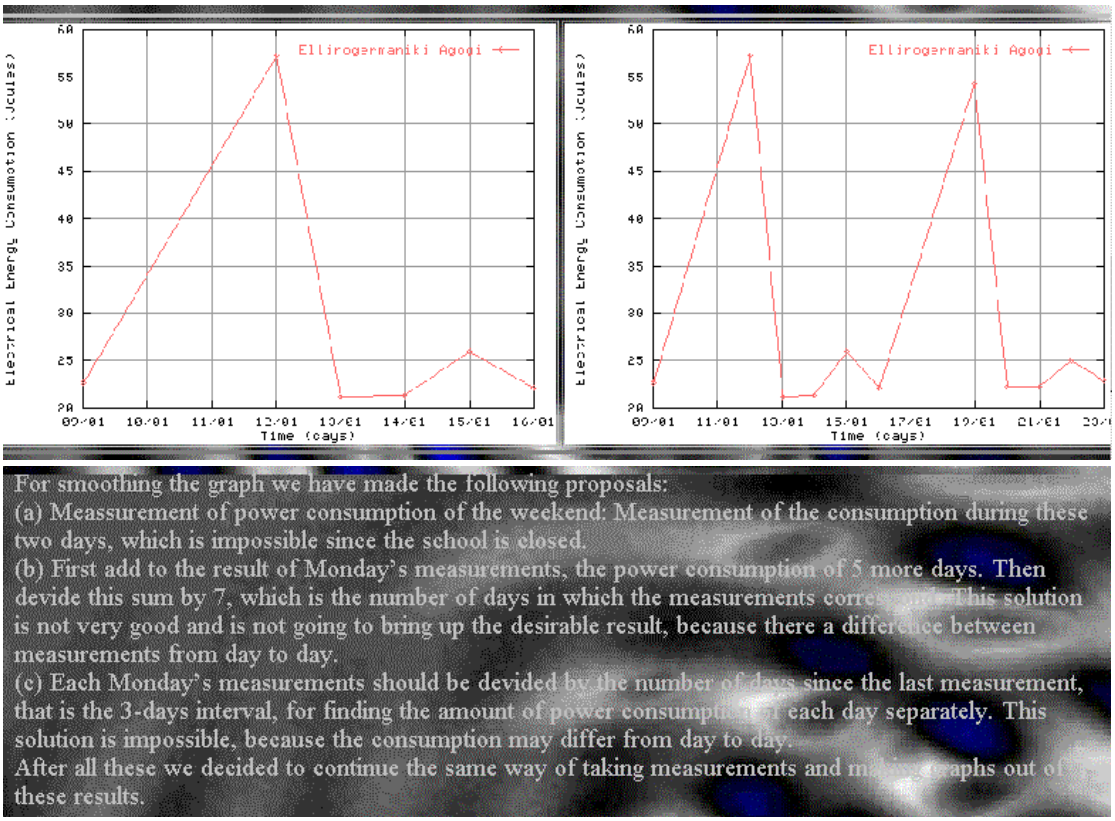


The validity of UV-measurements during May & June in Athens and Vienna has been discussed. After intercomparison of sensors in August in Athens, we now are convinced about the correctness of our readings, which has been doubted by some

co-workers. In fact, at a first glance, the results are somewhat puzzling:
1. During the measurement period, the readings in Schwechat where almost always higher than those in Athens.
2. The readings in Schwechat also showed a very irregular behaviour with distinct maxim and minima compared to Athens with a relatively stable increase during the measurement period. This gave rise to the assumption, the Schwechat sensor would be measuring garbage instead of UV.
In fact, our feeling "the hotter, the more UV" is simply wrong, - anyone who ever got sunburnt during skiing would agree upon this.
The simple explanation for points 1&2 lies in the different atmospheric conditions between Vienna and Athens: The keyword is "Turgidity" of the atmosphere, meaning the degree of clearance of the air, as governed by various factors like: Clouds, Humidity, Aerosols (Dust, atmospheric pollution with various gases like NOx, SO2... which all absorb UV-B to a great extent), water vapour and temperature layering of the lower atmosphere.
During spring time in Vienna, a typical day might exhibit a total cloud overcast with rain, resulting in low UV-B-intensities. These days often are followed by sunny days without clouds and very clear atmosphere, which has been washed out of aerosols by the previous rain. On these days the air turgidity is very low, giving us views of well above 50 km horizontally. It would not be unusual for such a day to show higher intensities of UV-B than during a summer noon. (As higher ground temperature during July and August causes upwelling of dust from the ground to the lower atmosphere, resulting in higher turgidity, less air clearance and thus stronger absorption of UV-B).
On the other hand, the weather conditions in Athens seemed to be more stable, with less periods of full overcast and rain. Therefore the stability in UV - readings (point 2). Plus high turgidity of the atmosphere in and around Athens, caused by dust upwelling and air-pollution - accounting for the general lower readings (point 1). The often cited "northern hemispherical ozone hole" cannot be made responsible for these effects.
From the teacher's point of view, these measurements are ideally suited to demonstrate the differences between subjective,

4. *As the probe run started with the submission of measurements in the e - tool, the first discussions amongst students on graphical representations of the measured quantities were performed, as well as a short report of their activities were presented.*





5. *The introduction of videoconference as a communication tool was noted to the E.S.E.M.*

Video Conference

On Thursday, the 22. October, we did a video-conference with Athens. There was also a woman from an university. She interviewed me (Sanja) and Marion, a girl from the other half of our class (there are a French and a Maths group in our class). The woman asked many things about the project, what we think of it, ...
There were many pupils, teachers and parents at the conference. I think the parents liked it because they could see what we do and learn for the project. We liked the conference too, it was very interesting. The pictures at the conference weren't very good, but that doesn't really matter. We asked the Athens' many questions about Greece, the weather and such things. We hope that the project will go on like this.

Videokonferenz am 2. 12. 1998

Bg S: Good morning! Can you hear us?
A: There is a problem with our speaker.
Bg S: We can see you, but we don´t hear you.
Neustart
Bg S: Hello! Good morning! (No wos is - Matthias ´s Kommentar)
Hello! Good morning Athens. Can you hear us?
Hello, Athens! Can you hear us.
We can see you very good, but we cannot hear anything. Now we hear something.
Please repeat!

Bitte langsam sprechen.
A: Habt ihr uns gesehen?
Bg S : Ja, wir haben euch gesehen. We think the reason is the weather.
A: Hat es geregnet?
Bg S: Nein, es hat nicht geregnet. Es hat geschneit. Habt ihr uns verstanden? Wir hören euch sehr gut, ihr mósst nur langsam sprechen. Hört ihr uns?
A: Wir wiederholen die frage: Hat es geregnet?

Bg S : Nein, hat es nicht. Im Moment schneit es. Habt ihr uns verstanden?
A: Wir hören euch nicht.
Bg S : Warum nicht?
A : Könnt ihr eure Antwort schreiben, wir können euch nicht hören?

6. E.S.E.M. was a nice opportunity for the students to get to know to each other by presenting local customs, habits as well as ways of entertainment, hobbies etc.

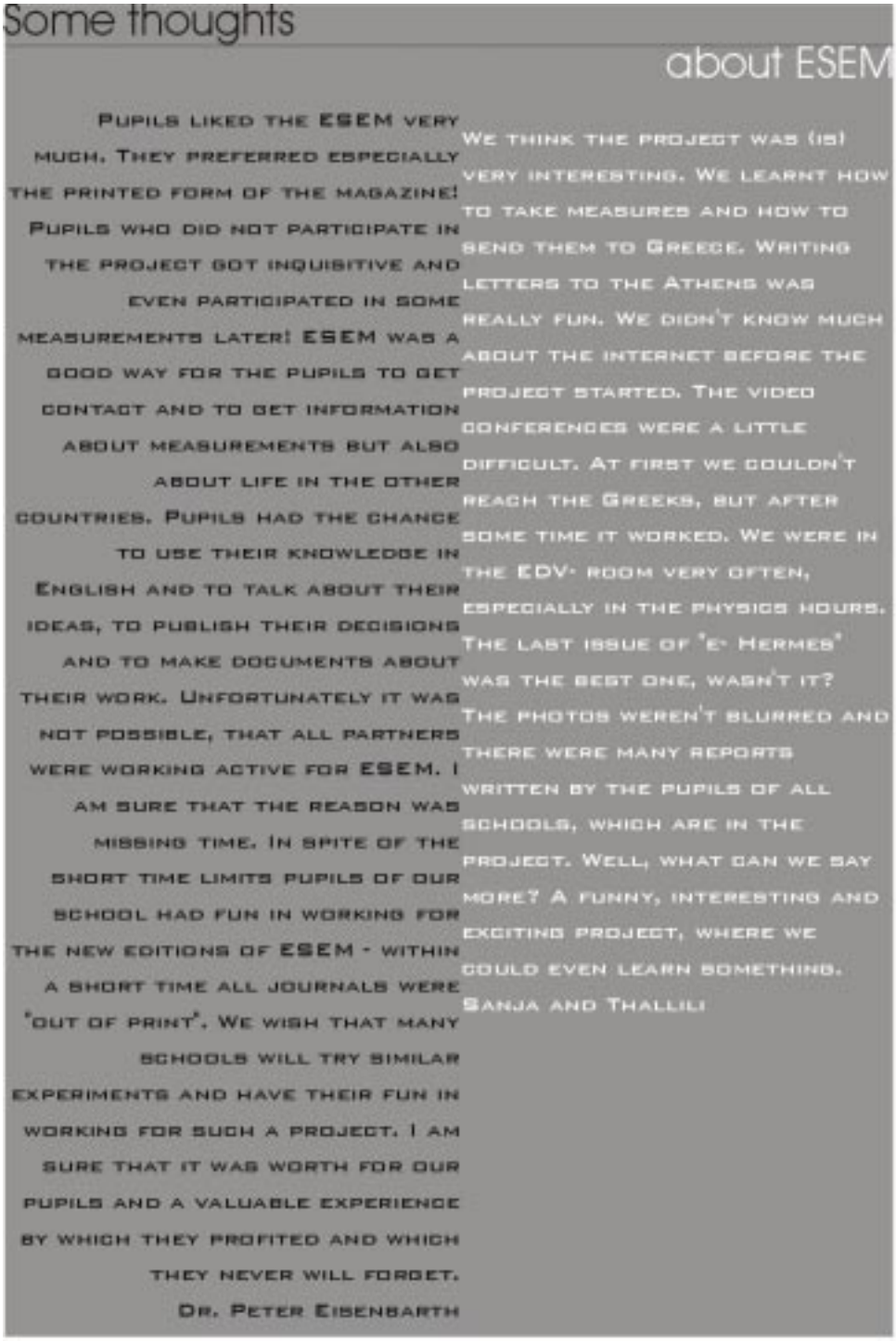
Christmas in Austria

The people in Austria call the 31st of December Silvester. The families celebrate with friends until the morning. The people meet in the late afternoon or in the evening. About 8 o'clock p.m. they have dinner and then they wait until midnight. Then they light fireworks. People tell each other "Prosit

plastic soft toy pigs. After that they often eat "Sauschödel" (a bit of a pig's heat). The people usually drink a lot (beer, wine or champagne) it's very funny every year. Next year, when we all celebrate the year 2000 we are sure that in every town and every city there will be a lot of parties. In the accidents, but such things don't happen too often... The big clock of the "Stephansdom" which call "Die Bumerin" let us every year hear when the year change. There stand lot of people in front of the "Stephansdom" and when she ring, all make a big party and they are very happy.
Dani Fazekas, Julia Kucharowits, Berit Krenn
The last four Sundays in December before Christmas Eve, we can see a light on the Candles of an "Adventkranz", which has different colours. On the 6th December comes the "heilige Nikolaus" to the little children and brings them little presents. At the day before the Krampus comes to the silly children.
The little Austrian children write a list of their wishes and send it to the "Christkind". There is a Christmas tree in every family. Some children help their parents to decorate the Christmas tree. But also some parents give their children to the grandparents. The grandparents go with them in the cinema, before they drive home. The parents decorate it with candles, sweets and biscuits. A famous cookie is the "Vanillekipferl". This is an old tradition, which is kept by nearly every family. Only on Christmas-Evening the children may enter the room, where the tree stands. The "Christkind" puts the presents under the X-mas-Tree. Most families eat fish or turkey. On Christmas day many people go to church. 26th December is called Saint Steven's Day.

By Marion, Raffi, Sanja and Thalhi

7. *At last, one of the most interesting parts of the magazine was the internal criticism and evaluation of the project by students and teachers. By these articles teachers and students freely expressed their emotions, their positive or negative thoughts, made suggestions for improvement and evaluated their participation in the project.*



Some thoughts about ESEM

Pupils liked the ESEM very much. They preferred especially the printed form of the magazine! Pupils who did not participate in the project got inquisitive and even participated in some measurements later! ESEM was a good way for the pupils to get contact and to get information about measurements but also about life in the other countries. Pupils had the chance to use their knowledge in English and to talk about their ideas, to publish their decisions and to make documents about their work. Unfortunately it was not possible, that all partners were working active for ESEM. I am sure that the reason was missing time. In spite of the short time limits pupils of our school had fun in working for the new editions of ESEM - within a short time all journals were 'out of print'. We wish that many schools will try similar experiments and have their fun in working for such a project. I am sure that it was worth for our pupils and a valuable experience by which they profited and which they never will forget.

Dr. Peter Eisenbarth

We think the project was (is) very interesting. We learnt how to take measures and how to send them to Greece. Writing letters to the Athens was really fun. We didn't know much about the internet before the project started. The video conferences were a little difficult. At first we coulon't reach the Greeks, but after some time it worked. We were in the EDV- room very often, especially in the physics hours. The last issue of 'e- Hermes' was the best one, wasn't it? The photos weren't blurred and there were many reports written by the pupils of all schools, which are in the project. Well, what can we say more? A funny, interesting and exciting project, where we could even learn something.

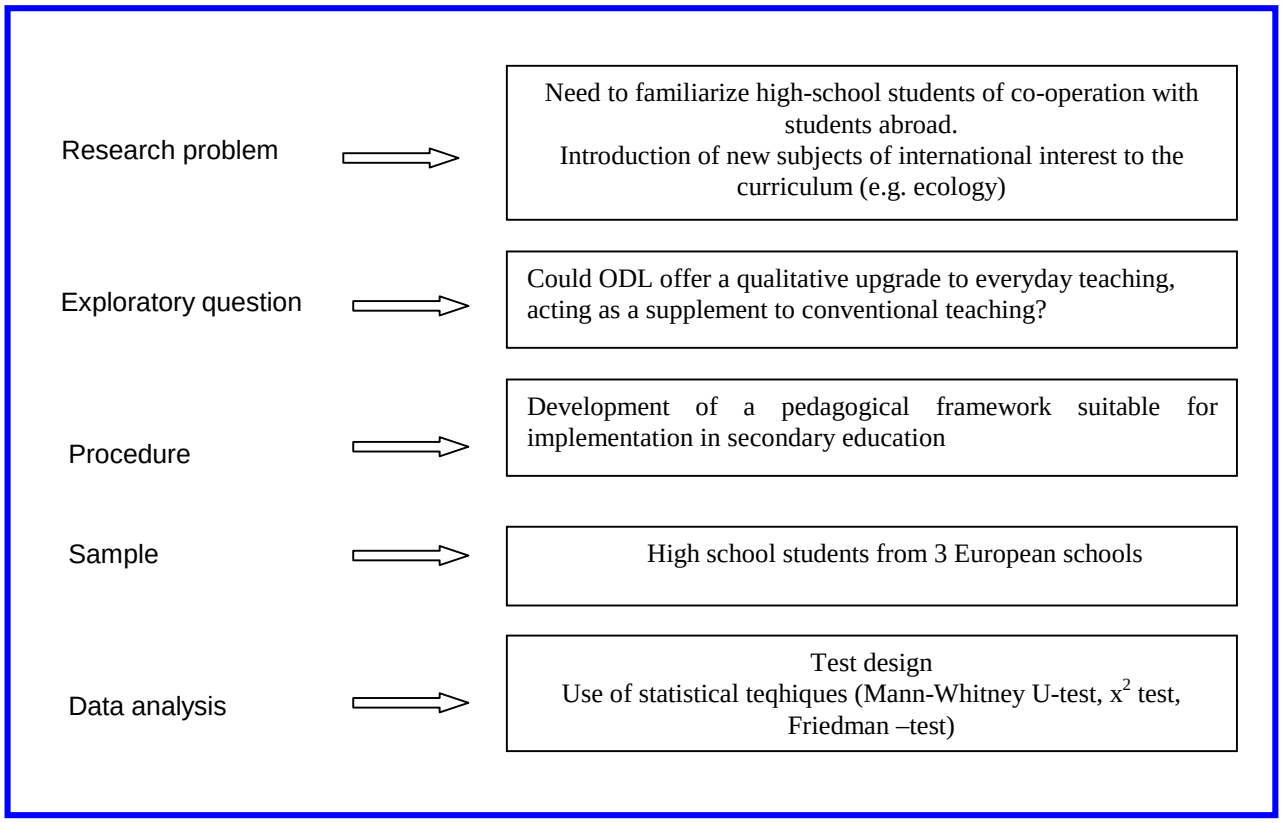
Sanja and Thallili

2

3.4 Evaluation of the e-Hermes project

3.4.1 Introduction

The task of the evaluation the of e-Hermes project was a matter of great importance since only a few ODL projects have been systematically evaluated so far. The research process adapted is presented schematically in the following graph. It includes the problem statement, the exploratory question (hypothesis), the description of procedure followed, the sample, the measurements, the tests and the methodologies used during the data analysis.



The research process in e-Hermes

Quantitative results of the project are obtained by numerical methods. Many statistical tests were carried out in order the development of understanding, knowledge and attitude towards the use of new tools as communication channels, to be observed. Many comparisons between the students' groups from the three countries were also performed.

The main aim of the present analysis is not to investigate and give final answers for all relevant questions about ODL's implementation in secondary education. The main purpose is to present the methodology that one has to follow in order to get really valuable data and set the guidelines for similar future applications

3.4.2 Test design

The evaluation was performed through the use of two questionnaires, one being applied at the beginning of the final run and the other at the end of it. Most of the questions of both questionnaires were identical. A two-group design with repeated measurements had been selected.

3.4.2.1 Questionnaires

The questionnaires used are presented in Appendix III. The questions were related to:

- personal characteristics of the students (1a-e),
- the students' attitude towards environmental issues (2 and 3) as well as to how they spend their free time (4a),
- the computer availability and usage at home (4b, 4c),
- the computer availability and usage at school (4d),
- internet issues and electronic media (4e-4h),
- their success in learning by using of the new media (4i, 4j).

Further questions are related to scientific methodology (5) and learning success (6). Students had to answer 60 questions alltogether.

Question groups 1-4 (36 questions) included scaled predefined answers where the students had to mark their preference. Six questions required to mark "yes" or "no". Questions 5 required free text answers (key words or sentences) and in questions 6 the students had to indicate mistakes or to compare different graph scales.

The questionnaires were written in the English language and translated to the students mother tongue by their teacher. In Germany a university student was filling out the questionnaires together with the pupils whereas in the other countries the pupils filled out the questionnaires themselves with a teacher present, who explained possible remaining problems.

With respect to the specific kind of the questions different standard statistical tests were used for the evaluation. Questions in consideration were analysed with the respective appropriate statistical test.

3.4.2.2 Sample

In each country (Austria, Greece and Germany) two groups of students participated in the evaluation:

- The experimental group, who was participating to the project,
- The control group, who did not participate in the project and served as reference group.

The data from the control group in each country were included in the analysis in order to rule out, effects of normal development and ageing, which would be interpreted as project outcome misleading the conclusions (confounding of variables). Over all 183 students filled out questionnaires, 100 male and 83 female (gender distribution in the three countries is presented in Table 3.4.1). 108 students participated to the experimental group and 75 participated to the control group as it is shown in Table 3.4.2. The age of the students ranged from 12 to 18 years. 171 students were from 13 to 16 years old as it is shown in Fig. 3.4.1.

Table 3.4.1: *Gender distribution in the three countries.*

Crosstable: Gender / Country

		Gender		
		male	female	total
Country	Germany	33	28	61
	Greece	43	36	79
	Austria	24	19	43
Total		100	83	183

Table 3.4.2: *Number of students participating in the experimental and control group per country*

Crosstable: Group/Country

		Group		
		experimental group	control group	Total
Country	Germany	31	30	61
	Greece	60	19	79
	Austria	17	26	43
Total		108	75	183

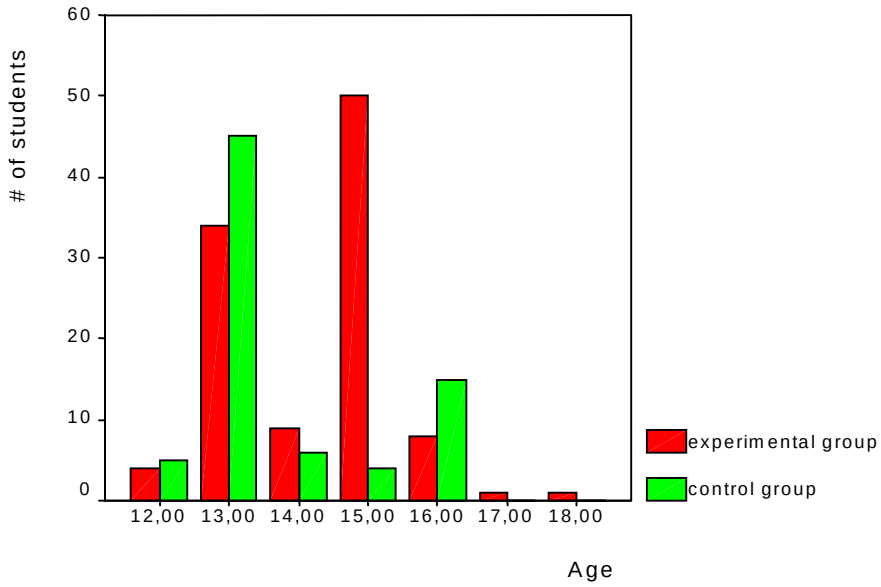


Figure 3.4.1: *Distribution of ages of the students participating to the experimental and control group. Note that the experimental group is on average older than the control group.*

3.4.2.3 Statistical Methods

Univariate analyses based on an ordinal scale were performed with the Mann-Whitney U–test, and for nominal scales the x^2-test was used. Multivariate analyses were performed with the Friedman-test, while a test including residuals of the linear regression is used for the evaluation of the differences between pre- and post-test [Hays, 1973]. A short description of the applied tests is presented below:

Mann-Whitney-U-Test

The U-Test of Mann-Whitney is used to compare the values of one variable in two independent samples with regard to their central tendency, respectively if they stem from the same or different populations. This procedure requires data with - at least - an underlying ordinal scale without specific distribution. The basic idea is to transform the data into their ranks by arranging them from the smallest to the highest value and by giving every single datum the rank that corresponds to its position in the new row. A mathematical comparison of the sums of ranks of each sample completes the test.

x^2 Test

The x^2 test involves grouping the observed data into classes with theoretical (expected) frequencies and comparing the observed frequencies with the theoretical ones [Balakrishnan, 1998]. As only frequencies are needed for such a procedure, data with an underlying nominal scale can be analysed.

Kruskal-Wallis-H-Test

The Kruskal-Wallis-H-Test is used to compare one variable in more than two independent samples of data with at least underlying ordinal scale. No requirement is made about the data's distribution.

Multivariate Friedman-Test

With this method, different variables (answers) of the included subjects are tested to see if the distribution of these variables differs or not. The test is based upon a built rank order of the k variables ranging from 1 to k.

Test including residuals of the linear regression

Linear regression means the determination of the straight line that is assumed to represent best a linear correlation between two or more specific variables. A residual of this linear regression is the distance of one value to this straight line. Calculating the residuals of the linear regression between the pre-test and the post-test, leads to level-independent measurements for existing differences between the two tests. In contrast to simple subtractions (post-test minus pre-test) these values reveal differences that are independent from the initial value. If, for example, a person marks a high score in the pre-test, he will likely mark a lower score in the post-test (statistical regression effect). Especially comparisons between different groups (country, gender, etc.) could then lead to incorrect results.

3.4.2.4 Measurements

Differences between pre-test and post-test were analysed on the basis of regression-transformed differences between pre- and post-test. For the standardised residuals of the linear regression between pre-test and post-test over all subjects comparison between experimental and control group has been performed with Mann-Whitney's U-test. This procedure allows to observe differences between pre- and post-test that are independent from the initial value at the pre-test (see paragraph 3.4.2.3).

The first important condition, on which the present analysis is based on, is the equivalence between the experimental and the control group before the project's implementation. The two samples have to be selected from the same population. For each question (from 1 to 4), there is given a value "*p*" that expresses the probability for the fact that control group and experimental group are coming from the same population. *p* is the probability that the two groups do not differ. The different values of *p* have the following meaning:

If	0.1<p	no significance, the groups do not differ
if	0.05<p<0.1 (*)	statistical tendency
if	0.01<p<0.05 (**)	statistical significance
if	p<0.01 (***)	high statistical significance

Please note that due to the pilot character of this study no Alpha-corrections [Hays, 1973] have been taken into consideration.

For the questions: *2a - 2h, 3b, 3c, 3d, 3e_1 – 3e_4, 4a_1 – 4a_6, 4c_1 – 4c_6, 4d, 4f, 4h_1 – 4h_6, 4i, 4j* a (nonparametric) Mann-Whitney-U-Test was used to find out whether the answers between control and experimental group differ significantly. For the questions: *3a, 4b, 4e, 4g* a (nonparametric) x^2-test was used to compare the answers of the two groups.

3.4.3 Data Analysis

3.4.3.1 Pre-test

- **Experimental Group vs Control Group**

The members of the experimental and the control group had to be selected out of the same population. This parameter is very important as the validity of the conclusions of the present analysis is depended on the equivalence of the two groups before the project's implementation. For comparison of the experimental group with the control group the nonparametric Mann-Whitney-U-test and x^2-test were applied to the answers of the pre-test. The results of these tests are the probabilities *p* that the compared groups are coming from the same population. That means, the greater value of *p*, the greater the probability that the groups do not differ in respect with the considered question.

It is assumed that for $p>0.1$ there is no difference between the groups, with $0.05<p<0.1$ there is a tendency, with $p< 0.05$ there is a probability that the groups differ and with $p<0.01$ it is most likely that the groups have mayor differences.

Statistical analyses showed that in most questions no significant difference in the answers between the experimental groups and the control groups was observed. However, there were some questions where differences between the groups were obtained with high significance. The answers of these questions have to be handled with special care.

Questions with highly significant differences ($p<0.01$) between experimental and control groups are:

4d PC usage at school at any time

4e access to Internet from school

4f usage of Internet in the classroom

4h_1 Internet sites: games (Greek groups only)

4h_5 Internet sites: astronomy (German groups only)

4i Improvement of the school marks with the help of Internet

For detailed listing of *p*-values of all questions and for comments on significant differences between experimental groups and control groups please see Appendix IV.

In the following graphs main effects between the experimental and control group are analysed in order to examine the comparability of the groups and respectively effects due to the selection of the groups. The graphics show the variable values for all countries separately; with respect to the question in consideration multifactorial effects are however not analysed statistically.

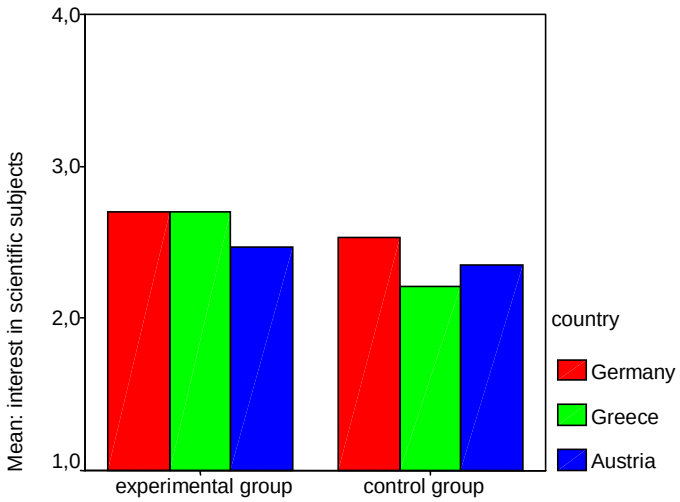


Figure 3.4.2: *Comparison between control and experimental group (Interest in scientific subjects, pre-test, p=0.037)*

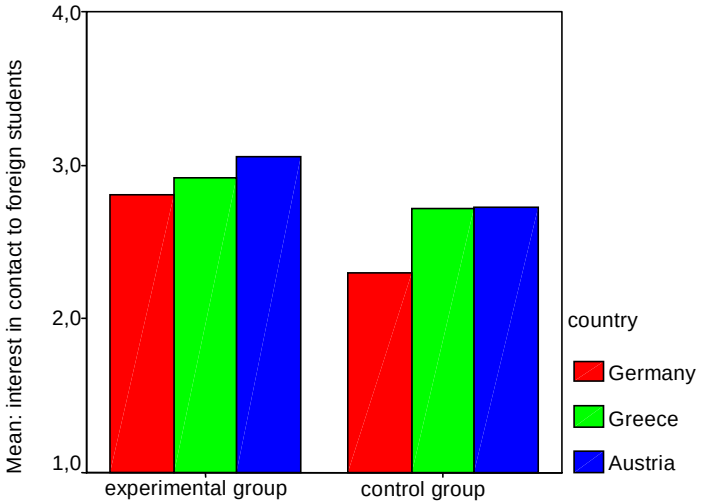


Figure 3.4.3: *Comparison between control and experimental group (Interest in contact to foreign students, pre-test, p=0.013)*

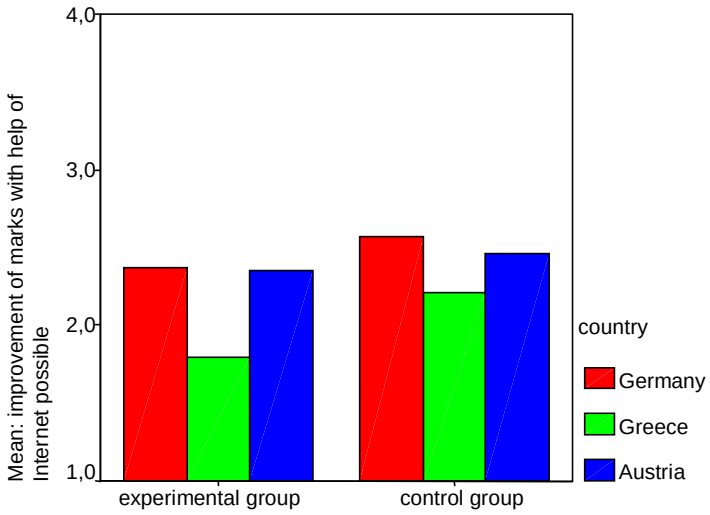


Figure 3.4.4: *Comparison between control and experimental group (Improvement of marks with the help of Internet, pre-test, p=0.005). In this case the two groups are not equivalent. The difference is owed to the different answers the Greek students gave.*

In most cases the two groups were equivalent (see Appendix IV). In figure 3.4.5 a comparison between the experimental and the control group is presented for the question *2f* (Interest in foreign subjects). For each group the sum of all countries is presented.

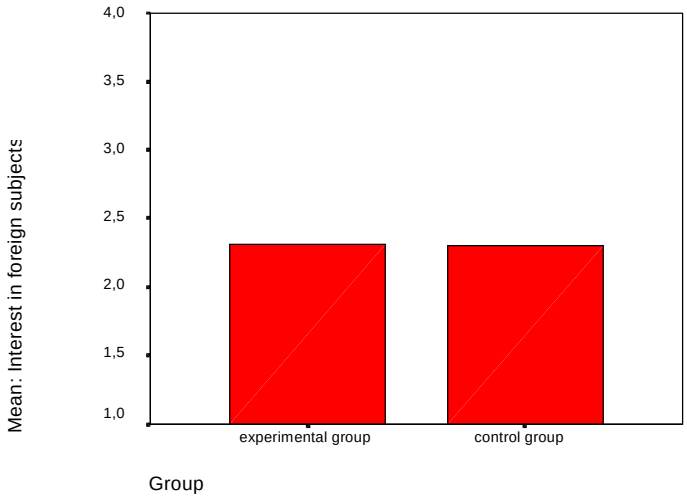


Figure 3.4.5: *Comparison between control and experimental group (Interest in foreign subjects, pre-test, p=0.974). In this case the two groups are equivalent.*

- **Countries**

It is interesting to see how cultural, sociological and geographical differences may influence a project where co-operation of students of distant countries try to learn and communicate over great distances. Therefore it an effort was made to find

out whether some of these characteristics are depicted in the answers of the students. It is interesting one to see where there are differences in the attitude towards environmental issues and in the usage of new technology between students of different countries. For this investigation the answers were sorted with respect of the country and no difference between experimental and control group was taken into consideration. A significance here means that at least one group (country) differs from the others.

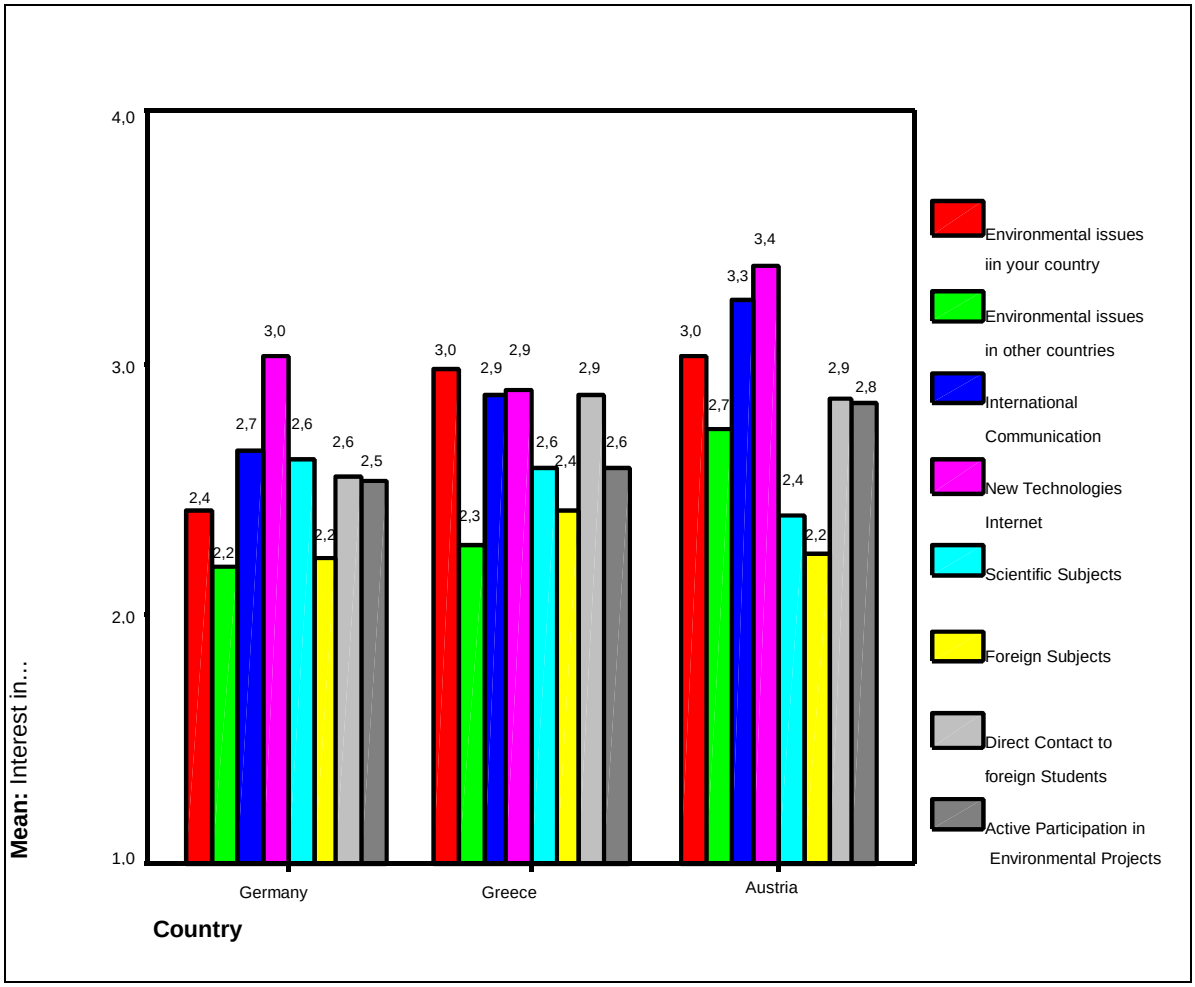


Figure 3.4.6: *Interest in different issues per country.*

Significant differences were found (by Kruskal-Wallis-H-Test) for questions:

2a. environmental issues in your country (p = 0.000)

2b. environmental issues in other countries (p = 0.005)

2c. international communication (p = 0.002)

2d new technologies/Internet (p = 0.021)

Remarks – Discussion

☛ The interest of students in new technologies and international communication

is generally very high, followed by the interest in environmental issues (in their own country only) and contact to foreign students (experimental group only). As expected the interest in environmental issues in other countries is considerably lower than that in their own country. However, there are differences between the participating countries.

☛ In Germany the interest in environmental issues in their own country is significantly smaller than in the other countries, where it is more than average. This is a somehow unexpected result as environmental issues have been thoroughly discussed in Germany. A lot of activities have been undertaken by political institutions and organisations as well as in industries. May be the students think that many people work for the protection of the environment and therefore these issues are proceeding without their contribution. Consequently they become more interested in other issues.

☛ In view of the interest in environmental issues of other countries in Austria the interest is significantly greater. The school is located near to chemical industries so it is expected students to be more sensitive on environmental matters. Another explanation may be that Austria is a country, which in the eastern part is surrounded by countries of Eastern Europe in which the investments in environmental technology have not proceeded as much as in the counties of the European Union. The consequence may be that air and river pollution coming from foreign countries may be a greater problem than in Western Europe.

☛ In Austria also the interest in international communication is greater than in the other countries. This is not surprising as Austria is placed in the middle of Europe and has borders to many (7) different countries with different cultures. Austria can be seen a mediator between East and West, North and South. It is the meeting point of European cultures and a preferential place for cultural exchange. The same is, in part, valid for Greece as an intersection between Southern Europe and Middle East. The interest of Greek students in international communication is also far more than average.

☛ Finally the extraordinary interest of the Greek students in new technologies has to be pointed out. This issue is of great interest in all countries and this was expected, as it is a new experience for students of this age. The even greater interest of the Greek students is possibly due to the fact that the particular school (Ellinogermaniki Agogi) has invested a lot in new technologies and had been using the new technologies in the educational procedure long before the other participating schools started to do so.

- **Environmental issues**

In this question the students are asked to estimate the importance of different environmental issues. They are asked to give the order of importance (most important to least important) of given environmental issues. Their vote for rank 1 (most important) was evaluated.

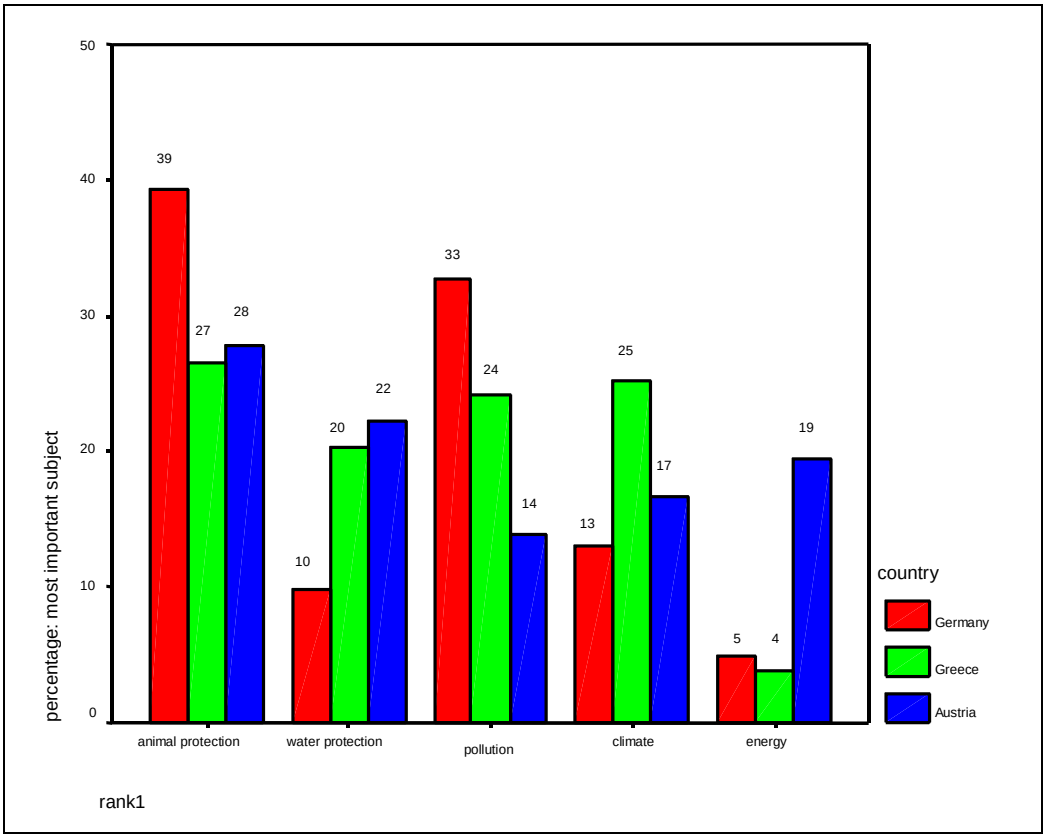


Figure 3.4.7: *Importance of different environmental issues sorted by country.*

According to the majority of the students animal protection (protection of endangered animals) is clearly the most important issue (mostly voted on place 1 for the given selection of environmental issues) whereas energy resources have been selected to be the most important issue by the smallest number of students. This is in good agreement with the fact, that ”energy resources” is most frequently placed on place five (least important). However, there are striking differences in the assessment of the students' assessments the countries.

The second most important environmental issue was the “protection of the rivers and the seas” to the Austrian students, the “climate” to the Greek students and the “air pollution” to the German students. “Energy” was not thought to be an important environmental issue by the students on the whole.

Remarks – Discussion

- ☛ The great importance for ”protection of rivers and seas” that is expressed by the Austrian students can be seen together with the relatively great interest in ”environmental issues in other countries” as it was discussed in detail in question 2.

- ☛ The relatively high importance of ”energy resources” in Austria is not obvious

compared with the other countries. Austria has plenty of energy resources in hydroelectric energy in its mountains. It is assumed that the nuclear power plant discussion is still in effect.

☛ The high preference of ”air pollution” in Germany is certainly caused by the discussion about the ozone enrichment in summer smog and the destruction of the ozone layer.

- **New Technologies / Internet**

In this question students were asked about the actual use of computers, about their access to computers/Internet at school and at home and about their estimation of how computers/Internet can assist in school education. Questions *4c* (What do you use your PC for?), *4h* (What sites do you look at when you surf the Web?), and *4i* (Do you think you can find something in the Internet that can help you to improve your marks at school?) were selected for detailed analysis and further discussion.

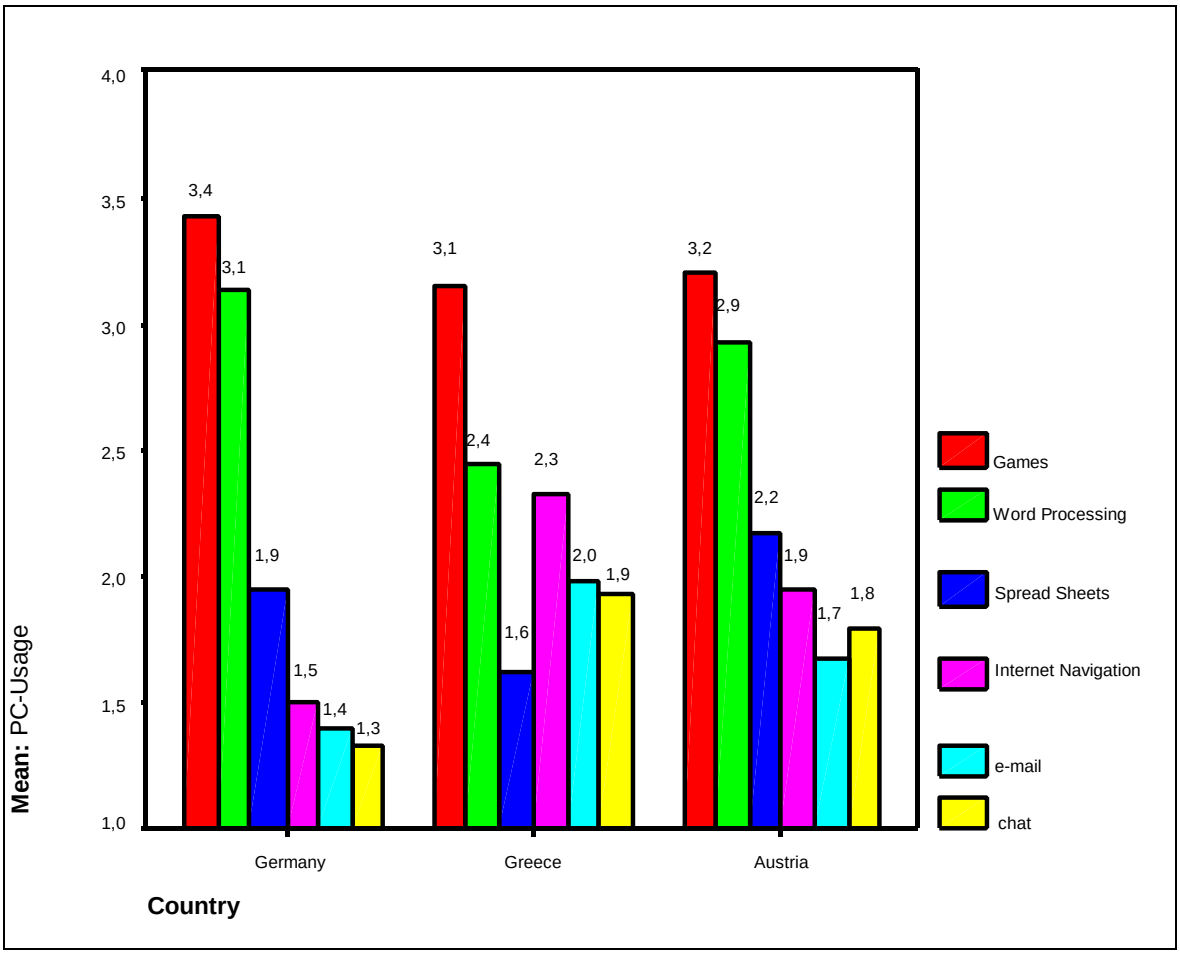


Figure 3.4.8: *Usage of PC per country.*

PC usage is dominated by “games” followed by “text processing”. All other applications were less used. The comparison between the countries (by Kruskal-Wallis-H-Test) shows differences in “word processing” (p=0.002), “Internet navigation” (p=0.002), “e-mail” (p=0.009) and “chat” (p=0.004). “Word processing” is

less used by the Greek students. “Spread sheets” are most used in Austria, followed by Germany and then Greece (p=0.032). Internet and its services, however, is most used by the Greek students, followed by the Austrian and by the German students. The same is valid for “e-mail” and “chat”. All results are very significant.

Remarks – Discussion

☛ This behaviour may be explained by the fact, that while Greek and Austrian access to Internet in their school. German students had poor access to Internet in school at the beginning of the project. “Internet at home”, however, had not been significantly different over all countries (question 4g). At the beginning of the project Greek students as well as Greek teachers seem to be more familiar with the Internet than the others. The Greek school has a long tradition in using the Internet to get information as well as in online-publishing. Word processing, however, is more used by the German and the Austrian students than by the Greek ones.

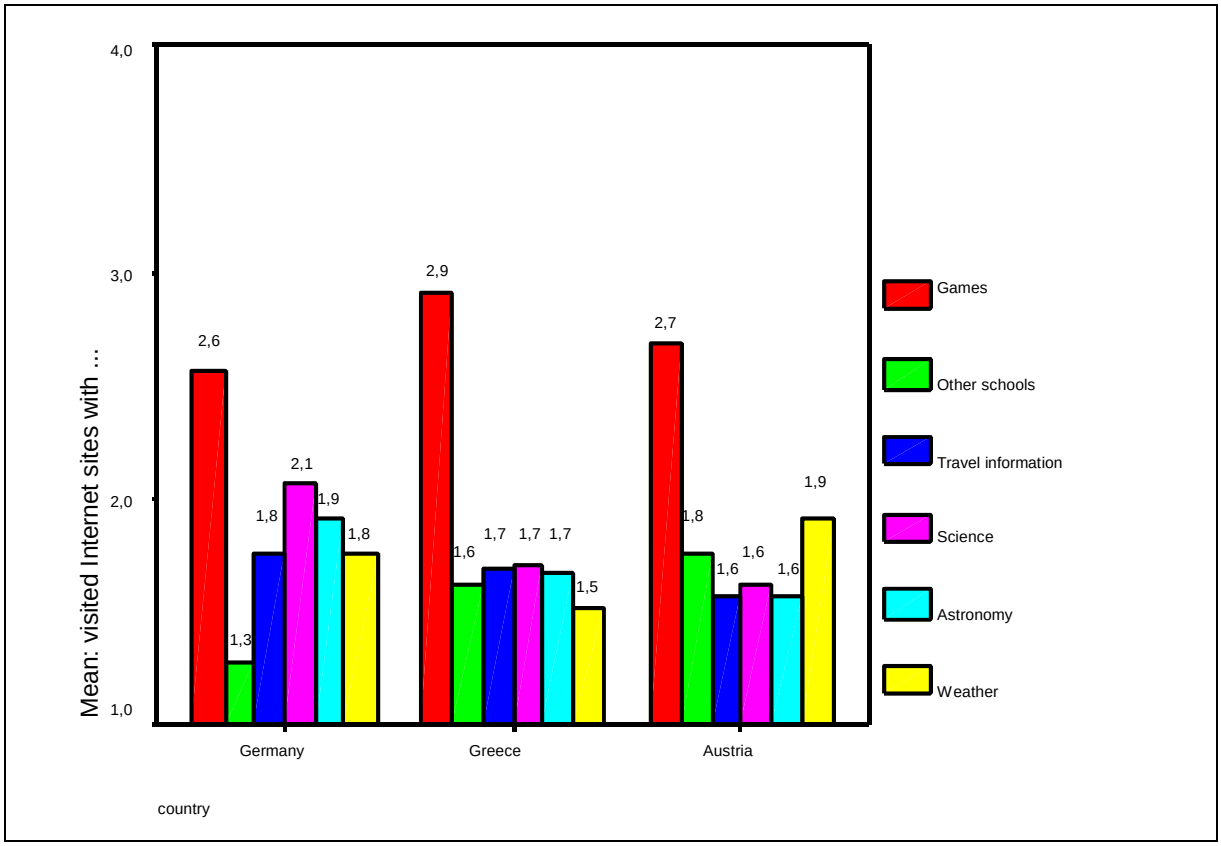


Figure 3.4.9: *Most visited Internet sites per country.*

Internet sites with games are greatly preferred by the students. All other sites are less visited. Differences between the countries appeared in visiting other schools (p=0.05), in science sites (p=0.069), and in weather sites (p=0.069). “Other schools” are most visited by the Austrian students, “science sites” are mostly visited by the German students. The interest in Web sites other than “games” was not very large. The average frequency at which these sites are visited is ”rarely” or even less.

Remarks – Discussion

- ☛ It is clear that the interest of students in games is predominant. The Internet in science was not expected to be at the same level. The low frequency for ”other schools” in Germany corresponds with the weaker interest in ”international communication” and in ”direct contact to foreign students” (question 2). A great interest in astronomy was expected in Germany but this is not shown in the data of the questionnaire.

Question *4i* (see figure 3.4.5) gave extremely important results, so further discussion has been made. Students were asked about the usefulness of information they can find in the Internet. Do they expect that they can profit from Internet information at school by improving their marks? The overall estimation is that they can find ”occasionally” something that could improve their marks at school. A comparison between the countries shows that the Greek students expressed the greatest disbelief in using the Internet information for improving their marks (p=0.001). The difference of the Greek students to the students of other countries is more striking in the experimental group than in the control group.

Remarks – Discussion

- ☛ At a first view the results of the evaluation with respect to this question were very surprising. Why do Greek students strongly underestimate the usefulness of the information that could be found in the Internet?

- ☛ The Greek students have Internet access at school and they are (as shown from the analysis of the questionnaires) familiarised with its use. Students as well as teachers are familiar with Internet services and have much experience in using the Web as an information source. Probably they have a better idea than the students in other countries on what sort of information can be found in the Internet and which information specifically could be useful at school tests.

- ☛ The Greek students’ attitude may be explained if they consider that only a low percentage of the information available in the Internet is of any value for school tests. They estimate that only a small amount of the available resources are really useful. This attitude is due to their good knowledge of the Internet. The students from the other countries – not so familiar with the use of the Internet – expect that the Web will offer them very helpful information in order to improve their marks at school. This is true only in the case that one knows exactly where to look for, as the great amount of the information available acts most of the times as a background noise for the really valuable data. As a conclusion it has to be admitted that the better they know the Web the more they know how difficult it is to find the information they need.

3.4.3.2 Post-test

A detailed analysis of pre-test and post-test in view of changes during the project presented very interesting and useful results. In the following section some selected items are described in order to give some hints about changes in attitude, in learning and usage of new tools by the students. In order to avoid to take into account changes, which are not depended on the project's implementation, all results are checked by using the control group as a reference.

- **Post-test vs Pre-test**

As it was described in paragraph 3.4.2.4, the differences between pre- and post-test were statistically evaluated with the use of non-standardized residuals of the linear regression from pre- to post-test; these residuals allow for an evaluation of changes that are independent of the initial values in the pre-test, which is a very important parameter in the data analysis. Comparisons between the experimental and the control group were calculated with Mann-Whitney's U-Test. In the following the changes between the pre- and the post-test are presented for the selected questions.

The most interesting questions are discussed in the following. Some explanatory details for the method used are given for the first question.

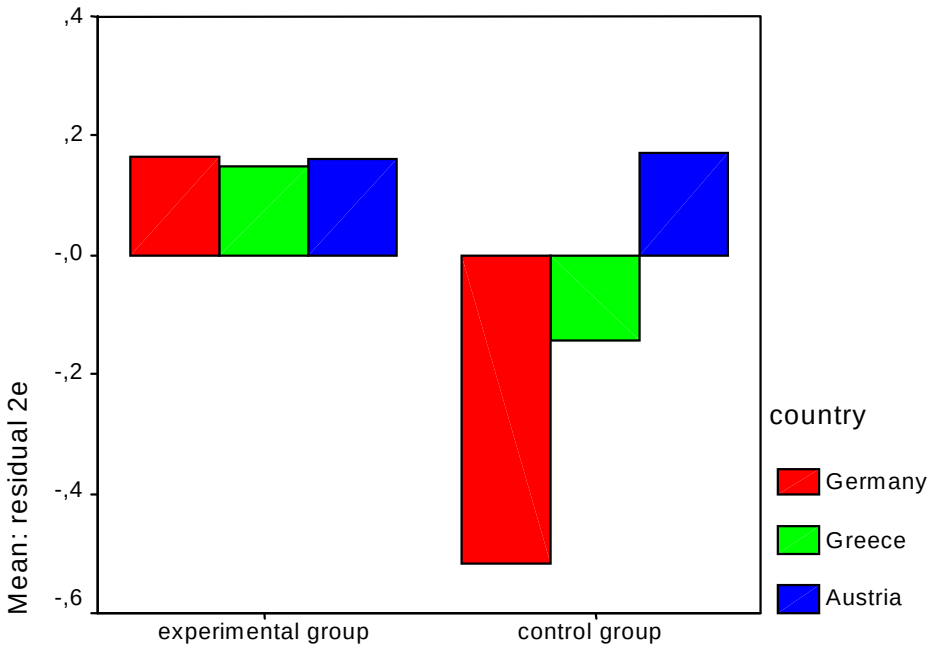


Figure 3.4.10: *Relative changes of experimental group and control group between pre-test and post-test for question 2e (Interest in scientific subjects).*

🕮 ***Explanatory note on figure 3.4.10:*** *In figure 3.4.11 the procedure followed for the comparison between the post- and the pre-test is presented schematically. It is based on the use of non-standardized residuals of the linear regression from pre- to*

post-test. Linear regression means the determination of the straight line (see figure 3.4.11) that is assumed to represent best the linear correlation between two specific variables. For example the answers of the students to the specific question at the pre-test are presented versus the answers of the students to the same question at the post-test. A residual of this linear regression is the distance of one value to this straight line. The calculation of the residuals of the linear regression between the pre-test and the post-test leads to level-independent measurements for existing differences between the two tests. In contrast to simple subtractions (post-test minus pre-test which are usually used) these values reveal differences that are independent from the initial value. If, for example, a person marks a high score in the pre-test, he to mark a lower score in the post-test (statistical regression effect, top effect).

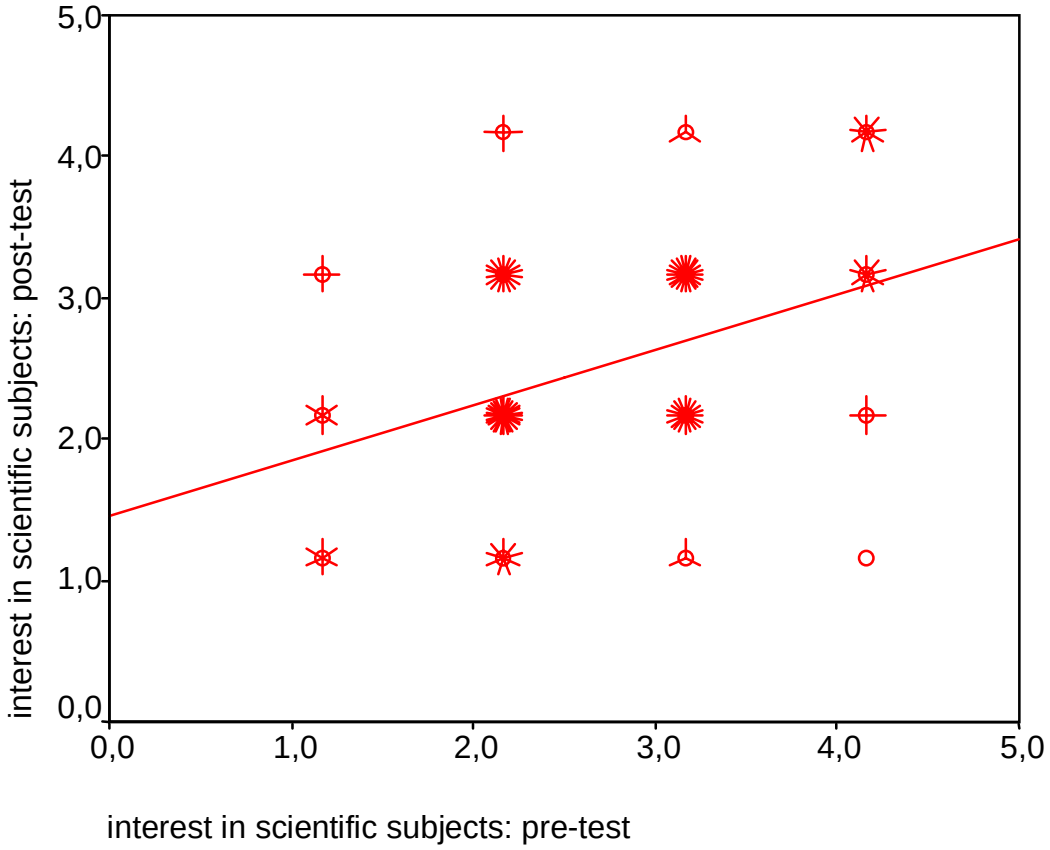


Figure 3.4.11: *The answers of students experimental group vs control group for question 2e (Interest in scientific subjects).*

The interest in scientific subjects (figure 3.4.10) has been near average for all countries at the beginning of the project and did not differ significantly between the schools. During the project there was a significantly different behaviour between the groups (p=0.018) which probably results to a stronger decrease of the control group with respect to the experimental group. The decrease is not significant as a whole. Probably this is a normal effect on students of this age. This effect is more clearly seen in Germany whereas in other countries it is weaker.

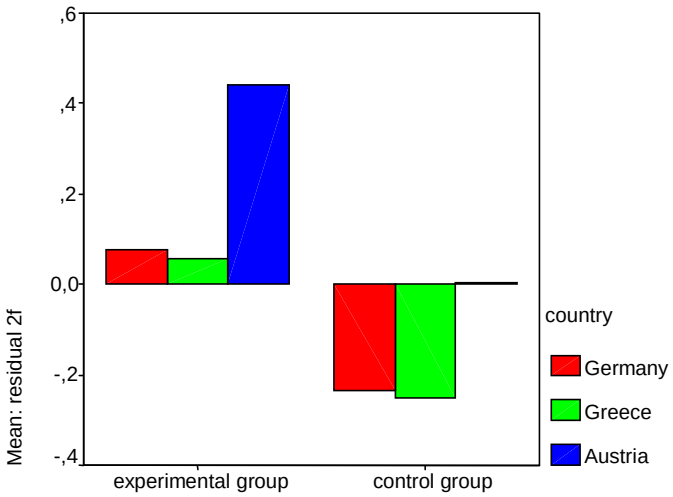


Figure 3.4.12: *Relative changes of experimental group and control group between pre-test and post-test for question 2f (Interest in foreign subjects).*

There is a tendency (p=0.064) for a different behaviour of the experimental group and the control group between pre-test and post-test as far as the interest in foreign subjects is concerned (figure 3.4.12). A comparison of the data between the countries suggests that it could be a result of a combination of a slight increase of interest in the Austrian experimental group with a small decrease in the Greek control group. The other groups show only marginal changes. The groups for each other, however, do not express significant changes.

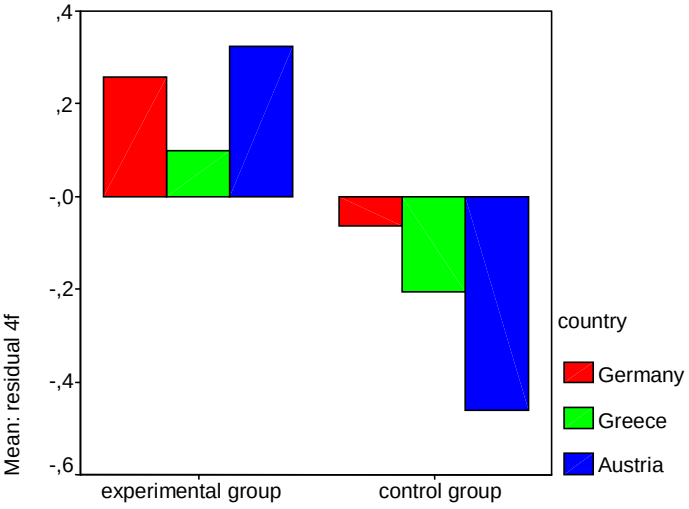


Figure 3.4.13: *Relative changes of experimental group and control group between pre-test and post-test for question 4f (Usage of Internet in the classroom).*

The analysis of the data for question *4j* (Have you ever found something

useful in the Internet?) shows a more than average agreement in both groups and a further significant increase of the experimental group during the project (see figure 3.4.14).

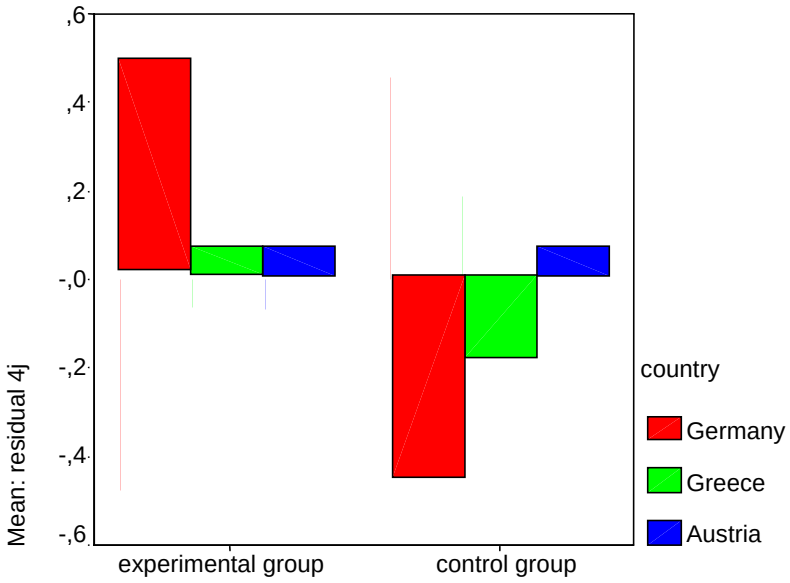


Figure 3.4.14: *Relative changes of experimental group and control group between pre-test and post-test for question 4j (Have you ever found something useful in the Internet?).*

This question points to the same issue with question *4i*, but it is more general. Good agreement between the answers to these questions was expected, such as a stronger agreement in this statement. The increase in the agreement for the experimental group confirmed the presumption. This result is strongly significant (p=0.007).

Remarks – Discussion

- First of all it was observed that the access to Internet in the classroom (question *4f*) has been improved during the project for the experimental groups (p = 0.000). This is obviously an effect of the project implementation in the schools. It seems the project has been a good reason for the school administrations to invest to new technologies and methods. Furthermore, the fast development of new technologies, the spreading of the knowledge in computer installation and network administration, and continuous decrease of technology cost help school administration and teachers to integrate new technologies into the school education. The access to computers at home was high from the beginning and did not improve significantly during the project.

- As far as the usefulness of Internet is concerned (question *4j*), it is assumed that is due to the relatively small experience in the Internet at the beginning of the project. At the end of the project the experimental groups have gained a

lot of experience in using the Internet and this may be the reason why the results of the experimental groups became rather similar. Additionally it has to be noted that there is a very strong agreement in the Greek control group. This strongly implies the development of a statistical bottom effect that means that an even stronger agreement is nearly not possible. Consequently this bottom effect leads most probably to a reduced agreement. This effect therefore is considered to be mainly as a statistical outcome rather than a project result.

- **Countries**

A detailed analysis has also been performed also in order different attitudes between the two groups from the same country to be estimated. The data from question *3* (solutions to the environmental problems will come from…) are discussed here. Generally "personal work" is estimated as the least important factor while the "International co-operation" is considered to be the most important factor.

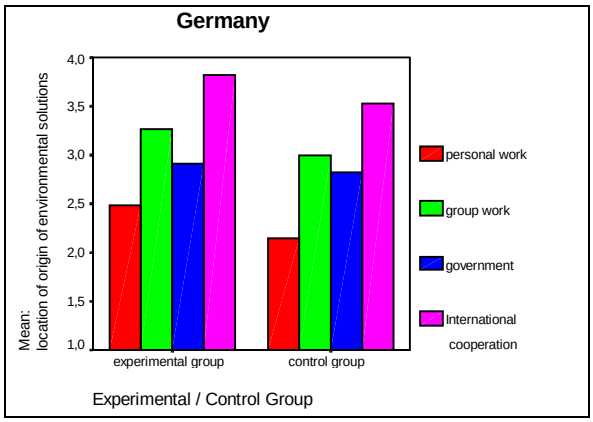


Figure 3.4.15: *Experimental group and control group for question 3 (Solutions to environmental problems will come from…). German sample.*

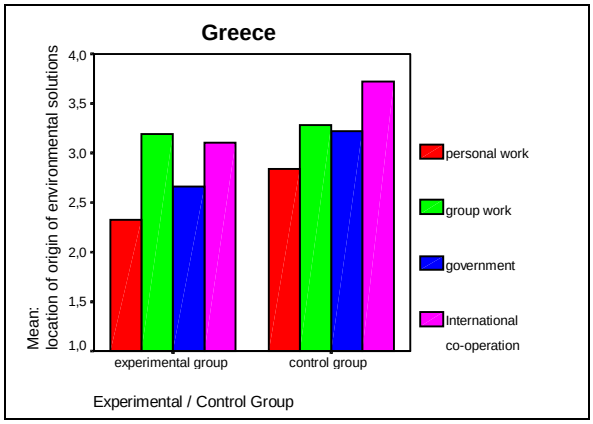


Figure 3.4.16: *Experimental group and control group for question 3 (Solutions to environmental problems will come from…). Greek sample.*

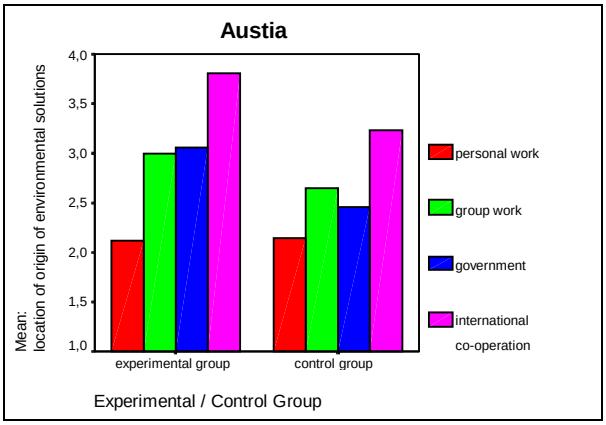


Figure 3.4.17: *Experimental group and control group for question 3 (Solutions to environmental problems will come from…). Austrian sample.*

Personal work is generally estimated lowest in every group.

- **Gender**

Further examinations show that question *3* was differently answered by male and female students. The results are shown in the following plot (figure 3.4.18).

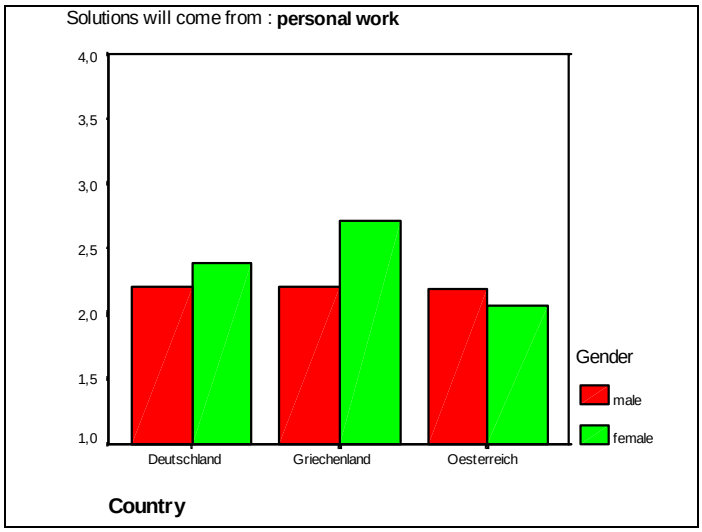


Figure 3.4.18: *Male and female students for the case "Solutions to environmental problems will come from personal work".*

In general male students differ from females slightly (p=0.076). Female students estimate personal work for the solutions better than males. The result lead to additional investigation to find out whether there are differences between the countries in relation to this question. Male students do not show any difference in respect to this question whereas female answered differently. The greatest difference between males and females appeared in the Greek sample (p=0.018), the

others are not significant. A similar result is obtained with the answer “Solutions will come from group work”. Female students seem to believe in “personal work “ more than the male students do (p=0.012). For the answer ”Solutions will come from government” no significant difference between male and female students was observed.

All students generally agree on the importance of the role of the international co-operation ion solving environmental problems. Here female students differ not very much but male students do (p=0.034). The result is shown in the following plot (figure 3.4.19).

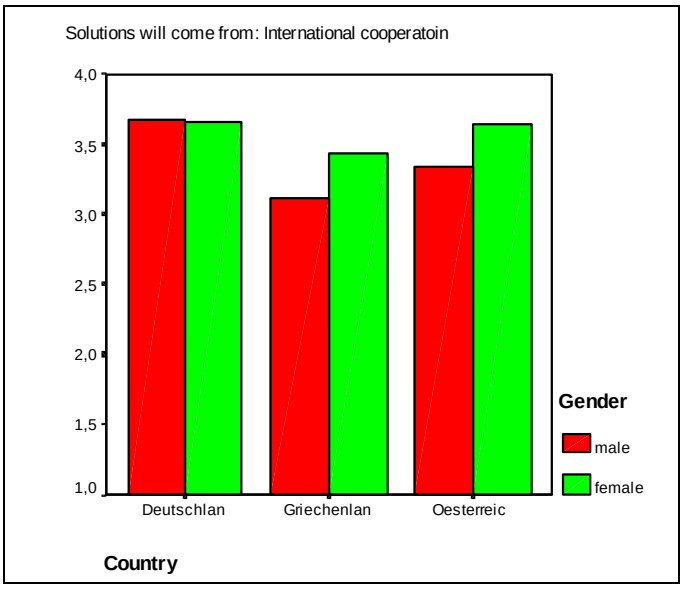


Figure 3.4.19: *Male and female students for the case “Solutions to environmental problems will come from International co-operation”.*

In many cases female students believe in the solution of environmental problems more than their male colleagues do. More general statements are not allowed on the basis of the questionnaire. One should keep in mind that the average age of the students is between 13 and 15 years. In that age commonly a fast development is taking place and the opinion changes more often than in the adult age. Therefore such facts should be taken very carefully into consideration.

3.4.3.3 Conclusions

Globalisation with its impact on society and economy certainly needs educational tools that allow international contacts and experiences already at school level. The Internet and especially ODL can be considered as one very promising tool to accomplish this objective. It allows to work on common projects, to communicate and to be continuously informed students about the progress of other students. Quite obviously, these activities are helpful for gaining a deeper understanding of how students have a different cultures think, behave, live or treat each other.

Although it is evident that changes in attitudes and skills are taking place,

without careful and precise evaluations one cannot predict the exact kind of these changes. This information is not only essential for gaining a better understanding of psychological and social processes, they also provide guidelines for the development of well designed pedagogical frameworks for ODL's implementation in the educational methodology. In the present pilot study a method has been developed and applied, that serves this objective to a high degree.

3.5 Qualitative analysis of the project

Two are the main factors, which play crucial role during the implementation of the project:

1. the role of students

2. the role of teachers

In the following paragraphs the role of each group is presented in detail.

3.5.1 The role of the students

The students' role in the project was the most important. The expected benefits for the students, from their participation in the project could be projected in two dimensions:

1. Transnational co-operation

2. Scientific methodology

3.5.1.1 The role of transnational co-operation

By introducing virtual classrooms in the educational methodology, overcoming borders and developing a transnational co-operation, a certain number of pedagogical benefits are expected for the virtual classmates:

- The possibility of a wider search for information, a search beyond the limits of the school, as well as the utilization of this information.

- The possibility to work in-groups, which reflects one of the main characteristics of the scientific way of working.

- The possibility to communicate and cooperate, especially when they have to overcome obstacles related to distance (video conferencing, chatting, mailing etc.).

- The opportunity to analyze and compose a problem so as to be able to be understood by a transnational group of students

- The possibility to take initiatives and make decisions. While discussing in the virtual classroom a variety of different opinions and hypotheses are presented. The virtual classmates must verify or reject them in order to come up with a conclusion.

- The ability to follow instructions and organize their way of thinking.

- The ability to fulfil tasks and work meeting fixed deadlines.

- Inductive thinking. Virtual classmates are asked to think of procedures and problems that they can solve.

- Decision-making. Virtual classmates are asked to make decisions concerning:

  - Formation of hypothesis.

  - Formation of procedure.

  - Coming up with conclusions.

  - Proposing possible solutions.

  In this way, decision-making ability is promoted, which is useful in every profession.

- Familiarization with the practical use of new technologies. The project promotes the actual use of computers and information technology in all subjects, since:

  1. Computers are used for gathering measurements.

  2. Computers are used for analyzing / presenting measurements in diagrams.

  3. Internet is the communication means of virtual classmates, which gives substance to the virtual classroom.

3.5.1.2 The role of scientific methodology

The participating students who familiarized themselves with the methodology followed were expected to get certain benefits. These benefits are utilization of various skills and interests of the students and are based on co-operation, the willingness to learn, interest on common matters, e.g. environmental issues, transnational community of citizens. Under this framework, e-Hermes project aimed to:

- Help students to get familiarized with natural sciences (physics - chemistry) as human activities with a certain social (environmental - ecological) impact.

- Treat natural sciences and school subjects in general, with a broader mind. Students understand that physics and chemistry are related to every other science that they are possibly more interested in. In this way the number of students that feel alienated from these subjects is strongly reduced. Another subject, Technology, is also interesting not only for those students that are closely related to computers and its role and close relation to other sciences are promoted, either as a helping tool or by critically examining its results.

- Provide teacher with another possible way to approach students, allowing them to promote various skills and extra-curricular interests. In this way school has a new role in educating young students.

- Provide a wide approach to school subjects, which is forbidden by curricular framework up to now. There are interesting chapters in every subject that may have a direct relation to everyday life or to students' social interests (e.g. biochemistry, electromagnetic radiation, sound etc.), that have been ignored due to lack of time in the curriculum.

- Provide students with the possibility to become aware of the different aspects of scientific methodology, through their activities, from the measurements to the very important task of writing a scientific study, since this is the milestone of scientific research and the confirmation of its value, as sharing of scientific experience with the rest of the scientific community.

- Provide students with the possibility to learn and use a scientific method to respond to various problems. Through this procedure of researching and thinking, as was obvious from the corresponding chapters – subject plans (see paragraph 3.3.3), students are taught about the structure of scientific research, as well as its stages: hypothesis, limitations, conclusions etc. Furthermore, writing reports which have a very strict structure will teach them to make a scientific research.

- Expose students to the terms and the language used by researchers. As we mentioned before, a very important part of the procedure “research and experiment” is the written report - outcome of the whole research. Students are asked to clearly define variables, define restrictions and variables regarded insignificant, state assumptions for relationships of variables and represent them graphically. Thus they become familiar to scientific terminology.

3.5.1.3 Degree of goal achievement

In the paragraphs above the benefits expected from the students participation in the e-Hermes project are presented. These benefits are also the goals of the e-Hermes project as far as students are concerned (as target group of the project).

A qualitative analysis of the project shows to which extend the students succeeded in playing the roles chosen for them. The main results of this analysis are

based on the teachers' assessment of the students during the project's implementation. In some cases quantitative results were also used (see figure 3.5.1) in order to obtain more reliable results, since these quantitative results cannot be affected by teacher's thoughts or emotions. The results of the qualitative analysis have shown that the most interesting tasks for the students were:

- Discussing through videoconference. Videoconference caused students great interest and made dialogue among virtual classmates direct. It also made dialogue among students of the same classroom more interesting. During the procedure questions were being formed by the students and they had the chance to get an answer immediately. For example, while discussing pH value of rainwater in the areas where the school buildings are located, it came out that the difference in pH values were due to the different location of the three schools. It came out that both the Austrian and the German school were located in an industrial area, whereas the Greek school was located in the countryside.

- Submitting reports to the E.S.E.M. became a motive for improving quality, as well as greater participation to the project.

- Contributing to the Bulletin Board had the same consequences as the videoconference, in a lower degree, due to the relatively lower interactivity. Bulletin Boards, while impossible to function on-line, were found to play a very significant role, since mails caused students great enthusiasm when answered by virtual classmates. On the other hand those remained without an answer caused disappointment.

- Submission of data to the e-tool. This procedure provided the partners with basic the tools of scientific research, such as diagrams with various combinations of depended and independed variables and a big amount of very interesting data.

In order to evaluate teachers' conclusions a series of "quality control" factors were used. A very interesting example is presented in figure 3.5.1. The "quality control" factor is the number of contributions to the two Bulletin Boards of the project. The first one is related to discussions of general interest. In the second one the "question of the month" was appeared. It was a general filling during the first months of project's implementation in the classroom that students were not so interested in participating in discussions through the Bulletin Boards. In order to activate students the idea of Videoconference was introduced the last week of November 1998. Students first had to discuss their ideas during a videoconference and then make their remarks and suggestions for the possible answers to the question of the month in the Bulletin Board. Due to technical problems the introduction of videoconference started in the beginning of December. As it can be seen from the graph there is an important rise in the number of contributions to the scientific Bulletin Board after the application of videoconference, while the number of contributions to the other Bulletin Board is more or less constant during the run of the project.

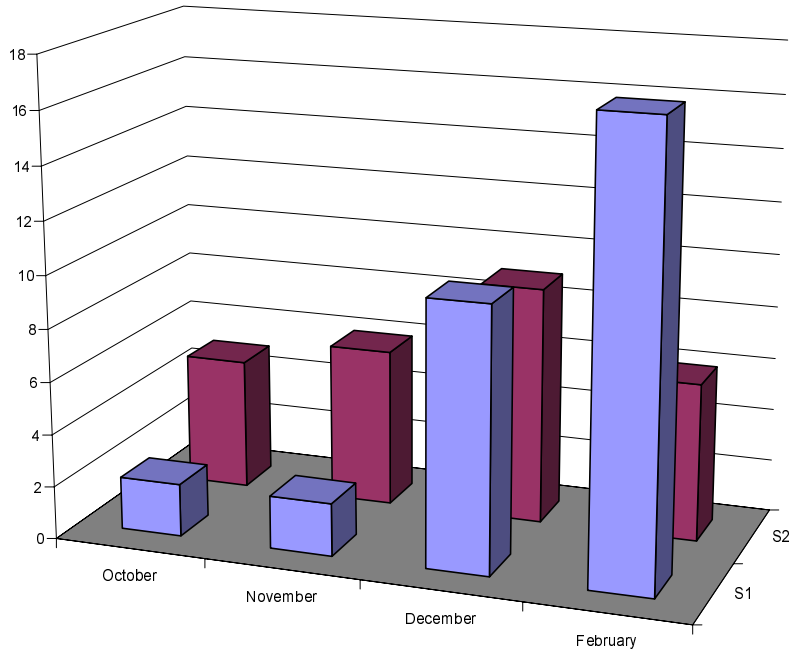


Figure 3.5.1: *Determination of students' behavior towards the project's implementation. Columns S1 represent the number of students' contributions to the scientific Bulletin Board (answers to the question of the month) while columns S2 represent the contributions to the Bulletin Board where general topics were discussed. Please note the significant increase in the number of contributions after the introduction of videoconference in the beginning of December.*

3.5.2 The role of the teacher

Equally important to the success of the project was the role of the teachers. This role had mainly two dimensions:

1. To act to ensure productivity of the project regarding benefits for students. This was noted in the discussion of presuppositions for the successful application, where the importance of the means' quality and the educational intervention of the teachers (ensuring the means' quality) are pointed out.

2. This same intervention constitutes the benefit that they have from the project, because they learn how to use an open curriculum, a student-based and group-working teaching method, non-conditional cooperative learning, new technologies, as well as small research activities and direct co-operation with teachers and curriculum planners.

The main responsibilities of the teachers involved in the project were:

- ***Data acquisition***

Teachers had to coordinate students through discussion for the correct use of instruments. He/she orientates himself/herself in working with groups of young

researchers. By supervising the submission of measurements in the e-tool, the teacher becomes aware of a teaching method that uses contemporary teaching means in the classroom and in the science laboratory.

- ***Coordination of the virtual classroom***

The teacher had to provide guidelines and phrase problems. He/she has to discuss with students the remarks being made by the virtual classmates and help to write down an agenda for discussions in the virtual classroom. For him/her even the coordination of the virtual classroom is a challenge and experience at the same time to a new educational reality. He/she is given the opportunity to work on issues outside the curriculum, nevertheless very interesting for most students, since they are related to everyday life and go beyond the narrow limits of the subject. Especially in the area of environmental issues, the teacher has the chance to place subjects on a real basis, going beyond the borders of a state.

- ***Preparation/presentation of the reports***

Besides benefits mentioned above, the teacher was given the opportunity to prove to students that scientific language needs to be precise (something for which students are convinced, merely compromising) and promote characteristics of a scientific work / publication.

3.6 Introduction of the project in the curriculum

3.6.1 Need to embed the project in the curriculum

During the probe run, e-Hermes project was not part of school subject's curriculum. Students had been working for the project during their free time, during breaks or after school, so they had to face a long series of problems. In this way the number of students participating the project was limited and discussions on subjects that were coming up were unsatisfactory. Nevertheless this was enough for the probe run. The most important conclusion from the probe run was that the project had to be embedded in the curriculum of the participating schools in order to achieve its goals.

3.6.2 Presuppositions

Introducing a project like e-Hermes in a school's curriculum, is not an easy task. All the parameters able to affect both the project's run as well as the normal flow of the school's curriculum have to be taken into consideration. In most of the cases a subject covering the subjects discussed in the project has to be chosen. In order to do so two main parameters have to be determined:

1. presuppositions for a subject to include the project and

2. needs of the subject fulfilled by the project

The presuppositions needed for a subject to embed e-Hermes project are presented in the following. As an educational methodology, e-Hermes project could be part of a wider educational projects' philosophy which gives emphasis to teaching how to learn rather than transmitting certain knowledge and skills. Such an educational project should offer students the ability to act according to their own way of thinking and understanding of the world, as a direct result of their observations and consequences resulting from their actions. As an example, the case applied to Ellinogermaniki Agogi is going to be presented. In this case the subject of Technology was the chosen to include e-Hermes in it curriculum.

3.6.3 Example of good practice

The subject of Technology (first grade of Lyceum, students' average age 15) seemed to meet every presupposition in general education needed for e-Hermes project. Technology in general education, is a subject that mainly gives emphasis to learning how to learn rather than to transferring students certain knowledge and skills. Indeed it is impossible for people (especially in today's information era) to store in their memories all existing technological knowledge, which is constantly increasing, making techniques and knowledge of today regarded as "old history" in a short while. Motivation for learning was also created by familiarization with systems for collecting, sorting and using information in scientific ways. These tools are of great use to students; furthermore knowledge is important when leading to discoveries, deep conception of various subjects and generalizations.

What is more the project itself answers to all educational activities that the subject of Technology demands from students, mainly to:

- Explore and value their interests and skills
- Evolve skills of applying a suitable communication / interaction with fellow students code, for group and self working
- Evolve skills of organizing practical and logical abilities regarding programming, designing and constructing manufactures that satisfy certain demands
- Evolve skills of researching and searching, as well as problem solving
- Evolve a conception about technology's effect on today's life
- Evolve a conception about defects and benefits from contemporary industrial way of life
- Evolve a conception about effects of industries on environment and their contribution to quality of life
- Evolve a conception about the importance of education, human factor and the

kind of human interference to contemporary society of information.

To face the task of evaluation in a correct way, teachers have to think of evaluation as a continuation of their own role in the classroom. Teachers have a coordinating role, making educational procedure easier. They help and survey students in solving research problems. At the same time they observe students' behavior in every suggested activity and evaluate them accordingly. Evaluation procedure has the form of "non-stop observation" and "recording" of all activities a student perform in order to solve a research problem. Of course it is natural for the teacher to use the traditional evaluation methods to find out the degree to which students learned of new subjects discussed in the classroom, as the procedure of conducting a research.

Special emphasis was given to the method used by each student to reach the solution of the problem he confronts. Students are also evaluated for their skill in searching for solutions through the widest possible variety of research tools given to them by e-Hermes project (video conference, Bulletin Board, E.S.E.M., e-tool). Teachers have to evaluate quality and logical sequence of "research activities" of every student, that is participation in videoconferences, contributions to the Bulletin Board, E.S.E.M. articles, e-tool diagrams. So teachers had to observe and evaluate each student separately. Each student may achieve the objectives of the project in different ways, as a result of individual differences. Two different students may both be regarded as having achieved an objective of both Technology subject and e-Hermes project, even if they have not showed it in the same way. On the contrary, "research and experiment" method, used for the project offers every student the opportunity to achieve objectives through his own way and does not demand from all students to "create" and invent in a uniform way, which would be impossible. That would be because students in "research and experiment" method use their minds and knowledge in a creative way and understand themselves their own individual skills and interests.

In the last part of the chapter a long series of examples of good practice in the project's implementation are presented, based on the use of the educational tools developed to meet the project's needs.

Video Conference:

- *Discussion of difference in the values of pH of the rain-water in Greece, Austria, Germany:*

Measurements registered in the project's first phase (probe run) have shown that pH of the rainwater (acidity) in Greece (Athens) was lower than that of Austria (Vienna) and Germany (Frankfurt). That seemed odd in the beginning because we usually refer to Athens as a city with very polluted atmosphere (figure 3.6.1).

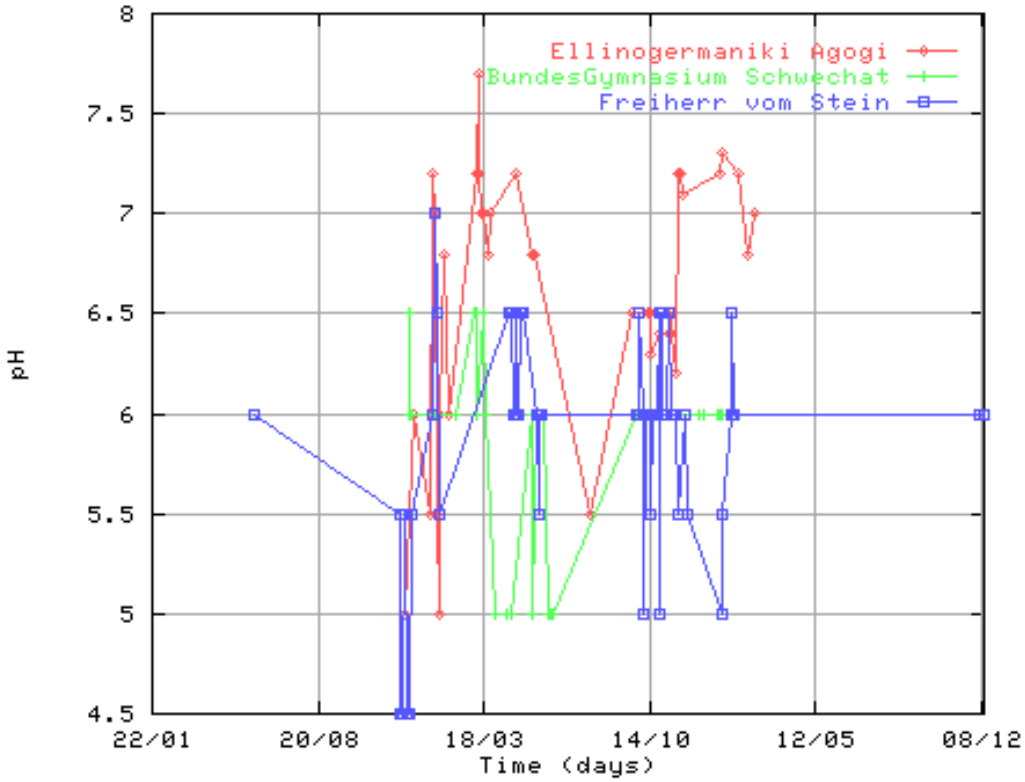


Figure 3.6.1: *The diagram presents the differences in the measured pH values.*

Through video conference discussion, it came up that the Greek school is located far from the center of Athens, in a district with low air pollution, while the Austrian and German school are located in an industrial area.

- *Discussion for the different noise levels in the Greek and the Austrian school:*

There was a discussion upon that in the classroom and all students agreed that probably it was due to a background noise, existing even in an empty school.

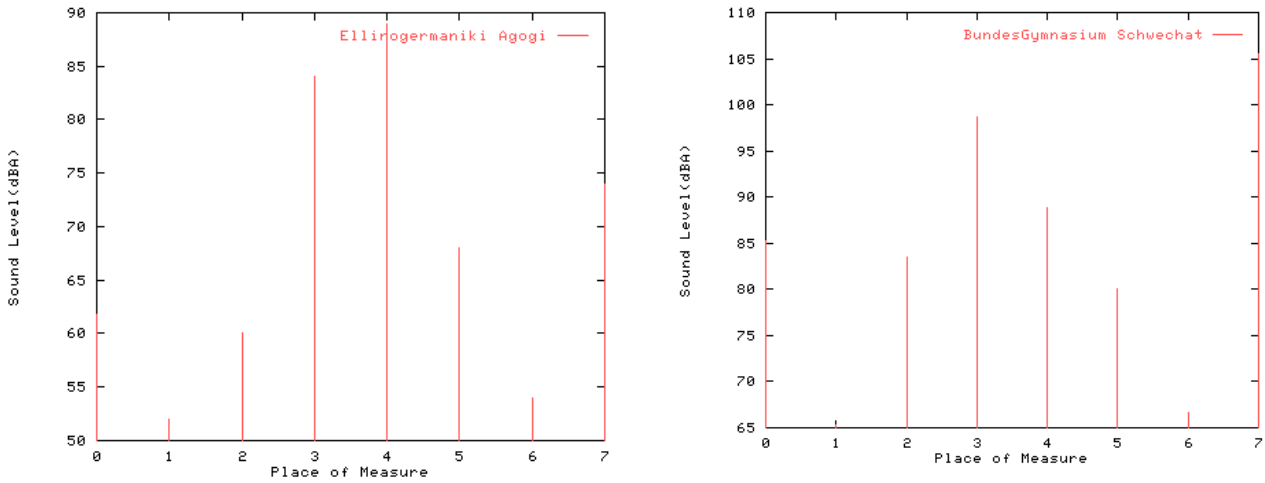
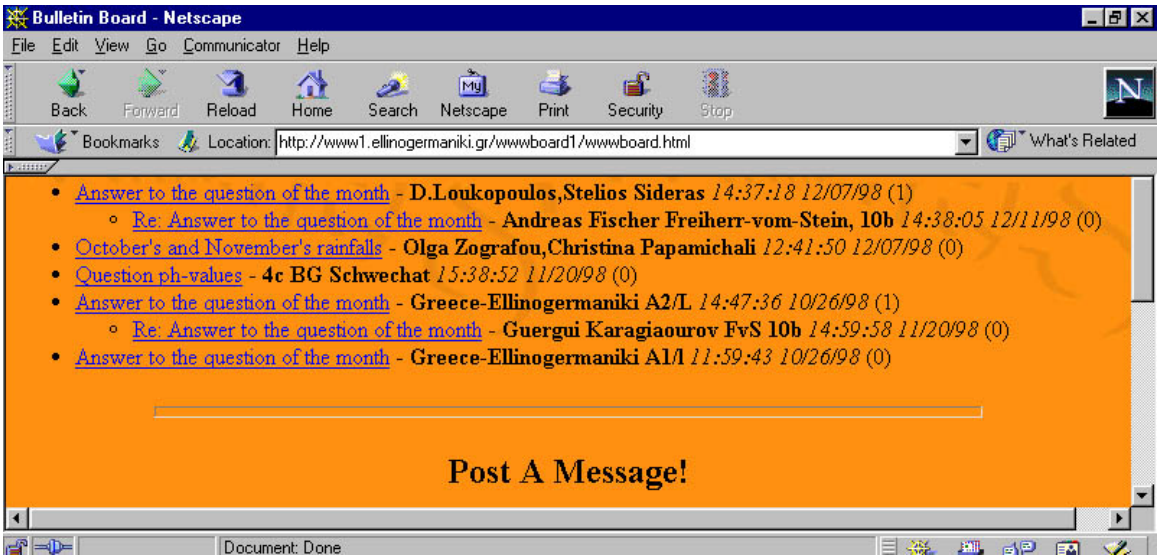


Figure 3.6.2: *The diagram presents the differences at the noise level measured in Greece and Austria.*

In the specific example students understood that they cannot simply deduct the background, but the procedure followed is depended upon the formula describing noise level, which in the specific case was logarithmic. Through videoconference it came out that the Austrian school was located next to a high way while the Greek school is located in the country site.

Bulletin Board:

The following sequence of e-mails presented in the Bulletin Board during the discussion about the pH values (see figure 3.6.1)



- *Discussion for different height of rainfall:*

While examining diagrams presenting rainfall heights, it was found out that many rainfalls occurred in Greece in certain time periods, being different in Germany and in Austria. Many subjects were discussed through the Bulletin Board.

- Similarities between weather conditions in Austria and Germany
- Fires during the summer time affecting rainfalls and their catastrophic consequences (fig. 3.6.3)
- Observation of world weather changes.

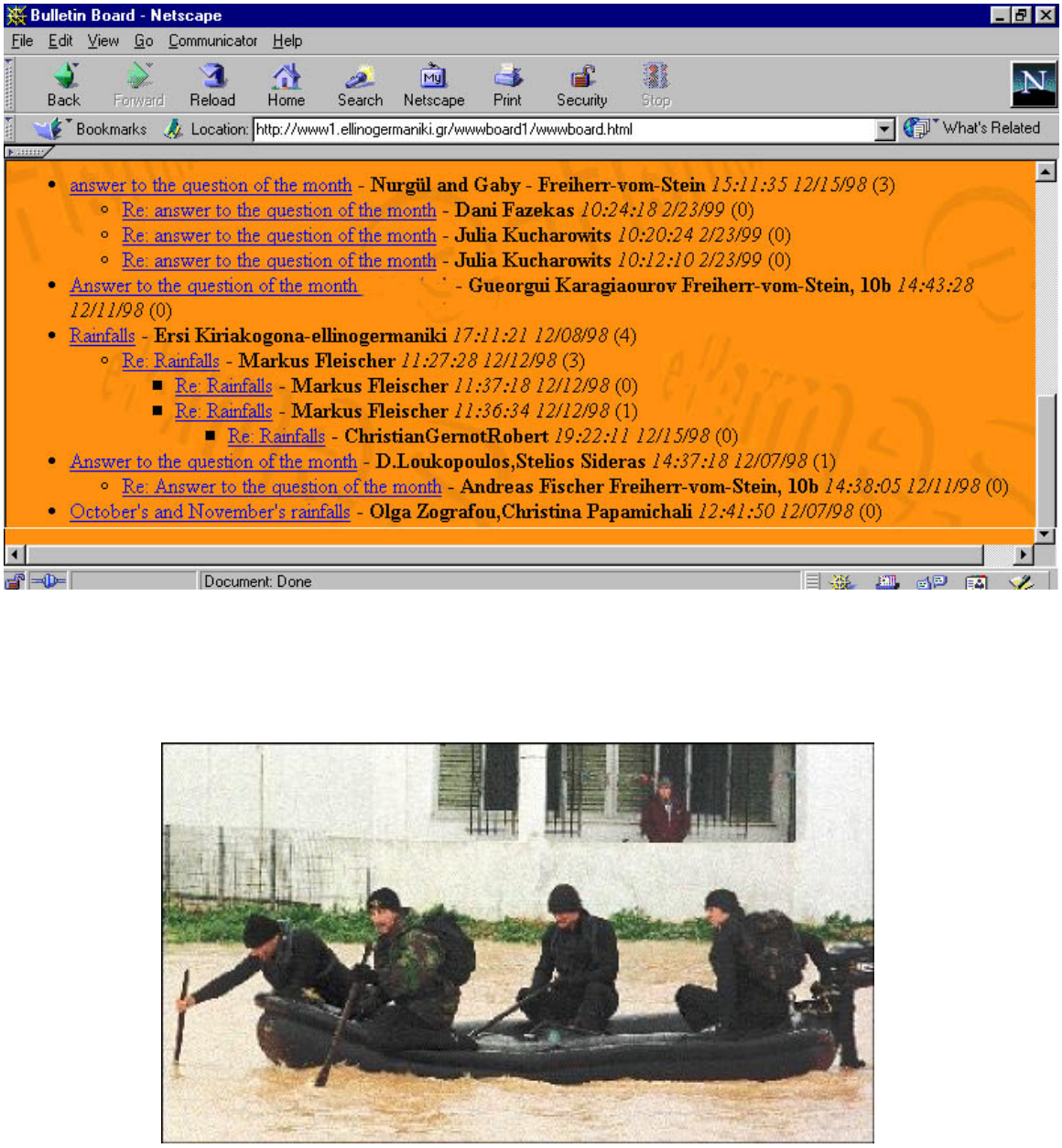


Figure 3.6.3: *The consequences of a heavy rainfall last winter in the wider Athens area.*