

ESPERE Climate Encyclopaedia

How to benefit from new media
for high quality teaching?

A Handbook for Science Teachers

Edited by Anita Bokwa and Marek Walczak

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Introduction

Nowadays classic teaching means as book, blackboard and overhead projectors have to compete more and more with new media. The access to the Internet in households as in schools is increasing and the volume of information available is huge. Pupils make use of it during their homework, teachers make use of it preparing the lessons. Online services for teachers and educational centres help with concepts to benefit from the new opportunities.

This handbook focuses on the example of integrating the wide range of natural science topics related to the climate system into geography, chemistry, physics and biology classes. Relying on the world's biggest Internet climate encyclopaedia for schools ESPERE and concepts developed by the German Internet service 'Teachers online' we present frames and concrete examples for modern science teaching.

1. What is ESPERE?

To bring the present scientific knowledge of the climate system and environmental sciences to schools, to make it understandable for teachers, pupils and also a wider public is the idea and the challenge of the project ESPERE (Environmental Science Published for Everybody Round the Earth). In an international project with educational institutes, teachers and climate scientists involved an Educational Network on Climate (ESPERE-ENC) has been built up and a large Climate Encyclopaedia has been developed in 2003 and 2004.

Topics like ozone hole, greenhouse effect, global warming and changes in the ocean streams make the headlines all over the world. The question of climate change will strongly determine the living conditions of the next generation. However, profound background knowledge on the climate system among pupils, their parents and sometimes also teachers is rare. Reliable information is missing, the news are confusing, contradicting or difficult to interpret. The scientific knowledge grows more quickly than teaching material can be developed.

ESPERE will inform about many aspects of the climate system: the atmosphere, the air we breathe, the relevance of ozone and other trace gases, in which way the oceanic circulation and phytoplankton in the oceans trigger our climate. Weather phenomenon will be explained as well as the big impact water vapour, particle formation and clouds can have on the future climate. The special conditions in the cities will be discussed as well as the impact of the climate and climate changes on farming and food-supply. Natural processes will be compared to human influences and political decisions and international treaties will be described. In many units and worksheets we explain the basic processes, terms and laws which are an inherent part of science teaching and how they can be applied on the climate system.

The ESPERE Climate Encyclopaedia relies on the present knowledge of experts from all over the world. Material for classes has been developed by professional teacher trainers and textbook authors.

Online resources and downloadable materials are freely available in seven languages at the domain www.espere.net. The project is funded by the European Commission and supported by many climate scientists and teachers. We have to consider, that to learn living in a changing climate will be one of the big challenges for our pupils, students and mankind as such.

2. Concept and contents of ESPERE and the ESPERE Climate Encyclopaedia

2.1. Structure of the website www.espere.net

ESPERE is an internet based multi-language information platform on the climate system. ESPERE consists of two different areas, an international area (information about the ESPERE project, communication and feedback in the Forum) and a national area (in so far seven different languages) (the Climate Encyclopaedia with background texts, worksheets for classes and interactive tools).

When you enter the website www.espere.net you will see the following (international) front page, which may slightly vary depending on temporary announcements:

International

ESPERE home - impressum | disclaimer - contact us

The ESPERE Association - Międzynarodowe Towarzystwo Naukowe ESPERE

Information on the climate system

... for schools and the world's citizens

General Assembly
21 Jan - 25 Feb 2005
Walne Zgromadzenie
21.01 - 25.02.2005

About us

Project ESPERE-ENC

Forum

Our climate: Air, Ice, Water, Rocks, Soil, Life

How are they interacting? In which way does man interfere? What scientists understood during the recent 30 years and what they are investigating today is going to be presented step by step on these pages - topical, multilingual, state of the art, comprehensible for everybody.

May we understand, what we are doing ...

ESPERE special 2004:
The day after tomorrow

Visitor
41600
since 02/21/01

The international area

The international area of ESPERE is only written in English.

On the right side of the screen you find links to:

Project ESPERE-ENC 1. information about the project in seven language versions;
2. information about the International Scientific Association ESPERE;
3. links to internet fori devoted to discussion and questions on projects and the climate system in general in several languages

About ESPERE

Forum

The national area

If you choose a language in the left bar you enter the national area and you will find several categories of information written in your chosen language:

- general information about ESPERE, the website and how to use it
- the ESPERE Climate Encyclopaedia
- the Encyclopaedia's summary 'Climate in Brief'
- tools and support for communication and interaction
- probably sections about topical issues and special projects

The Climate Encyclopaedia

is the core of ESPERE. The eight topics of the encyclopaedia are

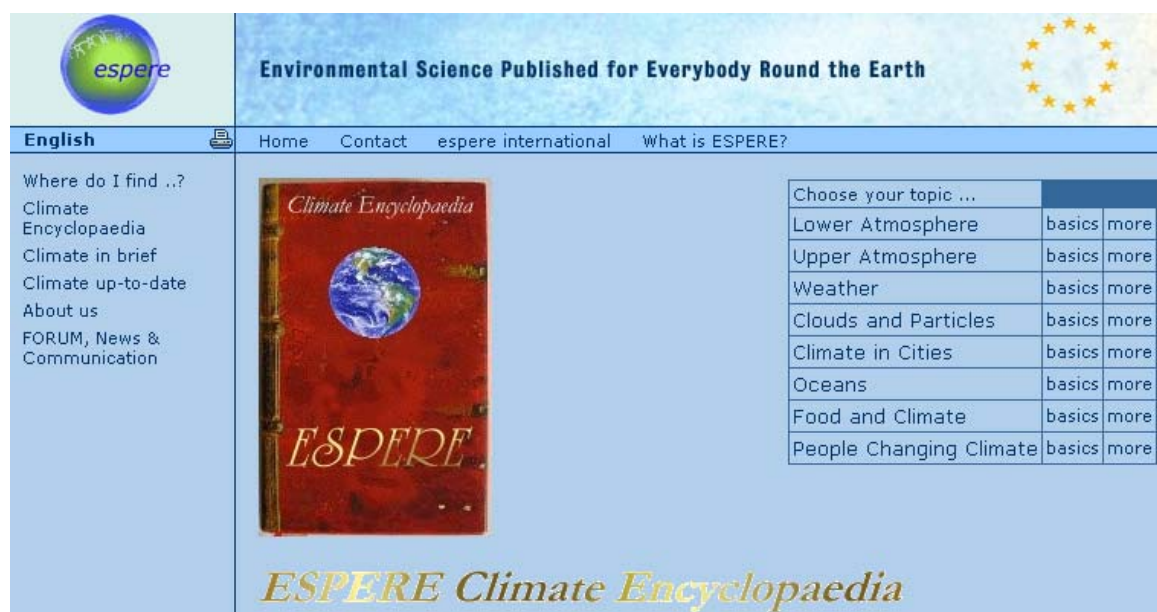
Lower Atmosphere	basics	more
Upper Atmosphere	basics	more
Weather	basics	more
Clouds and Particles	basics	more
Climate in Cities	basics	more
Oceans	basics	more
Food and Climate	basics	more
People Changing Climate	basics	more

Each topic consists of many texts and worksheets for use in classes. The texts are organised in units separated between the two knowledge levels *basics* and *more*. In the section 'How to use it?' of this guide we explain how to navigate through the Climate Encyclopaedia.

Since the ESPERE Association plans to update and extend the content of the webpage also in the future, the page structure may change. But the Climate Encyclopaedia will remain its core.

2.2. The content of the encyclopaedia and accompanying information

The ESPERE Climate Encyclopaedia is made in order to give a deeper insight into the various parts of the climate system and how they interact. With an overall volume of several hundred text pages and hundreds of illustration the encyclopaedia explains more than you usually learn in school or read in the news. Nevertheless it does not summarise more than the basic knowledge of climate science in an understandable manner.

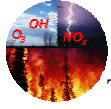


The screenshot shows the ESPERE website interface. At the top left is the ESPERE logo. The main header reads "Environmental Science Published for Everybody Round the Earth" with the European Union flag on the right. Below the header is a navigation bar with "English" selected and links for "Home", "Contact", "espere international", and "What is ESPERE?". The left sidebar contains a menu with "Where do I find ...?", "Climate Encyclopaedia", "Climate in brief", "Climate up-to-date", "About us", and "FORUM, News & Communication". The main content area features a large image of the "Climate Encyclopaedia" cover, which is a red book with a globe on the cover and the word "ESPERE" in gold letters. Below the cover is the text "ESPERE Climate Encyclopaedia". To the right of the cover is a table titled "Choose your topic ...".

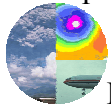
Choose your topic ...		
Lower Atmosphere	basics	more
Upper Atmosphere	basics	more
Weather	basics	more
Clouds and Particles	basics	more
Climate in Cities	basics	more
Oceans	basics	more
Food and Climate	basics	more
People Changing Climate	basics	more

The best way to get an overview is to read the section **Climate in brief** (left bar). Here all fields of the climate encyclopaedia are briefly summarised and links to the encyclopaedia are given.

The main navigation through the topics is within the table top right. You have the choice between two levels: **basics** and **more**.



The topic “Lower Atmosphere” describes main features of the troposphere and air composition. Greenhouse effect, tropospheric ozone formation and ozone smog are discussed. Also main atmospheric chemical reactions are described, and the techniques used in atmospheric research.



In the topic “Upper Atmosphere” we find information about the stratosphere, its structure, dynamics and chemistry. Stratospheric ozone formation and the problem of ozone hole are presented in detail.



The topic “Weather” explains the characteristics of weather, pressure systems, fronts and the atmospheric circulation. Mechanisms of El Niño, North Atlantic Oscillation, and major global wind systems are revealed. Several pages present extreme weather phenomena (e.g. floods, thunderstorms) and their effects, while another unit deals with the methods of weather forecast and their evolution in the past.



“Clouds and particles” is the next topic, explaining how the clouds and atmospheric particles are formed, and how they influence the climate system but also our health.



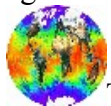
The next topic presents “Climate in cities”. The explanation of air pollution issues (origin, impact, mitigation) is followed by the description of the characteristic features of the local climate in cities (e.g. urban heat island). Finally the acid rain problem is discussed.



The topic “Oceans” shows interactions between the atmosphere and the oceans. The role of ocean currents and air-sea gas exchange (e.g. how oceans take up carbon dioxide) are presented. Several pages explain how phytoplankton and nutrients input (e.g. iron) influence the oceanic processes. The problem of sea level rise is presented, too.



Climatic impacts on agriculture are discussed in the topic “Food and Climate”. Apart from the drought, pests and diseases problems, the impact of greenhouse effect and global climate change are presented. The predicted future climate changes and their influence on agriculture are shown on chosen examples.



The topic “People Changing Climate” discusses man-made climate change, its origin and scope, possible effects (taking under consideration the various vulnerability and adaptation chances of particular regions) and ways of mitigation. International agreements concerning climate are discussed as well as new techniques or actions to be undertaken by individual citizens.

The single texts of the climate encyclopaedia refer to each other and provide also internal links. But they are sufficiently independent to be used each for itself as separate material in classes.

3. How to use it?

The international front page

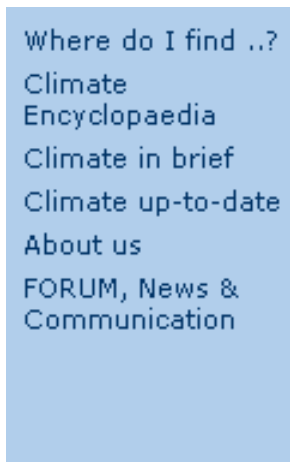
ESPERE-ENC is an international project with many components. The climate encyclopaedia is the core of it. Entering the international address www.espere.net you access the overall international home page.

Here you either find basic information about the project and the ESPERE Association in English on the right (international section), or you directly go to the front page of your language on the left (national section).

The national front page

On all pages in your language you find the basic navigation tools in a horizontal bar and dynamic (= changing) navigation tools on the left in a vertical bar. In the climate encyclopaedia itself you find in addition a navigation table top right, where you can choose thematic fields and levels.

What do you find in the left navigation bar on the front page of your language?

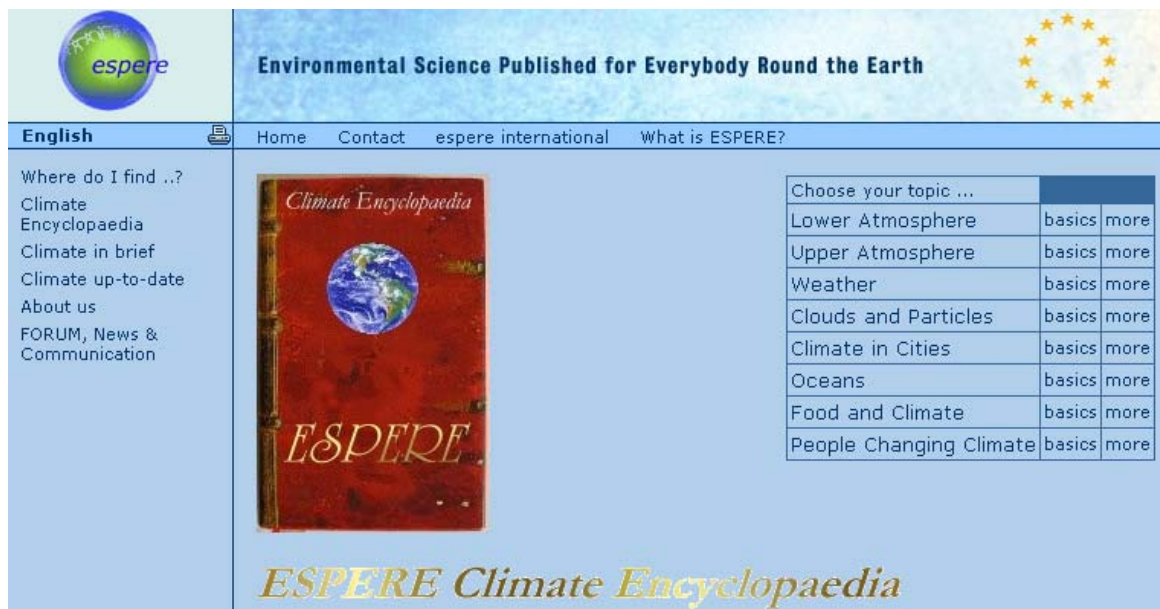


- 1) “Where do I find” provides a short explanation how to navigate within the Encyclopaedia and accompanying information;
- 2) “Climate Encyclopaedia“ leads you directly to the Encyclopaedia. On the front page of the encyclopaedia an overview of the full content is given;
- 3) “Climate in brief” leads you to an overview of the climate system and a summary of the issues explained in the Encyclopaedia;
- 4) “Climate up to date” may lead you to climatic news, public events concerning climate issues or other topical information; the availability of this section is variable.
- 5) “About us” leads to a short explanation of the project ESPERE – Educational Project on Climate (ESPERE-ENC);
6. “FORUM, News & Communication” leads to the Internet forum in your languages, newsletters and information about contact persons.

ESPERE provides the frame for further projects, which are not yet planned. Therefore the page may slightly change. Please inform yourself in the section “Where do I find?”

The Climate Encyclopaedia

The large ‘Climate Encyclopaedia’ is the core of the ESPERE website. Click on the link ‘Climate Encyclopaedia’ and you enter the world of the climate system.

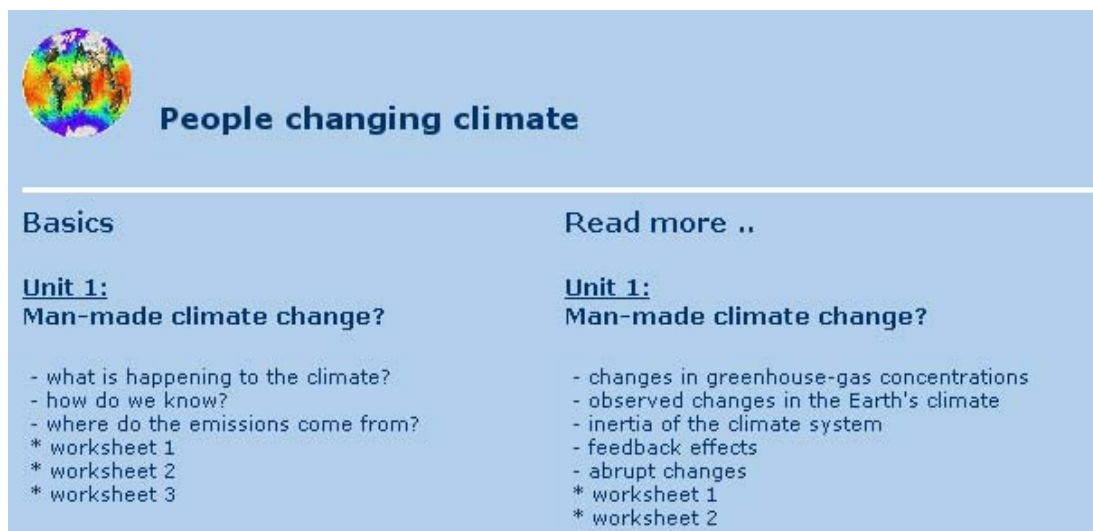


It consists of

- topics, which are divided in
- units, which are divided in
- background texts and worksheets

In order to see, where you are in the encyclopaedia, we developed a multi-level navigation, which provides on every page the full overview. Top right you have a table where you see the division of the encyclopaedia into ‘topics’. Here you make the first choice, in which major component of the climate system you are interested in: choose your topic-row and click on ‘basics’ (lower level) or ‘more’ (higher level).

The names of the topics are very general. Therefore on the front page of the Encyclopaedia, below the navigator, there is a sitemap with the list of units, texts and worksheets, which allows to see the content and topics discussed. Here is one unit example:



People changing climate

Basics

**Unit 1:
Man-made climate change?**

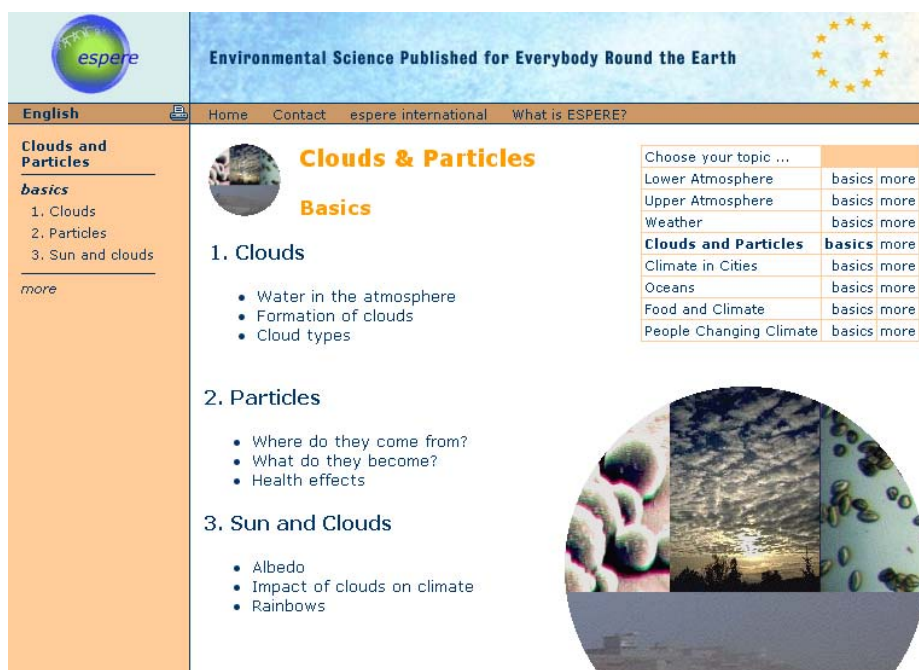
- what is happening to the climate?
- how do we know?
- where do the emissions come from?
- * worksheet 1
- * worksheet 2
- * worksheet 3

Read more ..

**Unit 1:
Man-made climate change?**

- changes in greenhouse-gas concentrations
- observed changes in the Earth's climate
- inertia of the climate system
- feedback effects
- abrupt changes
- * worksheet 1
- * worksheet 2

After choosing the topic and level (for example ‘Clouds and Particles’ basics), you will enter the front page of this topic.



Clouds & Particles Basics

1. Clouds

- Water in the atmosphere
- Formation of clouds
- Cloud types

2. Particles

- Where do they come from?
- What do they become?
- Health effects

3. Sun and Clouds

- Albedo
- Impact of clouds on climate
- Rainbows

Choose your topic ...	basics	more
Lower Atmosphere	basics	more
Upper Atmosphere	basics	more
Weather	basics	more
Clouds and Particles	basics	more
Climate in Cities	basics	more
Oceans	basics	more
Food and Climate	basics	more
People Changing Climate	basics	more

As long as you are in the same topic, you have the topic colour in the left bar (here light orange), the topic headline and the topic icon on top of the white part of the page. A sub-navigation appears on the left. Here you can choose the unit (for example ‘Particles’) and the specific text you are interested in (for example ‘Where do they come from?’). You can

navigate through all texts of both levels of a topic within the left bar. You only need the table top right again, as soon as you would like to change the topic.

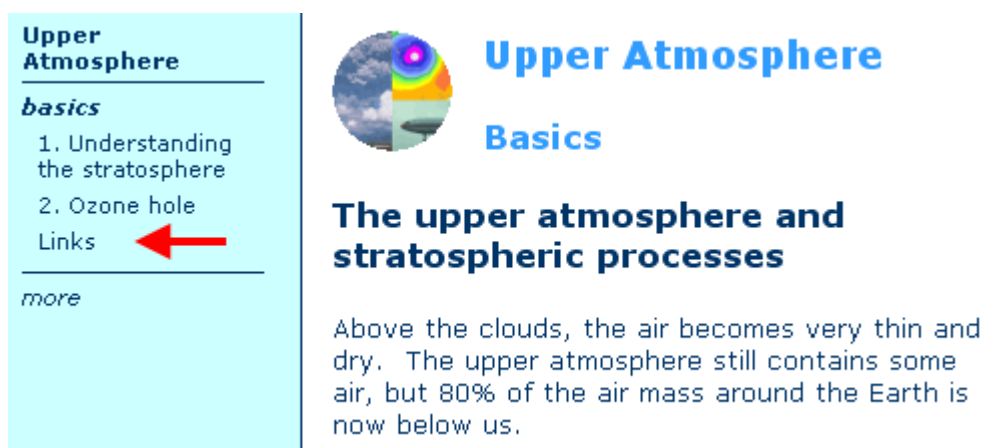
The two levels are made for students of 13-15 years (“Basics”), and for students of 16-18 years old (“More”). However, the proposed division is only a suggestion for the users; students and teachers should decide themselves which pages are needed and useful for them.

Every unit consists of 3-4 texts explaining various aspects of the unit’s topic, enriched with diagrams, photos, animations. At the bottom of many pages there are links to other pages of the Encyclopaedia, which can be useful for a more complete understanding of a given topic. Finally in the footer, you find information about the author, reviewers and last update.

In every unit, you also find worksheets, which often refer to the text. They include interactive quizzes, description of experiments and tasks for individual work, which help better to understand the issues presented. The texts were written by the scientists from research institutes in France, Germany, Great Britain, Hungary, Norway, Poland and Spain. The worksheets were prepared by pedagogists from didactic institutes in Germany and Norway specialised on geography, chemistry and physics.

The Link lists

In particular in English, but also in other language a lot of information on the climate system is published in the Internet. Such publications can be helpful in order to deepen your insight in a certain topic, find alternative aspects or related issues, which are not explained on the ESPERE pages. In each topic you have the choice to click on ‘Links’ in order to go to the respective part of a link list, where web addresses for further reading are given. The link lists are roughly sorted by topic, level of difficulty and exact issue the page is focussing on.



The image shows a screenshot of the ESPERE website. On the left is a light blue navigation sidebar with the following text: 'Upper Atmosphere', 'basics', a list with '1. Understanding the stratosphere' and '2. Ozone hole', 'Links' (with a red arrow pointing left), and 'more'. To the right is the main content area. It features a circular graphic of the Earth's atmosphere with a rainbow-like layer. The text reads: 'Upper Atmosphere Basics', 'The upper atmosphere and stratospheric processes', and a paragraph: 'Above the clouds, the air becomes very thin and dry. The upper atmosphere still contains some air, but 80% of the air mass around the Earth is now below us.'

Since Internet publications are in a state of continuous and fast fluctuation, we cannot guarantee for the quality and topicality of the selection made. However we hope that the given lists are a helpful start for your further inquiry and we also hope to improve them.

Communication

The Educational Network on Climate ESPERE-ENC was made not only in order to provide high quality material, but also in order to initiate the communication between pupils, teachers and scientists. Please make use of the communication tools, ask for the newsletter, use the contact addresses when you have questions and write them to the interactive forum as long as scientists are able to answer your questions there. All communication tools can be accessed from the front page of your language. In particular teachers are also invited to become member of the ESPERE Association and to help to achieve the goals of the initiative.

4. ESPERE and the curriculum

The ESPERE Climate Encyclopaedia shall be used to enrich teaching of various science subjects (geography, physics, chemistry, biology). However, teaching about climate is most often associated with geography.

The International Charter on Geographical Education, published by the Commission on Geographical Education of the International Geographical Union in 1992 (available at <http://education.qut.edu.au/~lidstone/clb361/Module1/Chartertext.htm>), states that geography curricula around the world are commonly structured in two main ways: as *regional studies* and as *thematic studies*. Thematic studies should always have a regional base. Thematic studies curricula in geography may be classified as *systematic*, *issues-based* and *systems* approaches. Climatic issues are included in:

1. Systematic approach to physical geography as climatic geography;
2. Issues-based approach (environmental quality, socio-spatial disparities, hazards and disasters, global change, population dynamics, urbanisation, hunger in the world, energy management, inequalities in race, gender or religion, limits to growth, crisis regions (social, natural, economic), conflict, development problems and strategies, sustainable development);
3. System approach: climatic system as one of the Earth's physical systems.

The ESPERE Climate Encyclopaedia will help to teach about climate regardless the approach chosen by a geography teacher, because the climatic issues are presented from many points of view and in many contexts. However, we believe that climatic issues should be taught not only during the lessons of geography, but also at other science subjects, because the proper understanding of climate requires not only geographical knowledge. Therefore, below we present the connections between ESPERE Encyclopaedia and the national curriculum of science subjects in Poland as examples of rather free curricula allowing transfer to other countries.

4.1. Poland

4.1.1. National curriculum for science subjects and ESPERE materials

If the ESPERE Climate Encyclopaedia was regarded as a source of information only about climate, then it should be useful only in teaching geography. The national curriculum of geography for schools called in Polish "gimnazjum" (for students 13-15 years old) and "liceum" (for students 16-18 years old) includes, among others, the following elements:

1. Functioning of the Earth's natural system – phenomena, processes, interactions, spatial and temporal environmental changes, e.g. weather changes and weather forecast, natural hazards.
2. Functional and spatial links and interactions in the system: humans – nature – economy.
3. The Earth's natural system (including natural environment of Poland):
 - a. climate and weather: causes and effects of climatic zones on the Earth;
 - b. oceans and inland waters: their role in the natural system and human economy;
 - c. soil-forming processes, soil types and their agricultural value;
 - d. flora and fauna: geographical conditions for their distribution and differentiation;
 - e. functioning of chosen types of environment, zonal and azonal;
 - f. explaining the causes and consequences of geographical processes and phenomena and their differentiation.
4. Natural basis for economy: geological structures and mineral resources, relief, climate, waters, soils, fauna and flora. Interactions among the environmental elements.

However, one of the main aims of ESPERE is promoting the education which presents the climatic issues in the context of widely understood science education. Therefore, not only geography should be taken into consideration but also physics,

chemistry, biology and ecological education as well as interdisciplinary approaches. The national curriculum is very general, and climatic issues are linked with so many environmental, economical, political, technical and other problems, that ESPERE materials may be used in many various classes. Below are presented educational aims, skills to be achieved by the students and the content of teaching mentioned in the Polish national curriculum of all mentioned science subjects. The list shows, that there are many occasions while teaching many subjects to use ESPERE materials and explain climatic issues. The next chapter presents concrete teaching programmes, based on the national curriculum, and shows which pages of the ESPERE Encyclopaedia can be used to realize particular topics during the lessons.

POLISH NATIONAL CURRICULUM

Educational aims:

1. Understanding the interactions existing in the natural environment.
2. Understanding the dependence of humans on environment and human influence on nature.
3. Teaching behaviours which help to protect the natural environment.
4. Becoming aware of the civilisation threats due to human activity.
5. Developing the responsibility for actions undertaken in the natural environment.
6. Supporting the self-education through finding and gathering information from different sources.
7. Preparing students for using correctly various sources of information.
8. Teaching students to select and evaluate the information found.
9. Developing the skills of critical usage of information sources.
10. Making it possible for the students to achieve information and practical skills but also the skills necessary to continue the education.
11. Enlargement of the student's knowledge on physics, chemistry and biology in order to understand better the possibilities and limitations of modern science.
12. Developing the research skills used in science.
13. Inspiring the inquisitiveness and searching attitudes of the students.
14. Showing the role of experiment, observation and theory in nature studies.
15. Teaching students how to build models and what is their role in explaining phenomena and making theories.
16. Showing the importance of discoveries in natural sciences for the civilization development and solving the problems of the modern world.
17. Developing the attitudes promoting the care of human health and the protection of natural environment.
18. Teaching students how to individually formulate the opinions about environmental issues, how to discuss using proper terms, and how to solve simple problems.
19. Providing the conditions necessary to plan and conduct experiments on physics, chemistry and biology, and to analyse their results.
20. Usage of computer-based methods to build models and analyse the results of experiments.
21. Showing the students the contemporary research techniques.
22. Teaching about the environment using the examples from every day life.
23. Showing the students the methods of observing, studying and describing the physical and astronomical phenomena.

Skills to be achieved by the students

1. Knowledge of the basic natural laws and the methods used to study them, at the level allowing to begin the university studies in science.
2. Developing the skill of observation and drawing conclusions from the experiments; making general statement based on detailed information.
3. Observation and description of the natural phenomena present in the environment around us.

4. Usage of various sources of information concerning nature.
5. Gathering, integration, studying and interpreting the information from different branches of science, necessary to explain the natural processes.
6. Usage of various methods in nature studies:
 - a. direct and indirect methods of gathering the information;
 - b. evaluation of the information reliability and usefulness;
 - c. principles of formulating and solving problems;
 - d. practical application of the knowledge about nature;
 - e. methods of the research results' presentation;
 - f. formulating the hypotheses;
 - g. analysing and interpretation of the observation and experiments' results together with the evaluation of their reliability;
 - h. analysing the structure and functioning of chosen ecosystems.
7. Evaluation of the changes in the natural environment due to the human activity and their influence on life quality; skill of problem solving.
8. Knowledge about the causes of the present state of the natural environment in local, national and global scale, and about the ways of limiting the effects of negative changes.
9. Noticing the influence of human activity on the environment and achieving the knowledge necessary to conduct pro-ecological actions.
10. Defining the properties of various substances and their impact on natural environment.
11. The skill of usage in every day life the knowledge achieved.
12. The skill of usage of various sources of information in order to enlarge the knowledge achieved.
13. Raising interest in the laws governing nature.
14. Skills of presenting the results of student's own observations, experiments and reasoning.
15. Awareness of the existence of the laws governing the world in micro- and macroscale together with the resulting philosophical reflection.
16. Knowledge about the nature and structure of physics and astronomy, their development and connection with other branches of science.
17. Usage of models to explain physical phenomena and processes, and the awareness on the models' limitations.
18. Planning and conducting simple physical experiments and astronomical observations, making notes about it and analysing the results.
19. Drawing and interpretation of diagrams.
20. Usage of the laws of physics to explain chosen natural processes.
21. Correct usage of geographical, chemical, biological and physical terms.

Content of teaching:

1. The Earth as a part of the Universe.
2. Basic natural laws.
3. Ecological balance.
4. The Earth as the life environment, its history and present state.
5. The Earth as an open physical-geographical system: interactions among the Earth's spheres and their dependence on external factors.
6. Biodiversity (in species, genes and ecosystems), the importance of its protection.
7. Causes and effects of unwanted changes in the atmosphere, biosphere, hydrosphere and lithosphere.
8. Interaction between the Earth and humans.
9. Changes in the relations between humans and the natural environment during various stages of socio-economical development; changes in opinions and attitudes concerning the relation between humans and the natural environment.

10. Economical and social aspects of the links between humans and their economy, and natural environment.
11. Global and regional environmental problems. Examples of international and regional cooperation in solving them.
12. Examples of the influence of geographical conditions on the human population health.
13. The value of the environment. Profits and losses due to its exploitation.
14. Contemporary global economical system and its influence on the degradation of natural resources.
15. International cooperation as a necessary condition of achieving the sustainable development.
16. Civilization threats caused by traditional and nuclear energy production.
17. The intensification of agricultural production and the threats caused by that.
18. Ecological agriculture.
19. State ecological policy.
20. Examples of landscape protection in Poland and other countries.
21. Functioning of the global system: economy-society-environment, and the consequences for life quality of the present and future generations.
22. Management of the Earth's resources.
23. Biological relations within a species and among various species.
24. Matter and energy cycles in various natural systems.
25. Variety of life on Earth.
26. Basic concepts and terms of ecology.
27. Life zones on land and ocean.
28. Substances and chemical reactions in our surrounding.
29. Metals and non-metals, air as a mixture of gases, properties of oxygen and nitrogen, oxides, air pollution.
30. Water and solutions, civilization threats resulting from water pollution.
31. Consequences of wrong usage of chemical substances.
32. Properties of matter.
33. Matter's density.
34. Motion and forces.
35. Gravitation.
36. Electromagnetic waves.
37. Light and its role in nature.
38. Propagation of light: reflection and refraction. The nature of light.
39. Commonness and relativity of motion.
40. Forces' fields and their impact on the motion's character.
41. Order and chaos in nature.
42. Unity of micro- and macro-world.
43. Hydrostatic and aerostatic phenomena.
44. The description of hydrostatic and aerostatic phenomena, and the examples of their usage.

The list above shows that there are many topics in the Polish national curriculum of science subjects which can be realized with the help of ESPERE materials. It does not mean, of course, that teachers of physics, chemistry, biology or geography will suddenly leave the textbooks and work only with the ESPERE website. However, in many cases they can use the ready materials from ESPERE pages instead of looking for it themselves. The ESPERE materials are most useful for interdisciplinary projects, realized during a few months or a semester. Even though they demand additional work, it is worth to undertake them, because the knowledge and skills achieved by the students during such projects are a good investment in their future life and career.

4.1.2. Chosen teaching programmes and the ESPERE materials

After having a look at the national curriculum, let us check how the general assumptions are realized in concrete teaching programmes used in Polish schools of various levels. The analysis was based on the most popular programmes, used nationwide.

Climatic issues are mentioned most often in the teaching programmes of geography and rather rarely in the programmes of physics, chemistry and biology. Theoretically, the national curriculum content should be rather well reflected in the teaching programmes, but in many cases it is not so. Therefore, there are numerous topics, including climatic ones, which are suggested in the curriculum but not found in the teaching programmes, although geography is an exception here. Below are presented some examples of the topics from **chosen** teaching programmes, which may be realised with the support of **chosen** ESPERE materials.

Subject: Geography

School type: "gimnazjum" (students 13-15 years old)

1. Publisher of the teaching programme: Wyd. Szkolne PWN, Warsaw 2001

a. Climate: Atmosphere, its importance for the human activity:

- atmospheric pressure and winds;
- air temperature;
- precipitation;
- climate controlling factors;
- climatic zones.

Encyclopaedia ESPERE: thematic field: *Weather*, level: basics, unit: *The basics about weather, pressure systems and fronts*

b. Interaction Earth-humans: impact of the environment on humans and vice versa, the necessity of the environmental protection.

Encyclopaedia ESPERE: thematic field: *People changing climate*, level: basics, all units

c. Climate of Poland: air masses controlling the weather in Poland, average values of the climatic elements in Poland, transitional character of the climate of Poland, the impact of climate on human life and economy.

2. Publisher of the teaching programme: Wydawnictwa Szkolne i Pedagogiczne

a. Atmosphere as a protective layer of the Earth, structure of the atmosphere. Climatic factors and elements.

Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *An Introduction of the Troposphere*; thematic field: *Higher Atmosphere*, level: basics, texts: *The layers of the atmosphere, Composition of the stratosphere*

b. Oceans: motion of the ocean water as a result of the influence of atmospheric and space factors, various kinds of the ocean water motion (waves, tides, ocean currents) and their consequences.

Encyclopaedia ESPERE: thematic field: *Oceans*, level: basics, unit: *Oceans and climate*

c. Interaction humans-Earth.

d. Monsoon climate, its characteristic features and impact on the agriculture in Asia.

Encyclopaedia ESPERE: thematic field: *Food and climate*, level: basics, unit: *Plants and climate*, text: *Distribution of crops over the world*

thematic field: *Weather*, level: more, unit and text: *Major wind systems*

e. Phenomena endangering the Earth's atmosphere. Ozone hole and greenhouse effect. Causes of the negative phenomena, possible effects and ways of mitigation.

Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *Greenhouse effect, light and the biosphere*, thematic field: *Higher Atmosphere*, level: basics, unit: *Ozone hole*

f. Weather and climate in Poland.

School type: “liceum” (students 16-18 years old)

1. Publisher of the teaching programme: Wydawnictwa Szkolne i Pedagogiczne

a. Processes controlling weather.

Encyclopaedia ESPERE: thematic field: *Weather*, level: more, unit: *More about the Major wind systems, SOI and NAO*

b. Causes of the differences in weather on the Earth and its temporal variability. Description of weather using meteorological observations, synoptic charts and satellite images. Weather forecast and phenomena preceding weather changes. Causes of false weather forecasts. Reactions of human body to weather conditions and changes.

Encyclopaedia ESPERE: thematic field: *Weather*, level: more, unit: *Biometeorology*

c. Weather anomalies and their causes. Examples of natural and economic consequences. Natural hazards due to atmospheric phenomena: drought, downpour, blizzard, storm, tornado. The resulting threats, the areas of occurrence, causes and consequences of natural and economic character.

Encyclopaedia ESPERE: thematic field: *Weather*, level: more, unit: *More about Floods & Thunderstorms*

d. Impact of climate processes and geographical factors on the climatic elements, and the impact of climate on the geomorphological processes, soils, vegetation and on the example of chosen climate types.

e. Climatic differences between rural and urban areas and their causes.

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics and more, unit: *Climate in urban areas*

f. Maritime and monsoon climates, and foggy coastal deserts as a result of ocean impact on climate. Effects of the changes in ocean water circulation (including the El Niño phenomenon).

Encyclopaedia ESPERE: thematic field: *Weather*, level: basics, unit: *The basics about the main circulation systems and El Niño*, text: *El Nino*; thematic field: *Weather*, level: more, unit: *More about the Major wind systems, SOI and NAO*, text: *El Nino and SOI*

2. Publisher of the teaching programme: Wydawnictwo Szkolne PWN

a. Atmospheric pressure, global atmospheric circulation, winds.

Encyclopaedia ESPERE: thematic field: *Weather*, level: basics and more, unit: *The basics about the main circulation systems and El Niño*

b. Water cycle, clouds, precipitation.

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: basics, unit: *Clouds*; thematic field: *Clouds and particles*, level: more, unit: *What happens in clouds?*

c. Climatic factors.

d. Weather forecast. Synoptic maps.

Encyclopaedia ESPERE: thematic field: *Weather*, level: basics, units: *The basics about weather, pressure systems and fronts, Folklore Weather Forecasting*

e. The impact of climate factors on climate elements in Poland. Transitional character of the climate of Poland.

f. Zonal differentiation of climate, vegetation and soils on Earth.

Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *An Introduction of the Troposphere*, text: *Different landscapes - the horizontal extension*

g. Interactions among the environmental elements.

Subject: Physics

School type: “gimnazjum” (students 13-15 years old)

1. Publisher of the teaching programme: Wydawnictwo Szkolne PWN

a. Energy sources.

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics, unit: *Air pollution due to human activity*, text: *Causes of anthropogenic air pollution*; thematic field: *Climate in cities*, level: more, unit: *Air pollution due to human activity*, text: *Fuel combustion in energy production and transportation*

b. Rational usage of energy resources by humans.

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: more, unit: *Air pollution due to human activity*, text: *Mitigation of air pollution*

c. Factors controlling weather on Earth and other planets.

2. Publisher of the teaching programme: Wydawnictwa Szkolne i Pedagogiczne

a. Gases and the vacuum.

b. Pressure and compressibility of gases.

Encyclopaedia ESPERE: thematic field: *Upper Atmosphere*, level: basics, unit: *Understanding and observation of the mid atmosphere*, text: *The layers of the atmosphere*

c. Earth's atmosphere. Relation between atmospheric pressure and altitude.

Encyclopaedia ESPERE: thematic field: *Upper Atmosphere*, level: basics, unit: *Understanding and observation of the mid atmosphere*, text: *The layers of the atmosphere*

d. Relation between a liquid's pressure and depth.

e. Relation between a liquid's volume and temperature. Thermometers.

Encyclopaedia ESPERE: thematic field: *Oceans*, level: basics, unit: *Oceans and climate*, text: *The special properties of water*; thematic field: *Oceans*, level: more, unit: *Oceans and climate*, text: *Sea level rise*

f. Melting. Energy conversion during melting.

g. Melting heat.

h. Evaporation and boiling. Air humidity.

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: basics, unit: *Clouds*, text: *Water in the atmosphere*

i. Evaporation and latent heat.

j. Heat conduction.

k. Centripetal force of the motion along the circumference.

Encyclopaedia ESPERE: thematic field: *Weather*, level: basics, unit: *The basics about weather, pressure systems and fronts*, text: *High Pressure Systems, Low Pressure Systems*

l. Gravitational force.

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: more, unit: *What happens in clouds?*, text: *Formation of droplets*

m. Waves on the water surface (starting from one point).

School type: “liceum” (students 16-18 years old)

1. Publisher of the teaching programme: Wydawnictwo Szkolne PWN

a. Motion in various reference patterns.

b. Types of interactions in micro- and macro world.

c. Thermodynamic processes, their causes and effects.

d. The Sun as the source of energy.

Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: more, unit: *Radiation, Greenhouse gases and the Greenhouse effect*, text: *Earth's radiation budget and Greenhouse Effect*

e. Convection.

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: basics, unit: *Clouds*, text: *Formation of clouds*
f. Heat conduction.
g. Determinism and indeterminism in the description of the nature.

2. Publisher of the teaching programme: Wydawnictwa Szkolne i Pedagogiczne

a. Physics and humans:

- time and motion;
- vibrations, waves, acoustics;
- optics and seeing.

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: basics, unit: *Sun and clouds*, text: *Rainbow*

b. Physics and environment:

- civilisation aspects of energy transformation;

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics and more, unit: *Air pollution due to human activity*

- atmospheric phenomena;

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: basics and more, all units
- The Earth and its place in the Solar System.

Subject: Chemistry

School type: “gimnazjum” (students 13-15 years old)

1. Publisher of the teaching programme: Wydawnictwa Szkolne i Pedagogiczne

a. Composition of the atmosphere.

Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *An Introduction of the Troposphere*; thematic field: *Higher Atmosphere*, level: basics, text: *Composition of the stratosphere*

b. Oxygen and carbon dioxide natural cycles.

Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *Greenhouse effect, light and the biosphere*, thematic field: *Oceans*, level: basics, unit: *Oceans and climate*, text: *How oceans take up carbon dioxide*

c. Air pollution and its effects.

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics and more, unit: *Air pollution due to human activity*

d. Protection from air pollution.

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: more, unit: *Air pollution due to human activity*, text: *Mitigation of air pollution*

e. Water in environment.

Encyclopaedia ESPERE: thematic field: *Clouds and particles*, level: basics, unit: *Clouds*, text: *Water in the atmosphere*

Subject: Biology

School type: “gimnazjum” (students 13-15 years old)

1. Publisher of the teaching programme: Wydawnictwo: Prószyński i S-ka

a. Soil, water and air pollution as the result of intensive economy.

Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics and more, unit: *Air pollution due to human activity*

- b. Examples of contamination in areas located far away from the industry centers, e.g. the ice in Greenland and Antarctic, as a proof of the air pollution long range transportation.
Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics, unit: *Air pollution due to human activity*, text: *Areas endangered by air pollution*
- c. Air pollution sources in your town/village: agriculture, industry, transportation, household.
Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics and more, unit: *Air pollution due to human activity*
- d. Sources of running water pollution.
- e. Classes of water quality.
- f. Composition of the air.
Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *An Introduction of the Troposphere*; thematic field: *Upper Atmosphere*, level: basics, text: *Composition of the stratosphere*
- g. Global threats: acid rains, ozone hole.
Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics and more, unit: Acid rains; thematic field: *Higher Atmosphere*, level: basics, unit: Ozone hole
- h. Greenhouse effect and its predicted consequences.
Encyclopaedia ESPERE: thematic field: *Lower Atmosphere*, level: basics, unit: *Greenhouse effect, light and the biosphere*; thematic field: *Lower Atmosphere*, level: more, unit: *Radiation, Greenhouse gases and the Greenhouse effect*
- i. Smog: a dangerous phenomenon proving high air pollution.
Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics, unit: *Air pollution due to human activity*, text: *Negative effects of air pollution*; thematic field: *Lower Atmosphere*, level: basics, unit: *Ozone and nitrogen oxides as key compounds*, text: *Ozone smog*
- j. Mitigation of the negative human impact on the environment.
Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: more, unit: *Air pollution due to human activity*, text: *Mitigation of air pollution*
- k. Types of behaviour which favour or hinder environmental protection.

School type: “liceum” (students 16-18 years old)

1. Publisher of the teaching programme: Wydawnictwo Nowa Era

- a. Structure and functioning of an ecosystem.
- b. Natural cycles of matter and energy in an ecosystem.
Encyclopaedia ESPERE: thematic field: *Oceans*, level: basics, unit: *Nutrients in the oceans*
- d. Impact of environmental pollution on ecosystems’ functioning.
Encyclopaedia ESPERE: thematic field: *Climate in cities*, level: basics, unit: Acid rains, text: *The impact of acid rain on the natural environment*
- d. Factors controlling the distribution of flora and fauna on Earth.
- e. Life in fresh waters.
- e. Life in the ocean.
Encyclopaedia ESPERE: thematic field: *Oceans*, level: basics, unity: *Gases from phytoplankton, Nutrients in the oceans*

The list above proves that the topics presented in ESPERE Climate Encyclopaedia may be useful for teaching all science subjects, using the teaching programmes available nationwide. Moreover, every teacher has the right to modify the teaching programme he/she is using, or even write a new one, in accordance with the national curriculum. That offers some freedom in the choice of the topics to be realized and materials to be used.

5. Methodology: using ESPERE materials at schools

First of all it is the teacher who has to decide how to treat ESPERE materials. However, the Encyclopaedia provides the means needed to realize a modern, active education model. The model is based on stimulating the students' activity during lessons which leads to better results in knowledge gaining. There are many methods used in science subjects' education to achieve those objectives. Teaching about climate should not be realized only within one subject, e.g. during the geography lessons. Chapter 6 presents how to use ESPERE materials with various technical equipment available at school, and chapter 7 shows examples of lesson scenarios. Every teacher can then choose content and methods which are most interesting and suitable for him. If several teachers from the same school would like to work with ESPERE materials, then the project method can be applied. Teaching about widely understood climate system should use methods which stimulate students to activity, based on inter-subject integration teaching.

5.1. The method of a project

It is a teaching method whose main assumption is that a group of students work on a common project, it takes more than one lesson, and the project may be of research character. It allows to make students very active as they work on concrete tasks in a long time. Students become more self-dependent, creative, and get the holistic image of the world through the interdisciplinary education. The final results may consist of written reports, albums, photos, maps, collections of certain objects, web pages, video films etc. Some of the works submitted for the ESPERE competitions were the outcomes of little projects and fulfilled those assumptions. The project method may also be used to plan or realize students' local actions and activities serving the environmental protection. As far as usage of ESPERE materials in education is concerned, the project method requires co-operation of teachers of science subjects in a certain school.

The method is realized in a few phases:

1. Preparation:

- a. choosing the topic of a project;
- b. definition of particular aims and methods;
- c. choosing the content;
- d. making an agenda and timetable;
- e. choosing persons responsible for the particular project's parts realization;
- f. definition of detailed evaluation criteria of the project's outcomes and students' activity;
- g. definition of cooperation level for the particular project's parts (which parts are done individually and which ones in groups).

2. Realization:

- a. students work in particular project phases;
- b. the teacher observes the students' activity and discusses both current outcomes and problems arising;
- c. improving the project through the changes in original assumptions done during the realization;
- d. preliminary evaluation of the work.

3. Presentation:

- a. internal presentation within the group working on the project;
- b. external presentation:
 - a written report e.g. for the local authorities (if appropriate);
 - exhibition at school;
 - organization of a session;
 - making a film;
 - making a web page.

4. Evaluation of the whole project:

- a. evaluation of the group working;
- b. evaluation of the individual student's work;
- c. evaluation of the students according to the school mark system.

The plan of the project should be well thought over at the very beginning, especially as far as the subject, aims and interdisciplinary teachers' cooperation are concerned. Good cooperation among teachers, supported with their enthusiasm, should even be the starting point for the realization of a project, using ESPERE materials. Once a clear plan is made, the cooperation should not cause much problem, as long as it is systematic and consequent. The presentation is one of the most important phase of the work. Especially the external presentation gives the final outcome a wider context. Students learn that their work should serve other people and not only assure a good mark at school register. The presentation should be well prepared already at the planning phase of the project, in order to make the students' work noticeable for the local community as much as possible. The evaluation within the group is also of great importance. The students can get the information how his work is perceived by the teacher and other students, which is one of the elements motivating for the work.

The project method is the most suitable for realizing education supported with ESPERE materials. However, other methods should also be used during particular phases of a project.

5.2. Other methods

Other methods which can be useful either while used individually during classes or as supporting methods during the project are the following:

1. Working with text: in the case of ESPERE materials it would be mainly the text on the screen of a computer, although all pages are also available in the printable version (in every page there is an icon with the printer in the main upper bar). By giving the students freedom in analysing a chosen text of the ESPERE Encyclopaedia, the teacher can direct their thinking to the topics they will work on later individually.
2. Description: analysis and observation of phenomena and processes, together with efficient problem solving, demand first knowledge and description of the analysed objects, so that they are defined precisely.
3. Observation: one of the typical methods of environmental research is observation of phenomena and processes in the area where the school is located or where the student lives. The teacher should prepare that form of activity to make it efficient. The student should know what to pay attention to, what he can expect, and how to make a report about it afterwards. Those tasks are mentioned in the Polish national curriculum of all science subjects.
4. Measurements: it is an indispensable element of good field exercises and observations.
5. Presentation: a presentation of the objects located in other countries or continents, using modern didactic means, can provide a student with facts and information necessary to analyse them. It is connected with indirect observation of the objects which are not accessible for the

student. The students can however learn about them thanks to modern media e.g. film, photos, Internet, video. Therefore, providing schools with modern technical didactic tools is of great importance.

6. Exercises: field exercises complete very well the knowledge gained through studying the material in Internet. The students can verify in reality the hypotheses and knowledge about the phenomena achieved in a classroom. Field exercises are the best method of direct learning about the environment, and it is the method closely related to the character of science subjects.

7. Discussion: it is very helpful for problem solving during the work on particular tasks. The ESPERE material may be a starting point for a discussion in a classroom or in Internet forum.

8. Case studies method: it is characteristic for the whole educational process of science subjects. Students individually achieve general knowledge starting from well chosen, concrete examples which allows them to see the large scope of environmental issues.

9. Mind map: a visual description of the solved problem is a very effective tool for discussion. It also allows to engage the whole group of students in the discussion and work performed.

10. Talk: facts, phenomena and processes which the students know from Internet pages of ESPERE may be a good start point for a talk organized by the teacher on chosen climatic phenomena.

11. Didactic games: climatic and environmental issues may be a good basis for didactic games, e.g. forecasting environmental effects due to changing a chosen environmental element.

12. Problem-solving method: it is very helpful in independent gaining of the knowledge by the students. Students, with the help of the teacher, try to find the best solution of a given problem. They already know the facts necessary to undertake such a task. The most interesting part of the method is the process of problem formulation and seeking the solution; it is also of great educational value.

6. How to use ESPERE with different technical equipment?

As far as technical equipment at school is concerned, the access to Internet is of great importance. Usually schools in Poland are equipped with overhead projectors and video players, many have beamers, but the complete usage of ESPERE materials requires first of all a computer, preferably with the access to Internet. Theoretically, in every school there are computers available for the teachers and students, but Internet access is not yet always the case. On the other hand, the Encyclopaedia is also available in the form of a CD-Rom, however the content of the Encyclopaedia may evolve in the future, which is often the case for Internet materials; then the CD version may soon become outdated. While using ESPERE materials, however, there is no need that every student sits all lesson long in front of a computer. Apart from using Internet, a student should also be engaged in other kinds of activity. So it is not the constant contact with computer that is needed to use ESPERE materials in an interesting and effective way. Internet and computers are only tools, and overestimating their role can hinder effective education. Below are presented various possibilities of using ESPERE materials depending on the technical equipment available in school, together with some ideas how to organize a didactic process at different options of students' and teachers' access to Internet.

The level of the technical conditions at schools can be evaluated according to the following model:

1) no access to either computer or internet in classrooms - the ESPERE material can be used as outprints of texts and worksheets, or as overheads,

2) access to one computer (with or without Internet access) in the classroom - the ESPERE material can be used from CD or Internet, with the use of the beamer, and the worksheets for the pupils can be printed out,

3) access to the ESPERE material possible for all pupils (CD/Internet) – let the pupils work on the computer provide them with a what-to-do paper (maybe electronical)
Internet access (points 2 and 3) provides the following possibilities: external links (more and not ESPERE-information), forum (e-learning, e-teaching), communication (more information, questions).

Taking under consideration didactic aspects of the computer usage in teaching and the conditions met in Polish schools, the above model can be further developed for Polish conditions in the following way:

6.1. Unlimited access to computers and Internet

If students and teachers have unlimited access to computers and Internet, both at school and at home, that is an ideal situation to use ESPERE materials. It allows the teacher to use the Encyclopaedia during the lesson, even sporadically. At any moment, the teacher can ask the students to enter a certain page of the Encyclopaedia and complete a given task. The materials can be used to enrich teaching of any subject and topic. Students can be given the homework consisting of searching for certain information in the Encyclopaedia or completing the tasks from the worksheets. The outcomes can be reported during the lesson or put to the internet forum, where the teachers can find them and put their evaluation. The lesson can be also organized in such a way that it is completely based on ESPERE Encyclopaedia. Then students complete their tasks in the classroom, using computer all the time, but the teacher directs their work and supervises it all the time. The unlimited access to Internet helps a lot in the realization of the educational projects, as e.g. the materials do not have to be copied, and the teacher spends less time on preparation of the needed materials. Additionally, students can participate in making new pages of Encyclopaedia and have access to current news published in the ESPERE website. Such good technical conditions help develop the new model of education and give students more flexibility in organizing their work.

6.2. Internet access only for the teacher

If it is only the teacher who has the access to ESPERE web pages, then he/she can use the Encyclopaedia to prepare tasks for the students. Internet in that case is only a source of information and didactic materials. The teacher can copy especially the graphic materials from ESPERE web pages and turn it into e.g. overheads. All texts and worksheets are available in the printable version (in every page there is an icon with the printer in the upper bar). Therefore, they can be used during lessons even at no access to internet for the students. It is also possible for the teacher to contribute to ESPERE website and place there his/her own materials or the materials produced by the students. The teacher controls the contact between the students and the website, e.g. decides which news shall reach the students. If the Internet access is limited only to the teacher, it causes him/her additional work, but allows to enrich significantly the educational materials used in classroom. It also helps to filtrate all the environmental information available in Internet, which sometimes is nothing but the “information noise”.

6.3. Limited access to computer and Internet

If both teachers and students have limited access to computers and Internet, e.g. in the afternoons at school library, then the usage of digital media during lessons is not possible. On

the other hand, everybody tries to use Internet most efficiently, without time-consuming surfing in the net. Therefore, the teacher can ask students to complete some tasks using ESPERE Encyclopaedia, but the task must be well thought over and do not demand a too long Internet access. In that case, ESPERE can be only a source of information for further processing in the classroom. If we assume that at least some part of the education with the usage of ESPERE materials should be realized during the lessons at school, then such Internet access limitations could automatically impose the usage of the materials only in educational projects prepared after the school lessons. However, we should remember that the teacher can order the Encyclopaedia in the form of CD-ROM and use it without Internet access. Even with limited access to Internet, a teacher can prepare hardcopies of some ESPERE pages. Students can also interact with ESPERE directly, not through the school or a teacher. Their activity can be stimulated e.g. with competitions or exchange with scientists announced at the ESPERE website.

6.4. Sporadic access to computer and Internet

In many Polish schools there are computer laboratories, with several computers and Internet access, but they are used exclusively for the lessons of informatics. However, lessons of other subjects can be organized there sporadically. In such circumstances, the teacher is in a privileged position, as he/she can use the computer lab individually quite often (almost as if he/she had an unlimited access), while the students can do it only during the lesson. To make good use of such a sporadic contact with Internet, the lesson must be carefully prepared. The teacher must choose only those issues from the teaching programme which are connected and need the usage of ESPERE Encyclopaedia. Students should know in advance what to look for, how to work with the information they find, and how to present it. Such type of Internet access seems to be sufficient to realize an educational project, where only a part of the work needs usage of computer and Internet. The described conditions are rather typical for Polish schools, however, even though the contact with Internet is rather sporadic at school, teachers and students have access to them at home but in various degree. It makes the chances of particular persons for using ESPERE uneven, and creates a rather complicated situation. Therefore, the lessons should be planned in such a way as to respect the possibilities of students who do not have any access to digital media.

6.5. No access to computer and Internet

Even in such situation the ESPERE materials can be used, and there are two possibilities. The teacher may print out the needed materials and use them for the realization of a project apart from regular lessons. Then the project is realized without or with sporadic contact with computers. Another option is choosing by the teacher some material and using it in lessons, so that the students are not even aware that they are using ESPERE materials. The students use materials prepared by the teacher, although containing e.g. figures from the ESPERE website. However, that form of usage of ESPERE materials is most time-consuming and difficult. Therefore, teachers may decide that the work invested is larger than the obtained results and simply refuse to use the website.

7. Lessons with ESPERE (examples)

7.1. Poland

Below we present the examples of lessons prepared by the teachers who participated in the ESPERE workshops in 2003 and 2004. The material is organized following the patterns used in the German “Teachers-Online” platform (<http://www.lehrer-online.de>). Every lesson is related to the issues presented in previous chapters (curriculum, teaching programmes, teaching methods, computer and Internet access). Teachers are encouraged to prepare the lessons' scenarios using ESPERE Encyclopedia, test them in practise, and then submit for the publication in ESPERE website, following the pattern described in the annex, at the end of the book.

Scenarios of the lessons realized with unlimited access to computers and internet at school

Example 1

Topic: Is sustainable development possible?

Authors: Malgorzata Boronska-Dabros, Agata Ciepichal, Eliza Wojtasik

Subject: geography

Students' age: 16-18 years (school type: “liceum”)

Time: 2 lessons

Technical requirements: 1 computer with internet access for every 3 students

Topics discussed during the lesson:

- what kind of air pollution is delivered by a particular branch of industry?
- are the most industrialized countries also most polluted?
- how the environmental protection depends on a country welfare?
- what is sustainable development and is it possible in global scale? Under what conditions?

Connection with the content of the curriculum and teaching programme:

a. relation to national curriculum:

Educational aims:

1. Understanding the dependence of humans on environment and human influence on nature.
2. Teaching behaviours which help to protect the natural environment.
3. Becoming aware of the civilisation threats due to human activity.
4. Developing the responsibility for actions undertaken in the natural environment.
5. Supporting the self-education through finding and gathering information from different sources.
6. Preparing students for using correctly various sources of information.
7. Teaching students to select and evaluate the information found.
8. Developing the skills of critical usage of information sources.
9. Developing the attitudes promoting the care of human health and the protection of natural environment.
10. Teaching students how to individually formulate the opinions about environmental issues, how to discuss using proper terms, and how to solve simple problems.

Skills to be achieved by the students

1. Gathering, integration, studying and interpreting the information from different branches of science, necessary to explain the natural processes.
2. Principles of formulating and solving problems.
3. Methods of the research results' presentation.
4. Formulating the hypotheses.
5. Evaluation of the changes in the natural environment due to the human activity and their influence on life quality; skill of problem solving.
6. Knowledge about the causes of the present state of the natural environment in local, national and global scale, and about the ways of limiting the effects of negative changes.
7. Noticing the influence of human activity on the environment and achieving the knowledge necessary to conduct pro-ecological actions.
8. The skill of usage of various sources of information in order to enlarge the knowledge achieved.
9. Skills of presenting the results of student's own observations, experiments and reasoning.

Content of teaching:

1. Causes and effects of unwanted changes in the atmosphere, biosphere, hydrosphere and lithosphere.
2. Interaction between the Earth and humans.
3. Changes in the relations between humans and the natural environment during various stages of socio-economical development; changes in opinions and attitudes concerning the relation between humans and the natural environment.
4. Economical and social aspects of the links between humans and their economy, and natural environment.
5. Global and regional environmental problems. Examples of international and regional cooperation in solving them.
6. Examples of the influence of geographical conditions on the human population health.
7. The value of the environment. Profits and losses due to its exploitation.
8. Contemporary global economical system and its influence on the degradation of natural resources.
9. International cooperation as a necessary condition of achieving the sustainable development.
10. Civilization threats caused by traditional and nuclear energy production.
11. State ecological policy.
12. Functioning of the global system: economy-society-environment, and the consequences for life quality of the present and future generations.
13. Management of the Earth's resources.

b. the authors used teaching programme for geography by U. Cichon, U. Majewska, W. Skrzypczak, published by EFEKT, Warsaw, 2003.

Educational aims:

- a. general: raising public awareness and understanding of environmental problems;
- b. operational: students understand the idea of sustainable development, evaluate the possibilities of sustainable development in global scale, understand the relation between the public awareness and welfare, evaluate the role of education and science in shaping the public awareness;
- c. didactic: analysing the sources of information available, becoming responsible for the present and future state of the environment, methodically proper usage of statistical data, learning to discuss and listen to the others, learning to work in groups.

The organization of the lessons (what the students do, what materials and methods are used):

1. Students are divided into the groups of 3 persons. Every group has the access to the computer with Internet connection.
2. Each group is given a table to fill in:

No.	Branch of industry	Air pollution

3. Students are given a short introductory lecture by the teacher and then use in groups:
 - a. ESPERE Encyclopaedia page:
<http://www.atmosphere.mpg.de/enid/3rr.html>
 - b. geographical atlases
to fill in the table.
4. Students use geographical atlases and the book “World in numbers” (published by WSiP, Warsaw, 2003) in order to:
 - a. give examples of countries where particular branches of industry are strongly developed;
 - b. give examples of countries where air and water pollution are the highest.
5. Brain storming:
 - a. the dependence between environmental pollution and economic situation in various countries;
 - b. formulation of the conclusions, e.g. the richer the country, the more money it spends on environmental protection;
 - c. formulation of the definition of sustainable development, and discussion whether it is possible in global scale;
 - d. summarizing the discussion.

Example 2

Topic: Influence of air pollution on human health

Authors: Marianna Chełmicka, Elżbieta Dobrowolska

Subject: geography, biology, chemistry, ecology

Students' age: 13-15 years (school type: “gimnazjum”)

Time: 2 lessons

Technical requirements: 1 computer with Internet access for every group of 2 students

Topics discussed during the lessons:

- sources of air pollution;
- influence of particular types of air pollution on human health;
- local meaning of particular types of air pollution.

Connection with the content of the curriculum and teaching programme:

- a. relation to the national curriculum:

- Educational aims:

1. Understanding the interactions existing in the natural environment.
2. Understanding the dependence of humans on environment and human influence on nature.
3. Teaching behaviours which help to protect the natural environment.
4. Becoming aware of the civilisation threats due to human activity.
5. Developing the responsibility for actions undertaken in the natural environment.
6. Supporting the self-education through finding and gathering information from different sources.
7. Preparing students for using correctly various sources of information.
8. Teaching students to select and evaluate the information found.
9. Developing the skills of critical usage of information sources.
10. Making it possible for the students to achieve information and practical skills but also the skills necessary to continue the education.
11. Enlargement of the student's knowledge on physics, chemistry and biology in order to understand better the possibilities and limitations of modern science.
12. Developing the research skills used in science.
13. Inspiring the inquisitiveness and searching attitudes of the students.
14. Showing the role of experiment, observation and theory in nature studies.
15. Developing the attitudes promoting the care of human health and the protection of natural environment.
16. Teaching students how to individually formulate the opinions about environmental issues, how to discuss using proper terms, and how to solve simple problems.
17. Providing the conditions necessary to plan and conduct experiments on physics, chemistry and biology, and to analyse their results.
18. Teaching about the environment using the examples from every day life.

- Skills to be achieved by the students

1. Developing the skill of observation and drawing conclusions from the experiments; making general statement based on detailed information.
2. Usage of various sources of information concerning nature.
3. Gathering, integration, studying and interpreting the information from different branches of science, necessary to explain the natural processes.
4. Usage of various methods in nature studies:
 - a. direct and indirect methods of gathering the information;
 - b. evaluation of the information reliability and usefulness;
 - c. principles of formulating and solving problems;
 - d. practical application of the knowledge about nature;
 - e. methods of the research results' presentation;
 - f. formulating the hypotheses;
 - g. analysing and interpretation of the observation and experiments' results together with the evaluation of their reliability;
5. Evaluation of the changes in the natural environment due to the human activity and their influence on life quality; skill of problem solving.
6. Knowledge about the causes of the present state of the natural environment in local, national and global scale, and about the ways of limiting the effects of negative changes.
7. Noticing the influence of human activity on the environment and achieving the knowledge necessary to conduct pro-ecological actions.
8. Defining the properties of various substances and their impact on natural environment.
9. The skill of usage in every day life the knowledge achieved.
10. The skill of usage of various sources of information in order to enlarge the knowledge achieved.
11. Raising interest in the laws governing nature.

12. Skills of presenting the results of student's own observations, experiments and reasoning.
13. Drawing and interpretation of diagrams.
14. Correct usage of geographical, chemical, biological and physical terms.

- Content of teaching:

1. Basic natural laws.
2. Causes and effects of unwanted changes in the atmosphere, biosphere, hydrosphere and lithosphere.
3. Economical and social aspects of the links between humans and their economy, and natural environment.
4. Global and regional environmental problems. Examples of international and regional cooperation in solving them.
5. Examples of the influence of geographical conditions on the human population health.
6. Substances and chemical reactions in our surrounding.
7. Metals and non-metals, air as a mixture of gases, properties of oxygen and nitrogen, oxides, air pollution.

b. teaching programme used: "Moje miejsce w przestrzeni geograficznej, Program nauczania geografii (gimnazjum)", 1999, (ed.) G. Wnuk, published by Stow. Oświatowców Polskich in Toruń.

Educational aims:

A student:

- can give examples of gaseous, liquid and solid air pollution;
- can describe main sources of air pollution;
- can distinguish the natural and anthropogenic air pollution;
- knows the terms: London smog, LA smog, acid rain, greenhouse effect, ozone hole;
- can explain the effects of air pollution, and their origin;
- knows gases belonging to the so-called "big five-group";
- can describe the effects of the above mentioned phenomena on living organisms (humans, animals, plants) and on climate and buildings;
- knows which branches of industry have the greatest impact on air pollution;
- can propose the ways of limiting air pollution;
- can justify the opinion that air pollution is not only regional but also international problem;
- can combine information and draw conclusions;
- can work in a group effectively;
- can present his own opinions;
- can find the needed information in the Internet.

Pedagogical comments (what was a problem for the students, what should be paid special attention during lessons, etc.): it was difficult for the students to combine information and draw conclusions, and to present their own opinions.

The organization of the lessons (what the students do, what materials and methods are used):

1. A short introduction by the teacher: air pollution and other kinds of pollution (e.g. in water and soil) which endanger our health.
2. Students are divided into the groups of two.
3. Each group is given a table prepared by the teacher:

Polluting substance	Chemical formula	Source of pollution	Impact on humans
Carbon monoxide			
Ozone			
Sulphur dioxide - sulphur oxide (IV)			
Nitrogen oxides			
Dust containing heavy metals			

4. Students fill in the table using ESPERE pages:

- Thematic field: "Climate in cities", level: basic, part: "Air pollution due to human activity", text: "Causes of anthropogenic air pollution"
- Thematic field: "Climate in cities", level: basic, part: "Air pollution due to human activity", text: "*Negative effects of air pollution*"
- Thematic field: "Climate in cities", level: more, part: "Air pollution due to human activity", text: "*Fuel combustion in energy production and transportation*"
- Thematic field: "Climate in cities", level: more, part: "Air pollution due to human activity", text: "*Industry and other branches of economy*"
- Thematic field: "Climate in cities", level: more, part: "Urban climate", text: "Urban bioclimate"

5. Brain storming: which air pollution is the most harmful for human health and why? (e.g. it occurs in many places, little amount causes huge danger)

6. Every group presents the outcome of its work and point of view.

Example 3

Topic: Air quality in your town

Authors: Marianna Chelmiccka, Elzbieta Dobrowolska

Subject: geography

Students' age: 13-15 years (school type: "gimnazjum")

Time: 2 lessons

Technical requirements: 1 computer with Internet access for every group of 2 students

Topics discussed during the lessons:

- system of air quality monitoring in your town,
- air quality and its changes in your town,
- factors controlling the air quality in local scale
- parameters used to evaluate air quality in Poland and abroad.

Connection with the content of the curriculum and teaching programme:

a. relation to the national curriculum:

- Educational aims:

- Understanding the interactions existing in the natural environment.
- Understanding the dependence of humans on environment and human influence on nature.
- Teaching behaviours which help to protect the natural environment.

4. Becoming aware of the civilisation threats due to human activity.
5. Developing the responsibility for actions undertaken in the natural environment.
6. Supporting the self-education through finding and gathering information from different sources.
7. Preparing students for using correctly various sources of information.
8. Teaching students to select and evaluate the information found.
9. Developing the skills of critical usage of information sources.
10. Making it possible for the students to achieve information and practical skills but also the skills necessary to continue the education.
11. Enlargement of the student's knowledge on physics, chemistry and biology in order to understand better the possibilities and limitations of modern science.
12. Developing the research skills used in science.
13. Inspiring the inquisitiveness and searching attitudes of the students.
14. Showing the role of experiment, observation and theory in nature studies.
15. Developing the attitudes promoting the care of human health and the protection of natural environment.
16. Teaching students how to individually formulate the opinions about environmental issues, how to discuss using proper terms, and how to solve simple problems.
17. Providing the conditions necessary to plan and conduct experiments on physics, chemistry and biology, and to analyse their results.
18. Teaching about the environment using the examples from every day life.

- Skills to be achieved by the students

1. Developing the skill of observation and drawing conclusions from the experiments; making general statement based on detailed information.
2. Usage of various sources of information concerning nature.
3. Gathering, integration, studying and interpreting the information from different branches of science, necessary to explain the natural processes.
4. Usage of various methods in nature studies:
 - a. direct and indirect methods of gathering the information;
 - b. evaluation of the information reliability and usefulness;
 - c. principles of formulating and solving problems;
 - d. practical application of the knowledge about nature;
 - e. methods of the research results' presentation;
 - f. formulating the hypotheses;
 - g. analyzing and interpretation of the observation and experiments' results together with the evaluation of their reliability;
5. Evaluation of the changes in the natural environment due to the human activity and their influence on life quality; skill of problem solving.
6. Knowledge about the causes of the present state of the natural environment in local, national and global scale, and about the ways of limiting the effects of negative changes.
7. Noticing the influence of human activity on the environment and achieving the knowledge necessary to conduct pro-ecological actions.
8. Defining the properties of various substances and their impact on natural environment.
9. The skill of usage in every day life the knowledge achieved.
10. The skill of usage of various sources of information in order to enlarge the knowledge achieved.
11. Raising interest in the laws governing nature.
12. Skills of presenting the results of student's own observations, experiments and reasoning.
13. Drawing and interpretation of diagrams.
14. Correct usage of geographical, chemical, biological and physical terms.

- Content of teaching:

1. Basic natural laws.
2. Causes and effects of unwanted changes in the atmosphere, biosphere, hydrosphere and lithosphere.
3. Economical and social aspects of the links between humans and their economy, and natural environment.
4. Global and regional environmental problems. Examples of international and regional cooperation in solving them.
5. Examples of the influence of geographical conditions on the human population health.
6. Substances and chemical reactions in our surrounding.
7. Metals and non-metals, air as a mixture of gases, properties of oxygen and nitrogen, oxides, air pollution.

b. teaching programme used: "Moje miejsce w przestrzeni geograficznej, Program nauczania geografii (gimnazjum)", 1999, (ed.) G. Wnuk, published by Stow. Oświatowców Polskich in Toruń.

Educational aims:

A student:

- knows methods of air pollution research, e.g. with lichens,
- knows how to measure the dust content in air (with the sticking band),
- can measure and evaluate air pollution on the basis of traffic intensity, in the places with intensive and low traffic;
- can analyse the results of air pollution measurements in a certain region;
- can compare the obtained results with the allowed thresholds levels;
- knows and can characterize ways of protection against the air pollution;
- can propose a project of improvements in the state of the environment in his town or region

Pedagogical comments (what was a problem for the students, what should be paid special attention during lessons, etc.): it was difficult for the students to break the communication barrier while making the questionnaires, and it was difficult for them to analyse the questionnaires and draw conclusions.

The organization of the lessons (what the students do, what materials and methods are used):

1. Before the lesson students should visit a local station of air quality monitoring. Addresses of the stations in Poland are available at:
http://www.gios.gov.pl/index_mapa.php?nr=2
2. During the visit at the station the students ask the staff about the results of measurements from last few years, in the form of tables or other format of the data.
3. Students make the questionnaire with the sheets prepared earlier. They ask 10 persons in the street about the intensity of traffic.
4. During the lesson students present the obtained results in diagrams, showing the changes in air pollution in time.
5. Students are divided into the groups of two.
6. Students compare the results presented in the graphs with the Polish allowed thresholds:

Allowed levels of air pollution in Poland

Pollution	Concentration ($\mu\text{g}/\text{m}^3$)	
	In the whole country except the industrial areas	In the protected areas (e.g. spas, national parks)
CO	1000	500
SO ₂	200	75
NH ₃	200	50
NO ₂	150	50
O ₃	30	20
H ₂ S	5	1
Dust $\varphi < 10\mu\text{m}$	120	60

7. Students compare the results with examples from the ESPERE materials:

a. Thematic field: "Climate in cities", level: basic, part: "Air pollution due to human activity", text: "*Negative effects of air pollution*"

b. Thematic field: "Climate in cities", level: basic, part: "Air pollution due to human activity", text: "*Areas endangered by air pollution*"

8. Students analyse the questionnaire and draw conclusions.

9. Brain storming: is the air pollution in your town high? Why? What can be done to change it?

Lessons with unlimited access to computer and internet at school only for a teacher

Example 4

Topic: International cooperation for the environmental protection

Authors: Malgorzata Boronska-Dabros, Agata Ciepichal, Eliza Wojtasik

Subject: geography

Students' age: 16-18 years (school type: "liceum")

Time: 1 lesson

Technical requirements: at least one computer with Internet access in the classroom and a beamer; preferably one computer with Internet access for every group of 2 students.

Topics discussed during the lessons:

- What are the regions most endangered with environmental pollution in your country and why?
- What can be done to diminish the effects of environmental pollution?
- What can we all do in local scale to support the efforts in regional and international scale?

Connection with the content of the national curriculum and teaching programme:

a. relation to the national curriculum:

- Educational aims:

1. Understanding the dependence of humans on environment and human influence on nature.
2. Teaching behaviours which help to protect the natural environment.
3. Becoming aware of the civilisation threats due to human activity.
4. Developing the responsibility for actions undertaken in the natural environment.

5. Supporting the self-education through finding and gathering information from different sources.
6. Preparing students for using correctly various sources of information.
7. Teaching students to select and evaluate the information found.
8. Developing the skills of critical usage of information sources.
9. Making it possible for the students to achieve information and practical skills but also the skills necessary to continue the education.
10. Inspiring the inquisitiveness and searching attitudes of the students.
11. Developing the attitudes promoting the care of human health and the protection of natural environment.
12. Teaching students how to individually formulate the opinions about environmental issues, how to discuss using proper terms, and how to solve simple problems.
13. Teaching about the environment using the examples from every day life.

- Skills to be achieved by the students

1. Gathering, integration, studying and interpreting the information from different branches of science, necessary to explain the natural processes.
2. Direct and indirect methods of gathering the information.
3. Evaluation of the information reliability and usefulness.
4. Principles of formulating and solving problems.
5. formulating the hypotheses.
6. Evaluation of the changes in the natural environment due to the human activity and their influence on life quality; skill of problem solving.
7. Knowledge about the causes of the present state of the natural environment in local, national and global scale, and about the ways of limiting the effects of negative changes.
8. Noticing the influence of human activity on the environment and achieving the knowledge necessary to conduct pro-ecological actions.
9. The skill of usage in every day life the knowledge achieved.
10. The skill of usage of various sources of information in order to enlarge the knowledge achieved.
11. Skills of presenting the results of student's own observations, experiments and reasoning.

- Content of teaching:

1. Biodiversity (in species, genes and ecosystems), the importance of its protection.
2. Causes and effects of unwanted changes in the atmosphere, biosphere, hydrosphere and lithosphere.
3. Interaction between the Earth and humans.
4. Changes in the relations between humans and the natural environment during various stages of socio-economical development; changes in opinions and attitudes concerning the relation between humans and the natural environment.
5. Economical and social aspects of the links between humans and their economy, and natural environment.
6. Global and regional environmental problems. Examples of international and regional cooperation in solving them.
7. The value of the environment. Profits and losses due to its exploitation.
8. Contemporary global economical system and its influence on the degradation of natural resources.
9. International cooperation as a necessary condition of achieving the sustainable development.
10. State ecological policy.
11. Examples of landscape protection in Poland and other countries.

12. Functioning of the global system: economy-society-environment, and the consequences for life quality of the present and future generations.
13. Management of the Earth's resources.

b. teaching programme used: "Program nauczania geografii w liceum ogólnokształcącym - kształcenie w zakresie rozszerzonym" by P. Wład, published by ORTUS in Raszyn, 2002.

Educational aims:

- students define their role and the role of the state in the environmental protection;
- students can name the elements of state environmental policy (legal, organizational, technical and economic activities);
- students can work with certain material using Internet;
- students can work in groups.

Pedagogical comments (what was a problem for the students, what should be paid special attention during lessons, etc.): students do not know legal basis for the environmental protection, so to facilitate the discussion it would be good to ask them earlier to prepare some information about it, e.g. from the internet.

The organization of the lessons (what the students do, what materials and methods are used):

1. Students are given a short introductory lecture by the teacher on the mitigation of air pollution, illustrated with the material from the ESPERE Encyclopaedia at the page: <http://www.atmosphere.mpg.de/enid/3rt.html>
2. Students are divided in the groups of 2 persons.
3. Each group receives a table with the information about euroregions in Poland (source: A. Stark, G. Wnuk, A. Zimonczyk, "Świat w fazie przemian", part 3, published by Stowarzyszenie Oświatowców Polskich in Torun in 2003). The students chose the euroregions where the environmental protection is the priority.
4. Each group obtains the contour maps of Europe (source: R. Domachowski, G. Młynarczyk, E. Pelle, "Zadania na mapach konturowych i topograficznych", chapter: Współpraca nadgraniczna – euroregiony, published by DEMART in Warsaw in 2004) and mark on them the chosen euroregions.
5. Students analyse the text from the ESPERE page mentioned above. In case there is no computer/Internet access for every group, students are given a printed hardcopy of the web page.
6. Brain storming: What kind of activities were undertaken in your town in order to mitigate the environmental pollution?

Lessons without access to computer or internet at school

Example 5

Topic: Natural optical phenomena

Authors: Danuta Biczewska, Jadwiga Jaworska

Subject: physics

Students' age: 13-15 years old (school type: "gimnazjum")

Time: 2 lessons

Technical requirements: preferably computers with Internet access in the classroom (1 computer per 2 students); in case only one computer with Internet access is available, the beamer is needed; in case no computer is available the overheads may be used, prepared earlier from e.g. ESPERE materials.

Topics discussed during the lessons:

- What are the properties of light?
- What are the processes connected with light?
- How can observed natural optical phenomena be explained with that theoretical knowledge?

Connection with the content of the curriculum and teaching programme:

a. relation to the national curriculum:

- Educational aims:

1. Understanding the interactions existing in the natural environment.
2. Inspiring the inquisitiveness and searching attitudes of the students.
3. Showing the role of experiment, observation and theory in nature studies.
4. Teaching students how to build models and what is their role in explaining phenomena and making theories.
5. Teaching about the environment using the examples from every day life.
6. Showing the students the methods of observing, studying and describing the physical and astronomical phenomena.

- Skills to be achieved by the students

1. Developing the skill of observation and drawing conclusions from the experiments; making general statement based on detailed information.
2. Observation and description of the natural phenomena present in the environment around us.
3. Usage of various methods in nature studies:
 - a. direct and indirect methods of gathering the information;
 - b. practical application of the knowledge about nature;
 - c. methods of the research results' presentation;
4. The skill of usage in every day life the knowledge achieved.
5. Raising interest in the laws governing nature.
6. Skills of presenting the results of student's own observations, experiments and reasoning.
7. Awareness of the existence of the laws governing the world in micro- and macroscale together with the resulting philosophical reflection.
8. Usage of models to explain physical phenomena and processes, and the awareness on the models' limitations.
9. Drawing and interpretation of diagrams.
10. Usage of the laws of physics to explain chosen natural processes.
11. Correct usage of geographical, chemical, biological and physical terms.

- Content of teaching:

1. Basic natural laws.
2. Properties of matter.
3. Light and its role in nature.
4. Propagation of light: reflection and refraction. The nature of light.

b. teaching programme used: Ministry of education signature: DKW-4014-105/99 published by Zamkom, DKW-4014-30/01 published by MAC Edukacja, DKW-4014-93/99 published

Educational aims:

a. general aims:

- fixing the knowledge about basic properties of light and the laws of geometric optics;
- showing the presence of natural optical phenomena and explanation of their origin using the laws of geometric optics;
- teaching students to observe changes in nature, to look for cause-effect connections, and to formulate conclusions due to observing certain phenomena and using the knowledge gained earlier.

b. Operational aims:

- the students know that the light radiates rectilinearly, provides energy, is reflected, and the atmosphere is able to reflect the solar light;
- the students know and can name and define: the law of light reflection, the phenomenon and the law of light refraction, the phenomenon of light dispersion, natural optical phenomena resulting from the light reflection and refraction (mirage, Fata Morgana, sun pillars, broken bow), natural optical phenomena resulting from the light refraction and dispersion (rainbow), other natural optical phenomena which cannot be explained with the laws of geometric optics (glory, corona (diffraction and interference), aurora (magnetic field), and light emission by flora and fauna;
- students understand and can explain typical situation for: occurrence of a shadow, relation between the angle of the light incidence and reflection together with its consequences, relation between the amount of solar energy reaching the Earth and amount and type of cloudiness, the protective role of ozone layer and clouds, the phenomenon of light refraction due to the difference in density and speed of the light radiation, the phenomenon of white light dispersion, the mechanism of the rainbow origin;
- students can use the knowledge in complex situations: draw the position of Earth, Sun and moon during the eclipse, explain the necessity of eyes protection from the solar light reflected from snow and water (accumulation of energy), can explain the colours of the sky at different times of the day, can explain the influence of dust air pollution on the sky colour, especially at sunset, can explain apparent shallowing of rivers and water reservoirs, can explain atmospheric optical phenomena connected with different light radiation in media of different density.

Pedagogical comments (what was a problem for the students, what should be paid special attention during lessons, etc.): while using the method of mind mapping it is important to remember that:

- The topic of the map must be in the centre of the paper sheet and may be replaced with appropriate icon,
- It should be key-words, not sentences that should be put down,
- Words should be written along the line,
- The line must be as long as the word,
- The icons replacing the words must well correspond to them.
- The work in groups should go on with a certain speed, that should be controlled.

The organization of the lessons (what the students do, what materials and methods are used):

1. The teacher informs the students that the method of mind mapping will be used during the lesson. If they are not familiar with it, the teacher presents shortly the method's assumptions.
2. The teacher presents the aims of the lesson to the students and writes its title on the blackboard: "Natural optical phenomena".
3. The teacher puts on the blackboard a big sheet of paper and writes in the middle of it: LIGHT, then draws three arrows and names them: "properties", "phenomena" and "observations".
4. A few students chosen to be the teacher's assistants give to every 2 students a few sheets of paper. The students will use it to copy the image created on the blackboard and for group work, i.e. for writing down the names of the phenomena and processes. Their sheets of paper will be then attached to the big one on the blackboard to complete it.
5. All students are divided into 2 groups and asked to recall the most important properties of light (it is not visible, the light radiates rectilinearly, the light carries energy), and processes connected with light (reflection, refraction, dispersion, diffraction, interference), and to put down that information in the form of key-words on the sheets of paper, which they then attach to the big one in the parts "properties" and "phenomena".
6. The students are asked to recall and name optical phenomena which they experienced themselves, or they heard about, and which can be explained with the laws of geometric optics. Students put down the names on the sheets of paper and attach them to the big one in the part "observations". **Attention:** the teacher must steer that discussion carefully.
7. The students try to explain the named phenomena using the basic laws of optics, the teacher verifies their statements, and does not allow to put on the big board the names of aurora, glory and corona; those names should be put aside, on the blackboard.
8. The teacher shows graphic material concerning the discussed phenomena. If there is no access to computer, overheads are used. If there is the access to computer but without Internet connection, a PowerPoint presentation can be used. If there is a computer with Internet access, the ESPERE materials can be presented directly from the website. The pages to be used:

<http://www.atmosphere.mpg.de/enid/3sm.html>

<http://www.atmosphere.mpg.de/enid/25y.html>

9. The students mark on their sheets of papers and on the big board the correct connections between phenomena and observations.
10. The teacher summarizes the lesson using the complete mind map, and tells the students that some phenomena cannot be explained with the geometric optics, but with the wave nature of light or other processes (and points the names of the phenomena written aside, on the blackboard). If there is enough time, the teacher can shortly explain those phenomena.

8. Test the pupils

8.1. Worksheets of the ESPERE Encyclopedia

ESPERE Climate Encyclopedia contains the worksheets for the students divided into:

- experiments
- tests, quizzes.

Worksheets accompany the texts and are integral parts of the units. Their content corresponds to information presented in the texts of a certain unit. The tests (quizzes) usually have about 10 questions, and the student should choose the right answer for every question, so the test checks the knowledge of the student gained after working with the ESPERE material. If a student is working with the computer and solves the test on the screen, then the programme shows the results at the end and allows to find out which answers were wrong. So it is a test designed mainly for the self evaluation of the student. However, if there is no access to computer and internet, the teacher can print out the test and ask students to fill it in on the paper. The teacher can also use fragments of the tests as a starting point of a lesson, e.g. start the lesson with the question what factors control the climate in a city? Another possibility is to give at the beginning the suggestions about possible answers, as hypothesis which the students verify during the lesson. The tests may be then used by the teachers in many various ways, according to the technical possibilities and preferred scenarios of lessons.

In some worksheets there are suggestions for the students which guide their work. For example students are asked to make some measurements or observations and then convert it into tables, graphs, maps. Such form of activity is not only interesting but also valuable from didactic point of view. It allows a student to use his skills and stimulates him for being active. Moreover, a student is motivated to learn more about the place in which he lives.

The worksheets test the students' knowledge in many different ways, and encourage them to observe and evaluate the phenomena in the world around us. It is therefore an interesting material which allows a student work independently, regardless the internet access. It is also a valuable didactic tool for a teacher, who can use the worksheets directly or after adjusting them to his needs.

8.2. Examples of the tests based on the lessons' scenarios and ESPERE materials

Every teacher can prepare his own lesson scenario using the ESPERE materials, as shown in chapter 7. Below are presented the examples of tests for students, prepared on the basis of those scenarios and materials from the ESPERE Encyclopaedia.

Test 1

Topic: Is sustainable development possible? (chapter 7, scenario example No. 1)

Task

Chose the right answers:

1. The exhaust gases deliver to the air mainly:

- a) sulfur dioxide
- b) nitrogen oxides and carbon monoxide
- c) mercury

2. Sulfur dioxide is delivered to the air mainly by:

- a) refineries

- b) energy production
- c) building materials production

3. Energy production does NOT cause delivering to the air:

- a) sulfur dioxide
- b) mercury
- c) nitrogen oxides

4. The heavy metal delivered to the air by both energy production and transportation, metallurgy and chemical industry is:

- a) mercury
- b) cadmium
- c) lead

The ESPERE page used: Thematic field: "Climate in cities", level: more, part: "Air pollution due to human activity", text: "*Industry and other branches of economy*"

Test 2

Topic: Influence of air pollution on human health (chapter 7, scenario example No. 2)

Task

Which organs of our body are especially susceptible to damage due to the air pollution effects? Fill in the table below.

Organs	Pollution							
	SO ₂	NO _x	CO	Cd	Pb	F	O ₃	VOCs
Lungs								
Heart								
Eyes								
Brain								
Liver								
Kidneys								
Bones								

The ESPERE page used: Thematic field: "Climate in cities", level: more, part: "Urban climate", text: "Urban bioclimate"

Annex

How to create teaching units for ESPERE

The following recommendations address teachers, who would like to build up online units, either on the ESPERE platform or on any other teaching platform, perhaps also provide them on their own website for the pupils. Recommendations base on the long term experience of the German Internet service for teachers 'Lehrer online'.

Fundamentals

text files

Use Microsoft doc-/rtf-format or the Adobe pdf-format for text files. The whole text has to be in one file (no collection of different files). If you integrate images within the text, please make sure that the images are also separated from the text in an image directory (zipped in one file). Working sheets are separated files for download – zip them to spare download time.

Formatting

Do not use much formatting within text files. But use more captions and sub-captions and structure the text in small amounts to make it readable for the internet.

Pictures and graphics

Pictures and graphics are sometimes very small when they are representend on the screen. So pictures are only understandable if they don't have too much details. If you have to use pictures or graphics with much details please make sure that they can be opened in a separate window. The format of the pictures and graphics should be of gif-, jpg- or png-format. Check the copyright especially for pictures.

Links

If you use internet-links think about that the relevant content can be found by simple means. Use only sites where you can be sure that the URL and the contents of the site will be stable for a long time (wishful thinking).

Do not use much links within the text. It's better to have a link-list at the end of the text and it's better to have some good links only than too much links. Working sheets for the pupils should only contain a small amount of internet-links.

Copyright

As an author you are responsible for the content of your work. If there is a copyright from another side inside your work you have to clear the right beforehand and you have to mark the copyright of another side inside your work.

Contact e-mail

It is important for questions and remarks of the readers for the author to give an e-mail-adress. This address will be published with your personal description at the end of the text.

Personal description

The personal description of the author includes age, education, job, working field

The structure of a teaching unit with Espere

The teaching unit has to be publishable for the internet and has to be structured in following parts:

Short description

Here you describe the content and structure (central learning aims) of your unit and how long it takes to teach (a maximum of 500 words)

Learning aims

Oriented at the Curriculum you describe what competences of the pupils will be strengthened. Differentiate between subject-related learning aims and media-related learning aims.

Summary

in tabular form:

theme of the unit

author

subject

age of pupils

time (how long does it take to teach the unit – how long is the preparation time for the teacher)

media (what kind of media do you need for the unit)

technical constraints (for example: internet access for all pupils / only for the teacher)

How to do

A detailed time frame of the unit helps the other teachers to get an overview of your unit.

Use the following table:

<i>Phase</i>	<i>Content</i>	<i>Action</i>	<i>Media / Data</i>

Didactic-methodic comments

Argue for your kind of how you did this unit and say why it's good to use the Climate Encyclopedia ESPERE for this unit

Download

Make your working sheets downloadable (zip-file). The workings sheets should be in rtf- or pdf-format..

Internet-adresses

Please list here all the Internet-adresses (URLs) which are used within the unit or the teacher needs for preparing the unit

Further informations

Here you can give further informations like other units which fit to the current one, other units of the author etc.

Author information

Some short descriptions as age, education, job, working field and e-mail-adress for contacting the author

Length of the unit

1500-3000 word + working sheets