The ENVRIplus guide for teachers

Motivating Secondary School Students To Learn Research Methodology In Science

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A guide to accompany you through the game

The Game guide is designed to give you indications on how to use the project with your students. The project is addressed to high school students and teachers, and it consists of a series of consecutive steps leading to the final game. The project includes a number of supporting materials deepening the themes approached in the course of the game; each of them described in detail throughout this guide with indications of the **teacher's** role.

If you would like to further understand the pedagogical basis and background of this project, please visit our web site.

A step-by-step guide

1. INTRODUCTION

1.1 What is the link between schools, the game and students?

In a Europe that needs to adapt to a rapidly changing business and learning environment, it is critical for students to understand how science and technology provide the basis for the fundamental advances in education and workplace. The goal of the ENVRIplus GAME is to develop a new teaching approach and pedagogical strategy for learning a methodology useful in all the subjects of the scientific research, and also to realize and apply creative and innovative thinking.

Today science and scientific methodologies cannot be limited to the small percentage of science students in schools, all students must understand these processes and the part they will play in their future educational paths and careers.

The use of new technologies, including different types of games that go in the direction of the Problem Based Learning, will make a discipline more appealing and engaging for students of new generations. Therefore we propose a project that involves students and **teachers** giving them the opportunity to know and use new technologies and interact with each other in Europe.

1.2 Aims of the Project

What is the ENVRIplus GAME?

The ENVRIplus Game is an online project open to all schools in Europe. It is suitable for 10 year-old or older students. Your pupils and you will be invited to test students' skills on the scientific method and biodiversity research.

The ENVRIplus Game project will motivate secondary school students by replicating the excitement of scientific research. The Project has created an Internet-based game to develop an understanding of the research work and teach best practices.

Why to participate?

Playing the games proposed by the project, your students will improve their knowledge concerning the scientific way to study the reality around them, particularly biodiversity. By 'doing' these activities, students will become able to plan on their own new exciting ecological

researches. Moreover students will participate in a big final European competition, during which they will be demanded to interact with students from other European schools!

In fact, during the ENVRIplus Game, your pupils will collaborate internationally across Europe, to build hypotheses, research and test the validity of their hypothesis, and finalize a theory based on their findings. They will be expected to share their research findings with the other groups.
Students will learn in a fun and engaging way the logical thinking and deductive reasoning, a core skill required not only in science, but also in all their futures activities

What is the ENVRIplus Game's aim?

The project aims at:

FOR STUDENTS	motivating young people towards research and enhancing their ability to realize creative thinking, apply test and hypothesis, get confidence and practicality, and develop research projects as a valuable tool for their future careers
	helping young people to acquire the basic life-skills and competences necessary for their own personal development and future employment opportunities
	helping the promotion of creativity and competitiveness in the working environment.
FOR TEACHERS	supporting European **teachers** to use these proposed innovative approaches to set up a research work
	supporting the development of innovative ICT-based contents, services, pedagogies and practices for lifelong learning
	improving the volume of partnerships among schools in different Member States

1.3 Why playing the ENVRIplus Game and learning the scientific method?

Why do young people need science and the scientific method in their life?

- Do they take pills?
- Do they use a mobile?
- Do they surf on the Internet?

All these normal, everyday activities are based on the scientific method and research, the basis of science. Even simple everyday things needs science for their development and

manufacture. Today and tomorrow, young people will use the scientific method and its analytical structure for their education and careers.

In this context the Research Game represents an opportunity for young people to learn more about the scientific method.

The Game has been conceived for secondary school students and will show how the scientific method is the system that all those who want to develop an effective and productive education and career need to understand. Without the scientific method, and its way of thinking, it is hard to progress in the modern world.

Moreover, the ENVRIplus Game allows students to find out how to do a lot of the things summarized in the *learning outcomes:*

- develop an understanding of scientific methodologies
    - improving clarity about different stages of problem solving
    - developing an understanding of how to formulate hypotheses, identify relevant variables, collect and analyse data, interpret findings
    - stimulating, inspiring and enhancing their motivation to undertake research projects and apply the scientific methodology
    - developing their ability to deal with uncertainty
- develop skills and competencies in a wide range of environmental research domains
    - improving students' awareness and knowledge of biodiversity
    - becoming active citizens and stewards of the environment
- make learning more engaging and relevant to young people
    - developing logical reasoning and critical thinking skills
    - developing transversal competencies
    - providing opportunities for informal learning through game playing activities
    - promoting the use of the Internet and information technologies
- provide challenge and the opportunity to communicate with students from all over Europe
    - developing logical reasoning and critical thinking skills
    - connecting local investigations to global issues.

The game will challenge students to complete a scientific research on **Biodiversity,** this field has been chosen as it includes a number of different areas of science and is relevant to everyone. Studying Biodiversity your pupils can learn more about the genetic diversity, the diversity in terms of species, the diversity in terms of ecosystems and landscapes.

1.4 What will happen during the project?

The Research Game includes three main steps and can be played either as part of the curriculum, or as an extra-scholastic activity. It includes:

a) training components, with entry-level materials available on the project website and tools for deepening their knowledge

b) self-training sessions, to practise and earn points in the game, designed on the basis of a *learning by doing and cooperative learning* approach

c) a final competition played through an online game.

The fundamentals of the game are:

1. students' autonomy
2. use of English, or other common languages, to communicate within each collaborative international group – game submission languages dependent on partner language competencies
3. **teachers as facilitators and mentors ONLY**
4. students as key actors of the game – learning by doing
5. structured appropriate documentation for students and teachers:
4. game templates.

2. A quick guide to the ENVRIplus Game

2.1 Training components

Should you want to know more about the *training components* aspects (see section 1.4), different types of material about the general characteristics of the project, background documents on the scientific method, on ecology, biodiversity and more are available on the project web site.

2.2 Learning by doing and cooperative learning

The activities that **teachers** and students have to perform during the '*learning by doing and cooperative learning*' phase are summarized in the following scheme. As soon as the registration of the teams opens, they will have access to the ENVRIplus

Game website and begin with the process that will lead them to the final competition, improving their score at every step completed along the process.
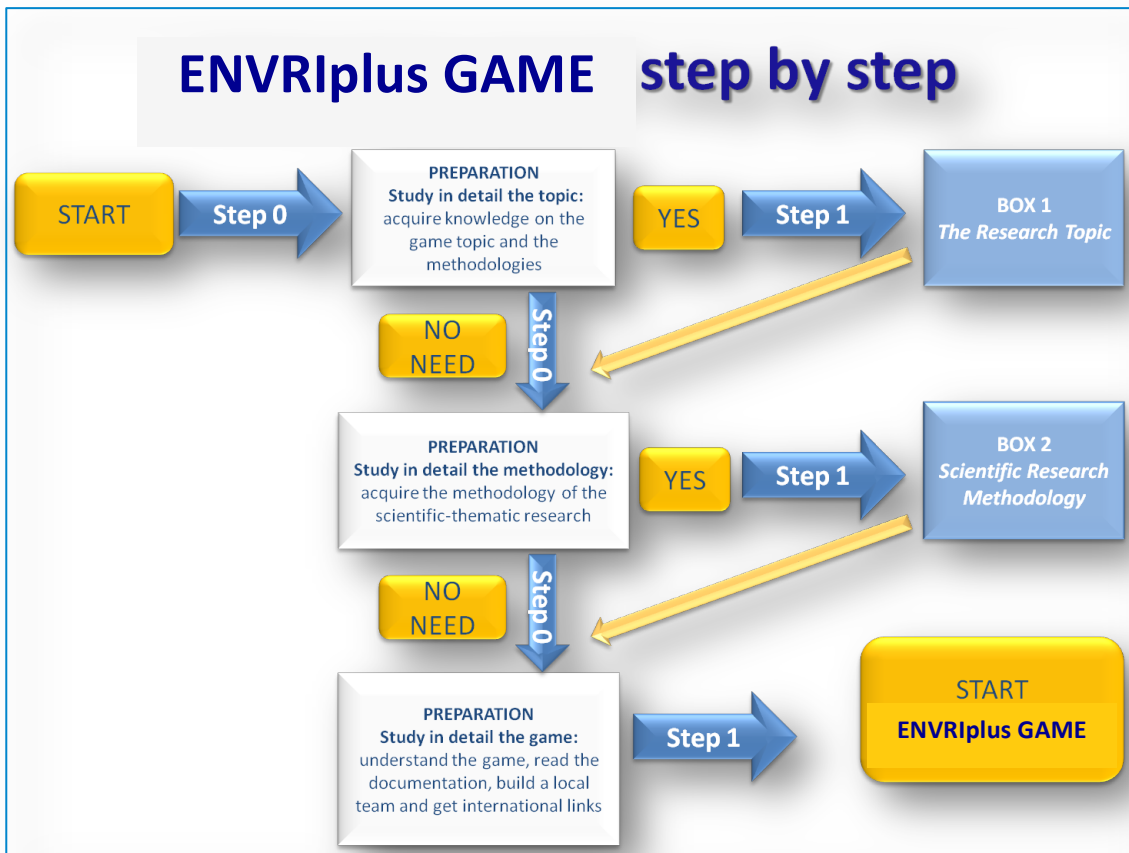
Starting from the training sessions, **teachers** will discuss with the components of their teams the learning approach to the game, having the open option to acquire information about the topic of the game and the methodology from the project web site, where they will find specific sections dedicated to these aspects.

❖ '*Learning by doing and cooperative learning*' description

The '*learning by doing and cooperative learning'* is in itself a self-training session for the teams and has to be intended as a preparation for the final game. However this phase will be included in the overall evaluation. Although schools from all countries will be invited to participate to this phase, this will be consider a facultative session of the game. Teams will not be required to compulsory run any *learning by doing* session to be admitted to the final online competition.

In this session, the *cooperative learning* method is part of the active learning methodologies, based on the positive interdependence between group members. It is useful to underline that the cooperative method is an experiential and motivating educational approach, able to value the different intelligences and learning approaches of the groups' members.

However, teams who had run the *learning* session will keep their scores when entering the final online competition.

During the *learning* session each team in the schools will carry out simple experiments about the biodiversity following the schematic steps suggested by the project team in this guide. These may be field or laboratory experiments, as well as desk experiments, run on computers using available experiments and data. The teams will then enter their work results into the ENVRIplus project website and share the products of the own research work (e.g., video, paper, report). Teams will also be invited to review and evaluate the reports submitted by the other teams, highlighting limits in the methodology used and in the consistency of the results presented and the conclusions drawn on that basis. The teams' activities, including the experimental work done, the report and the review work on other teams' reports, will be evaluated by an Awarding Commission, which will evaluate every team's activity, granting credits that teams will use during the final competition.

All required information/videos/documentation will be included within the game itself and all pre-required information to play the game will be made available on the project's platform.

The learning session includes the following stages:

✓ activities
✓ compare & report
✓ the "what I have learnt" game

The different stages are described in the table below together with the roles of **teachers** and students composing each team.

	Game Stage	Students	Teachers
Activities	Introduction to the project		What we are going to do? Introduction to the creation of a hypothesis on environment - Question based
	Pre-game / preparation	Completing pre-questionnaires to asses expectations & experience	Completing pre-questionnaires to asses expectations
	Team	Composing the teams	Oversight
	Hypothesis	Selecting the idea (hypothesis)	Oversight
	Observation	Observing and taking notes	Oversight
	Desk study	Preparing & completing desk researches Studying the chosen topic using books, internet or other sources; identifying what is known	Oversight
	Ask questions	Formulating work hypothesis	Oversight
	Field and/or laboratory study	Preparing & completing field researches Designing sampling or laboratory experiences (test of the hypothesis; use of the controls; choice of the techniques)	Oversight
	Compile and analyse data	Organizing data, applying data analysis and methodologies	Oversight
	Discuss the results	Comparing with what is known	Oversight
Comparison & reporting	Draw the conclusions	Drafting the conclusions. Formats: document and video	Oversight
	Compare with a paired school	Repeating the experiment (if s possible) Drawing the critical conclusion	Oversight
What I have learnt game	The Online game	Playing the online game based on aspects of the scientific method	In-game guidance
	Questionnaires	Automatic compilation of results	Oversight

The results of the students' work will be presented as:

    a.   video records of the work and the reached conclusions - including field research/ conclusions. In the video (a very student friendly medium) students will be presenting their idea and research approach in maximum 3 minutes.

    b.   'one or two page summary' reporting their findings in a more structured and official way.

2.3 The final competition

The online competition will be actually composed by different levels, each one asking different questions to the players with an increasing degree of difficulty. All levels will address aspects of the scientific research methodology on biodiversity that are expected to be have been treated by the teams in the training and self-training preparatory sessions.

However, the online competition is set at a quite difficult level. Each team has to play collaboratively in order to get a high score.

The points earned in the learning by doing session and in the final online competition will determine the overall score of each team.

How getting scores

There will be two ways to get scores in the game: a self-training session, the so called *learning by doing*, during which all teams are encouraged to develop a complete research activity in the field of biodiversity to learn and understand all aspects of the scientific method through direct experience. Then the online competition, in which teams will have to face simulating research activities showing that they have understood the scientific method and have been able to apply it in a correct way to the case that they encounter in the online game. **Teachers** will have a key role mainly in the self-training session, encouraging the teams to develop their researches, stimulating teams to discuss on all points and aspects of their researches and participating as senior scientists to these discussions.

3. EXPLORING BIODIVERSITY IN THE FIELD AS EXAMPLE

In the following schemes, **teachers** can realize the main steps of the experimental work on biodiversity that each team will carry out in order to get scores.
Teachers will oversee their students during the practical work.

During the experimental work, teams can follow these steps as guidance for both the 'subject' and the 'methodology'.

- Step 0-step 3: students need to learn about the subject and collect information about the research topic from book, scientific papers, web.
- Step 4-step 5: students make a general question about the topic, interacting with other students. It is now time to go to the 'methodology'.

ENVRIplus GAME 'The subject' *step by step*
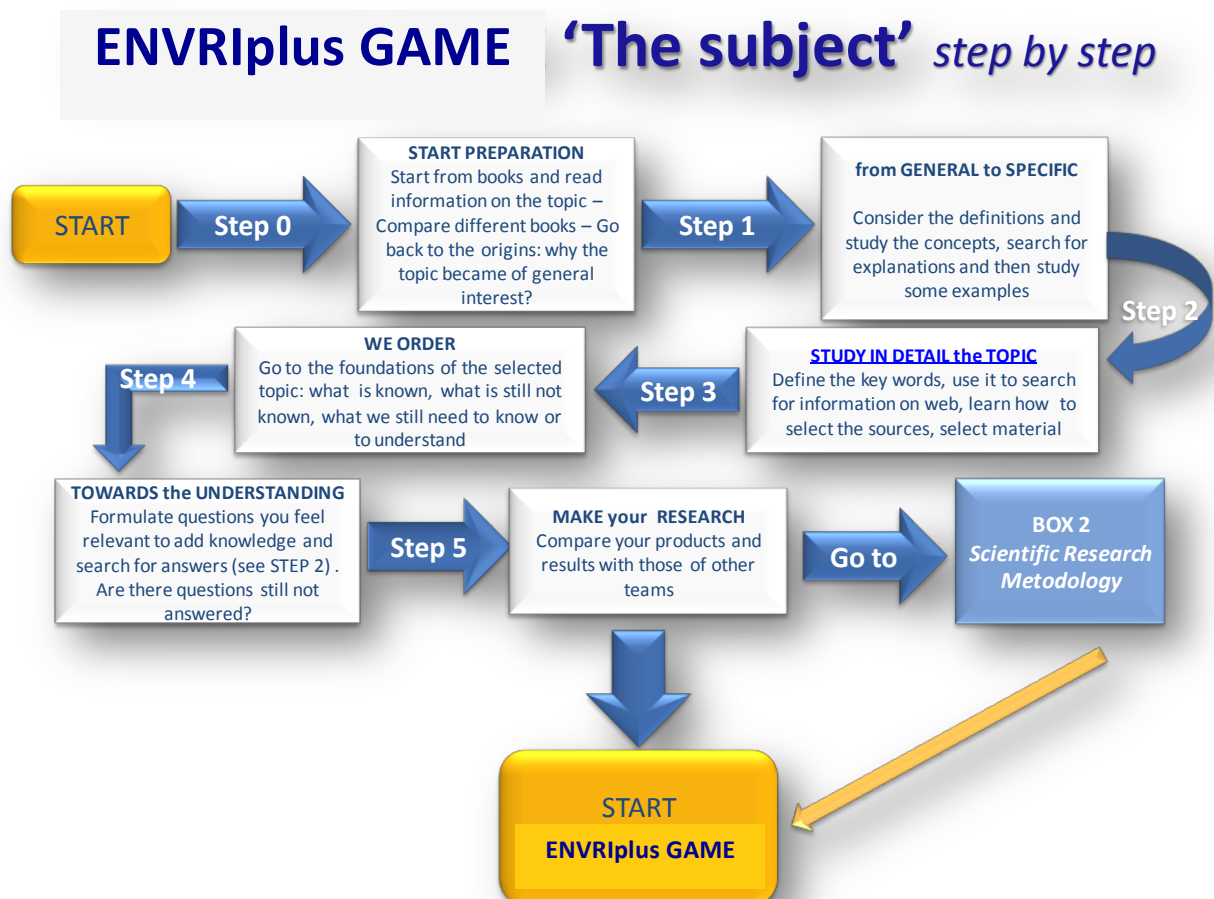
- Step 0: students can read on the scientific methodology in order to learn more (see project website).

- Step 1: students make the scientific hypothesis, null and alternative hypotheses, about the research topic.
- Step 2: students test the scientific hypothesis and have to know how much information is necessary to test it.
- Step 3: students organize the experimental plan on the research work fixing each point to set up.
- Step 4: it is time to go to the field and collect data following the steps decided in the experimental plan.
- Step 5-step 6: students organize their data in order to perform a simple statistical analysis. At the end of this step, they will get one or more products of their work.

ENVRIplus GAME   'The scientific methodology' step by step

START

Step 0

SCIENTIFIC METHODOLOGY
Scientific 'truth': theory and paradigms. Study approaches: inductive, deductive and hypothetical-deductive

Step 1

SCIENTIFIC HYPOTHESES
Scientific hypotheses: null hypothesis and alternative hypothesis. When do you accept an hypothesis? The error risks

Step 2

SAMPLING TECHNIQUES
Choose the technique in order to collect information

Step 4

EXPERIMENTAL DESIGN
How collect information? Identify the general information and choose the method: random, systematic, stratified, multi-stage

Step 3

EXPERIMENTAL 'TEST'
How test a hypothesis? What information do you need? How much information do you need for what error risk?

Step 5

DESCRIBE the RESULTS
Fix and describe the theoretical concepts, try to transform it in mathematic concepts

Step 6

ANALYSE the RESULTS
Perform a general statistical analysis and prepare statistical tests on the hypotheses

YOU ARE READY!

START
ENVRIplus GAME