










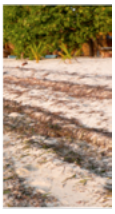








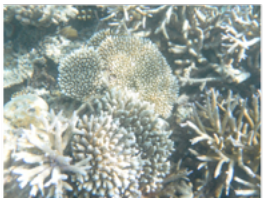

TEACHERS' TRAINING COURSE

Lifelong Learning Programme

Supporting materials

Authors

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Find more information on the project website www.researchgame.eu

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Table of contents

1. INTRODUCTION

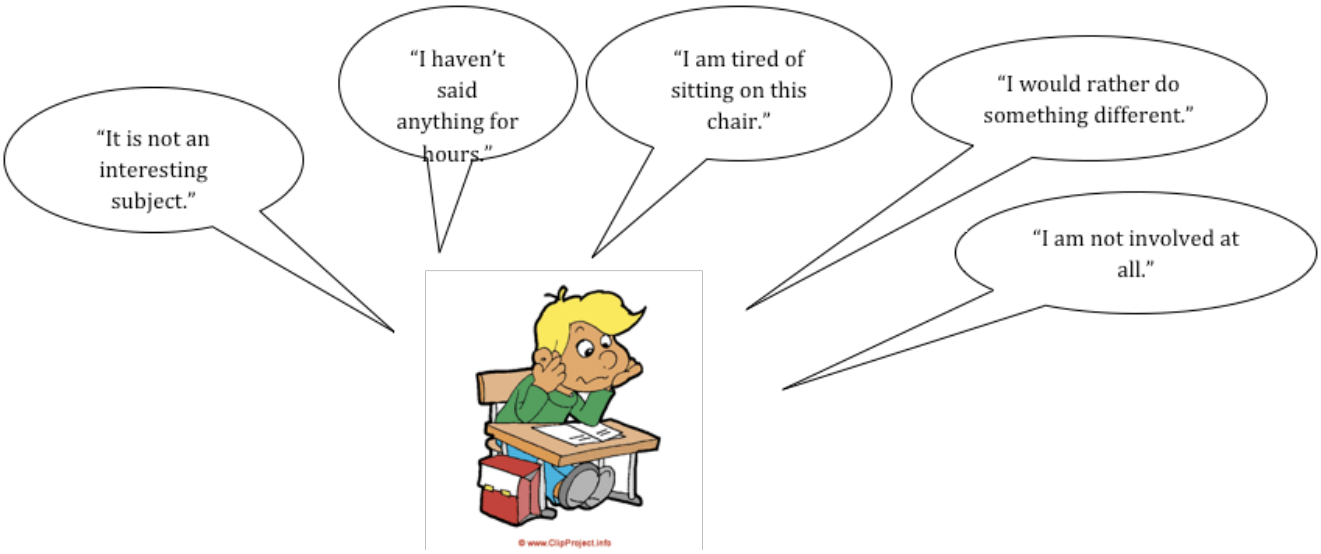
This document is an integral part of the *The European Scientific Research Game Project*, constituting a supporting material for teachers during the training workshops and a starting point of discussion during the workshop.

Today science and technology provide the contents for fundamental advances in education.
The goal of the *Research Game Project* is giving the opportunity for teachers and students to know and use new technologies in education and interact with each other in Europe. This Project introduces 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. Also, this will improve students' knowledge concerning the scientific way to study the reality around them, particularly biodiversity.
Let's look first to the process of learning and teaching methods closely. Then, it will be suitable to take a glance at game based learning. Later we will discuss using games in science teaching.

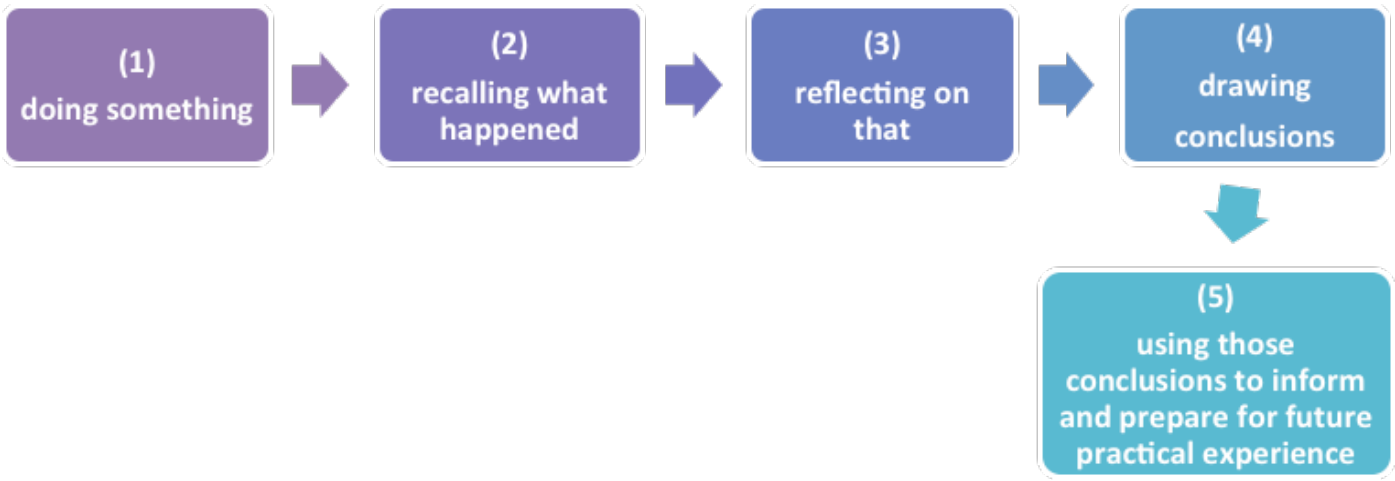
2. LEARNING AND TEACHING METHODS

Teaching may be defined as "showing or helping someone to learn how to do something, giving instructions, guiding in the study of something, providing with knowledge, causing to know or understand" (Siddiqui, 2008). Teaching cannot be defined apart from learning. The understanding of how the learner learns determines the philosophy of education, teaching style, approach, methods and classroom techniques.
The conventional image of a schoolroom is "the teacher standing at the front of the class 'teaching' and the students sitting in rows listening". This teaching style is often based on the assumption that the teacher is the 'knower' and has the task of passing over his/her knowledge to the students. Throughout the lesson, the teacher keeps the control of the subject matter, makes decisions about what work is needed and orchestrates what the students do. But, when the teacher is 'teaching', it would unclear how much 'learning' is taking place.

There are many things that students may feel and think during the lesson. The followings are a few of those:



A good process of learning should involve five steps (Dewey, 1938):



Teaching is not just reading from a book and reproducing in the classroom. As students learn in many ways-by seeing and hearing, reflecting and visualizing, teaching methods also vary. Some instructors lecture, others demonstrate or discuss; some focus on rules and others on examples; some emphasize memory and others understanding. Recognizing the need for teachers to select a good instructional method has long been an important issue in education.
How much a student learns in a class is determined partly by that student's native ability and prior preparation but also by the compatibility of his or her characteristic approach to learning and the instructor's characteristic approach to teaching (Felder and Henriques, 1995).

The teacher, in the new frontiers of education, is a tutor (Bruner, 1986). The teacher, in other words, is like an orchestra conductor who brings unique presence and talents, a personal history, and an individual style to the persons with whom he/she works. These among the most difficult components of education to measure, yet one of the crucial factors for student success, the teacher as an instrument of thought influences the teaching/learning process.

2.1 Learning Style Theory di Kolb

In the framework of the educational theories particularly useful for us is the Kolb's experimental learning style theory. Kolb (1984) developed a cycle of learning in which immediate/concrete experiences provide the basis for observations and reflections. Experiential learning theory defines learning as "the process whereby knowledge is created through the transformation of experience. The ELT model portrays two dialectically related modes of grasping experience -- Concrete Experience (CE) and Abstract Conceptualization (AC) -- and two dialectically related modes of transforming experience -- Reflective Observation (RO) and Active Experimentation (AE) (Kolb and Boyatzis, 2000). Kolb meant by the word 'dialectically' that we cannot do both at the same time, and to an extent our urge to want to do both creates conflict, which we resolve through choice when confronted with a new learning situation. We internally decide whether we wish to do or watch, and at the same time we decide whether to think or feel (http://www.businessballs.com/kolblearningstyles.htm).

According to the four-stage learning cycle, immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experience (Kolb and Boyatzis, 2000). So, according to Kolb's learning theory, there are four types of learners whose characteristics are shown below in Figure 1.

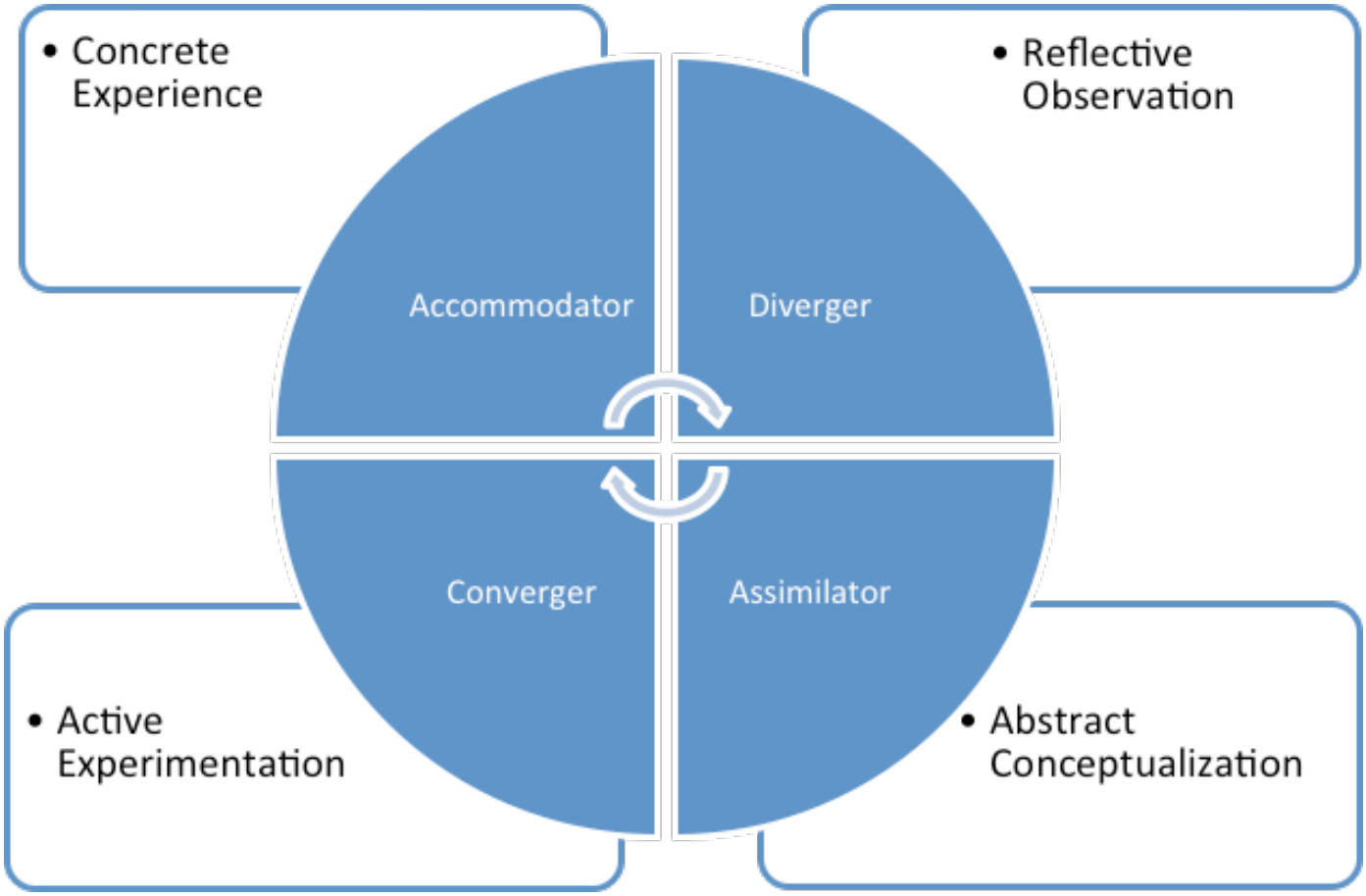
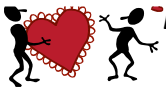


Figure 1: The Experiential Leaning Cycle and Basic Learning Styles (Kolb, 1984)

Accommodators learn through concrete experience, transform learning into abstract experimentation. The accommodators need a mentor, like example, and require teachers encourage them.

Convergers learn through abstract conceptualization, transform information through active experimentation. They are usually not emotional, and learn better by doing and questioning, prefer objects, dislike group activities, like questioning, and problem solving.



Divergers learn through concrete experience, transform learning by reflective observation. The learners who use this learning style are emotional and imaginative. They need to be motivated to learn. Brainstorm and problem solving techniques are suitable for them to learn better.

Assimilators earn through abstract conceptualization, transform learning through reflective observation. The students who use this learning style like text reading, conducting research, organizing events, and prefer traditional classroom teaching.

Active Experimentation

ACCOMMODATOR

Accommodators Ask: **"How can I do it?"**

Concrete Experience

Concrete Experience

DIVERGER

Divergers Ask: **"What is it?"**

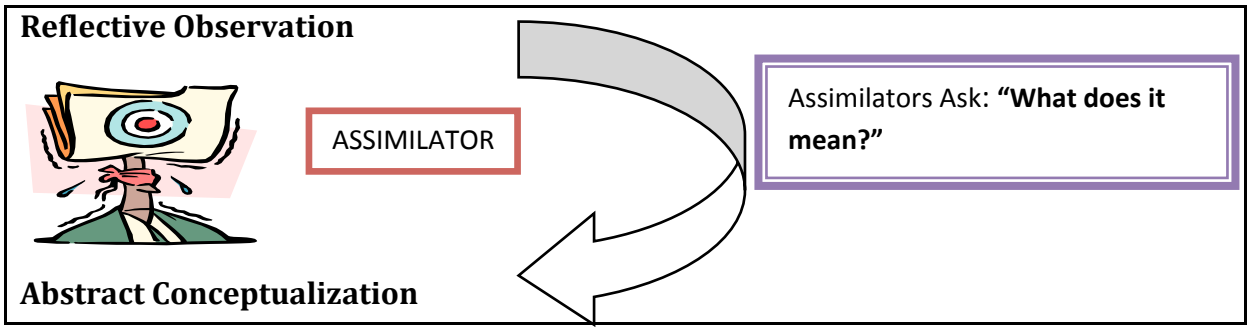
Reflective Observation

Abstract Conceptualization

CONVERGER

Convergers Ask: **"What can I do?"**

Active Experimentation



Concrete Experience	Reflective Observation	Abstract Conceptualization	Active Experimentation
Laboratories	Logs	Lecture	Simulations
Observations	Journals	Papers	Case studies
Text readings	Discussion	Model building	Laboratories
Simulations/games	Brainstorming	Projects	Field work
Field work	Thought questions	Analogies	Projects
Films/videos	Rhetorical questions	Projects	Homework
Readings	E-Mail List Serves		
Problem sets	On line discussion forums		
Examples	Thought Questions		

Table 1. Processes to acquire and use information and skills for different phases

Kolb's experiential learning cycle has four phases, each of which involves using different processes to acquire and use information and skills. The four phases are described in Table 1, along with examples of instructional activities that support each phase (http://www.iupui.edu/~idd/web_assets/kolb_exp.pdf).

2.2 Teaching Methods

Instructional models are related to theories about how we learn. Some examples include: behaviorism, cognitivism, constructivism, and connectivism. Various learning theories fit within these general categories, i.e., adult learning theory, transformative learning, social interaction, motivation theory, etc. Within each model several strategies can be used. Strategies determine the approach a teacher may take to achieve learning objectives (http://teachinglearningresources.pbworks.com).

Let's take a look to the teaching methods and their characteristics.

Direct Instruction:

- This is a teacher-centred method.
- When used appropriately, direct instruction enables the teacher to communicate complex knowledge and information at the learners' level.
- It allows the teacher to present information that is not readily available to the learners from other sources or by other means.

Indirect Instruction:

- This is a learner-centred teaching method.
- It promotes learner involvement in the learning process and in doing so, fosters true learning for understanding.
- It enhances creativity and helps to develop problem-solving skills.

Independent Study:

- Learners involved in independent learning are often highly motivated by the opportunity to explore topics that are of interest to them.
- Learners can capitalize on their strengths while improving areas of weakness.
- It is especially valuable in a classroom where learners' knowledge, skills, and abilities vary widely.

Interactive Instruction:

- Interactive instruction provides opportunities for learners to interact with peers, experts, and their teachers in such a manner as to improve their social skills as well as their abilities to assess information and structure an effective response to the information.
- The interaction is often highly motivating for learners.

Experiential Learning:

- Experiential learning is constructivist learning, where learners are active learners, constructing their own knowledge, rather than observing the demonstrative behavior of a teacher.
- Because experiential learning is active learning, learners more readily understand what they are learning.
- The hands-on nature of experiential learning is highly motivating for learners.

2.3 Which of them could be the best?

Today's students have grown up in an environment in which Internet communication and computer technology is an ordinary component of daily routines. They 'require multiple streams of information, prefer inductive reasoning, want frequent and quick interactions with content and have exceptional visual literacy skills' - aspects that are well supported by game-based learning approaches.

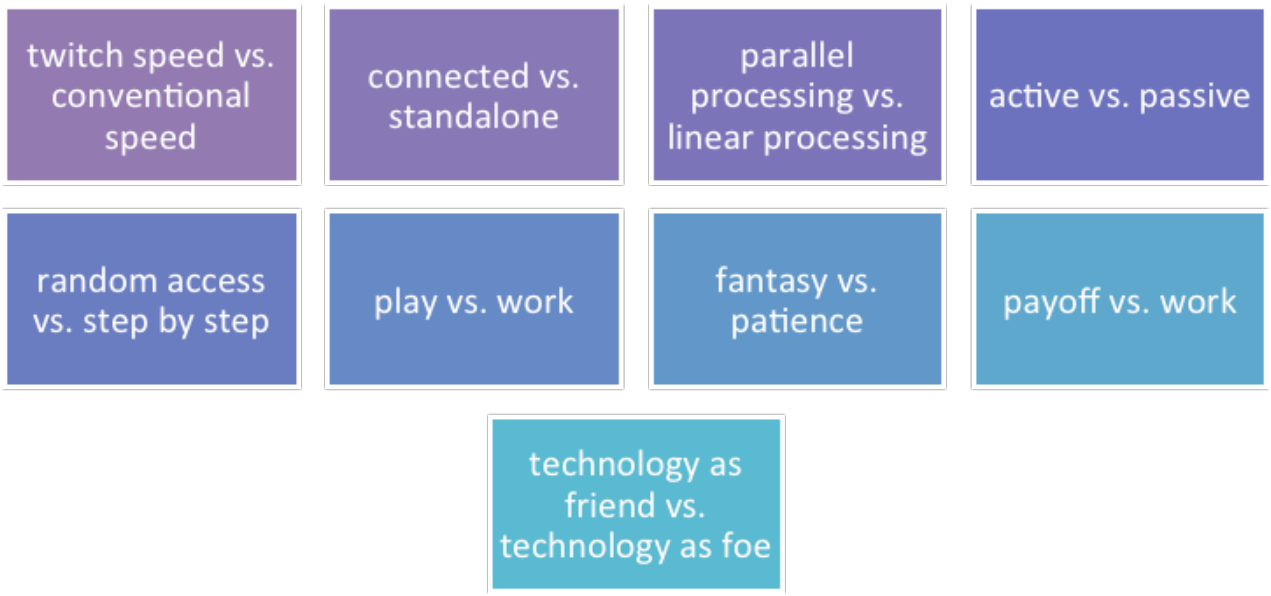
Traditional Methods like books, board marker, black board/white board chalk/chalkboard and printed page, are not attractive for Net generation any more. The infusion and integration of technology in the education process have presented new avenues by which teachers can enrich and enhance teaching and learning activities. However, teachers respond to their use in the classroom setting in a number of ways. First, there are those teachers who fear using any form of technology apart from those with which they are very comfortable (e.g., chalk/chalkboard and printed page). Second, others make use of some form of technology even if they do so infrequently (e.g., overhead projector and videotapes) during class presentations. Third, some teachers maximize the use of different technologies sometimes to the point of overuse during classroom activities (Duhaney, 2000).

Today, learning for many students become more exciting as they are actively involved in the process. It should be noted that new generation want to see classroom environment as the "Play-Ground". They expect to be able to learn and study whenever and wherever they want to.

Thanks to the new information and communication technologies, there is a new emphasis in the classroom on more **challenge-based** and a**ctive learning.** There is strong evidence that students learn better if they are actively engaged in their learning, rather than being passive recipients of information provided by a teacher/lecturer. The newer forms of technology have created a renewed interest for their use in supporting teaching and learning activities.

Media should not be regarded merely as teaching aids or tools for learning. If the teacher wants to use computer games or the internet or other digital media to teach, he or she needs to equip students to understand and to critique these media: It cannot be regarded them simply as neutral means of delivering information, and should not used them in a merely functional or instrumental way (Buckingham & Burn, 2007).

Let's discuss around this scheme!



3. GAME BASED LEARNING

Let's think about online games in education as a chosen teaching method.
Games contain rules and strategies but the costs of losing are generally only consequential within the game world. Games are often defined in terms of their interactive and engaging nature: An interactive and entertaining source of play which sometimes used to learn a lesson.

It can be defined the key characteristics of games as: *rules, goals and objectives, outcomes and feedback, conflict* (and/or competition, challenge, opposition), *interaction, and representation of story*.

The learner must attend to the relevant content information and be able to meaningfully organize that material cognitively while integrating the new knowledge acquired with prior knowledge. If the learner can accomplish this, it will lead to long-term memory of the instructional material. Since simply playing a game will not accomplish this, the instructional methods for accomplishing this can be embedded within a game-like environment (Dowling, 2012).

3.1 The principles of game-based learning

- Intrinsic motivation
- Learning through intense enjoyment and "fun"
- Authenticity
- Self-reliance and autonomy
- Experiential learning.

3.2 The Mechanisms of the Game-based learning

- Rules
- Clear but challenging goals
- Progressive difficulty levels, underpinned by understandable criteria for progression
- A fictional setting or "fantasy" that provides a compelling background
- Interaction and high degree of student control.
- Immediate and constructive feedback
- A degree of uncertainty and unpredictability
- A social element that allows people to share experiences and build bonds

3.3 What Games offer to traditional education?

In order to make a compelling argument for game-based learning, students must learn something from games that traditional education cannot provide. In a typical classroom, a teacher lectures while students passively listen and take notes without context or application. However, games are interactive; that is, "when the player does something, the game does something back that encourages the player to act again". Traditional education treats students as passive recipients while games allow them to be active members in their own education which allows for more self-directed, creative, and engaging learning.

3.4 Pitfalls to using Games based learning

While online learning has many advantages ("anytime, anywhere, anyplace") there are also disadvantages such as increased setup costs, more responsibility is placed on the learner who has to be self-disciplined and motivated, increased workload on students and staff, non-involvement in the virtual community may lead to feelings of loneliness, low self-esteem, isolation, and low motivation to learn.
Games will never be able to revolutionize education all by themselves. Games are not the best teachers, and they should not be understood as teaching tools, as well. That is why we should focus from game based learning to game based teaching. So, the teacher remains the cornerstone of successful game based learning. There are multiple barriers to implementation. Games can be expensive to maintain or purchase. However, many have found a way to get around this cost, such as pairing students to one computer, using free browser games, or creating applications for the smartphones that many students already own.

Teachers may not have the professional development needed to incorporate games into their lesson plans, and they might find it difficult to implement a game in a 40-50 minute period. Students also come with different games and technology proficiency. While some may play games consistently, some may feel uncomfortable with the technology. A discomfort with technology may disrupt any potential learning.

3.5 Types of Games

There are three general **types** of games; trivial, serious and epistemic games. Trivial games are purely played for entertainment purpose and do not generally have an educational value. Serious games are designed for purposes other than pure entertainment. Serious games tend to have a specific educational purpose such as training or learning how to do something and can sometimes be referred to as **edutainment**. Epistemic games are games that go beyond edutainment. Learners are immersed in a real world situation while playing the game.

A meta-analysis by Chiu et al. (2012) found that the type of game used has an impact on learning as far as language learning is considered. Meaningful and engaging games, in which learners are given opportunities to explore, interact and engage with a complex game world, are more effective than simpler games that rely on drill and practice.

That's way in our research game project we combine practical activities, exercises but also mini-games in order to ensure the involvement of the students. Moreover, the chosen of the 'biodiversity around us' as thematic of our game, constitutes a complex framework exciting to discover.

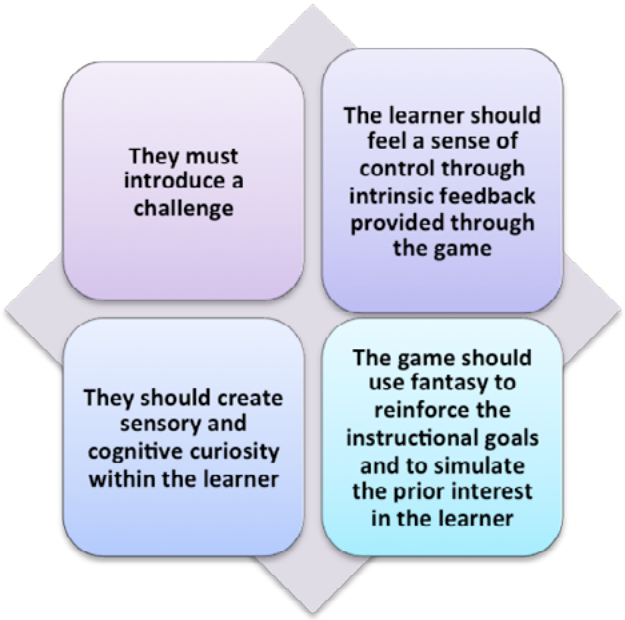
3.6 Motivation and Flow Theory

Motivation is an important part of learning. Csikszentmihalyi (1990) defines flow theory as a method for understanding and implementing motivation. The learner becomes completely involved in an activity by being provided with a challenge, setting goals, having structured control and being provided with clear feedback. If the learner is in complete "flow state" there is complete motivation. Games foster play and produce a state of flow, therefore increasing learning and fostering motivation.
In exploring the reasons for game-based learning having an impact on student motivation, Ya-Ting (2012) suggests that by immediately providing students with praise, encouragement and reinforcement, gaming software helps students develop confidence and motivation to continue with the task.

The joy of doing something is the key in understanding the flow. In Flow, subjects describe their experiences as intrinsically rewarding. When individuals engage in activities and lose awareness of time and space, they are involved with flow experiences.

3.7 Flow in game based learning

Research has documented the effectiveness of games for instructional purposes and there are four key attributes that educational games must include:



Games -> Play -> Flow -> Motivation -> Learning

The following statements, drawn from research, support the use of games:

Even today, "practice makes perfect." The Internet and games can capture student attention, engage them in learning, and make practice happen.

Online educational games challenge fine motor coordination while developing logical thinking skills and content mastery.

Interactive games allow learners to construct new understandings on many different levels through seeing and hearing.

Teaching with online games allows educators to better meet the needs of students with diverse abilities while at the same time increasing motivation of all students.

Games provide immediate feedback to participants, and mistakes do not result in unwanted consequences

Games have been found to serve a range of functions in education including tutoring, exploring and practicing skills, and attitude change.

According to the results of the research game players are able to rapidly analyze new situations, interact with characters they don't really know, solve problems quickly and independently, think strategically in a chaotic world, and collaborate effectively in teams. Besides, teachers and parents recognized that games play can support valuable skill development such as strategic thinking, planning, communication, application of numbers, negotiating skills, group decision-making, and data-handling. However, neither teachers nor parents were happy with the notion of playing games in lesson time since such skill development did not match the criteria assessed in centralized national tests. Due to this reason, it is an important matter to design new games for education, so that the desire to harness the motivational power of games in order to 'making learning fun' and a belief that 'learning through doing' in games such as simulations, offers a powerful learning tool.

The games provide a comfortable learning format for the current generation. In addition games motivate students to stay focus on the subjects. Games offer the simulated environment that allows learners to experience the scenarios that would otherwise costly. Repeatability is the key that people master certain knowledge. Students learn from mistakes and experience. Certainly there should be clear criteria for performance; student should be able to evaluate how well or how poorly he/she is doing at any time. At the same time, good games are fabulous at exactly this. When we encounter and solve problems within games, we regularly receive feedback measuring and evaluating our effort.

4. USING GAMES IN SCIENCE TEACHING

There are some barriers to children engaging in research because of their lack of research knowledge and skills. Reflecting on the skills needed to undertake research it soon becomes apparent that these attributes are not necessarily synonymous with being an adult, they are synonymous with being a researcher, and most researchers have undergone some form of training. Many, perhaps most, adults would not be able to undertake research without training. It would appear, therefore, that a barrier to empowering children as researchers is not their lack of adult status but their lack of research skills.

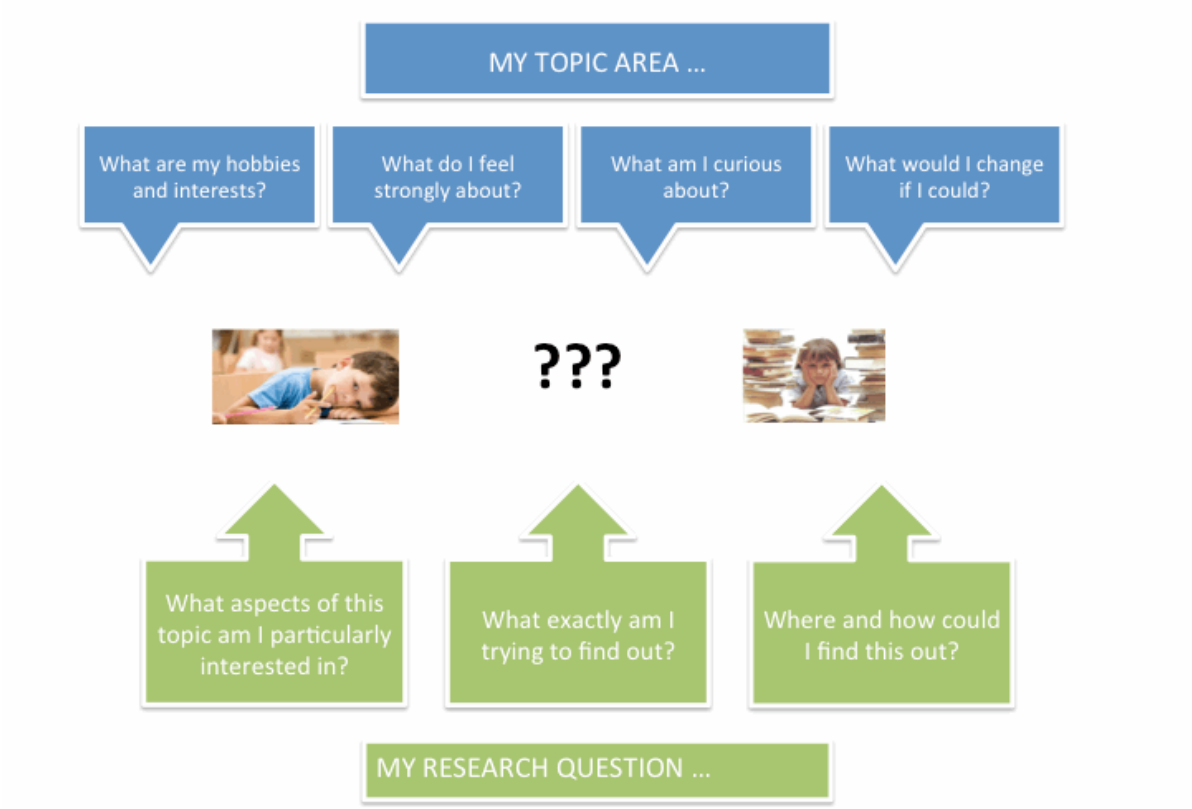
HOW SHOULD WE BEGIN?

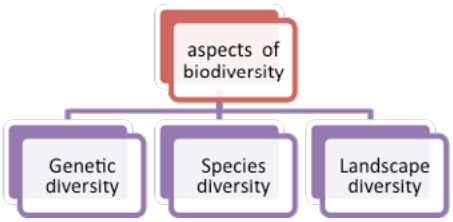
1. Identifying areas of interest for their own research

2. Selecting the topic: Ecology and Biodiversity

3. Acquiring research tools, methods, and skills to help the children make informed choices about their research design and the kinds of methods they would use to collect their data

4. Understanding nature of quantitative and qualitative analysis





The Deductive Method

It is a cognitive process, going from the general to the particular.

In the deductive method two general statements are required in order to deduce a third statement.

Example:
- **All men are animals**
- **All animals are mortal**
- **(so) All men are mortal**

The Inductive Method

It is a cognitive process from the particular to the general.

In the inductive method, the researcher tries to reach a general statement from the observation of some details of reality.

Example:
- **Charles saw a black panther**
- **John saw another black panther**
- **(so) Probably all panthers are black**

The Experimental Method

It is mainly based on the observation of physical phenomena using mathematics and reproducible experiment

Once the hypothesis is confirmed by repeated experiments, **it becomes a scientific law.**

The same method (experimental) can be used to refute existing laws.

5. Writing Scientific Hypotheses

A "good" scientific hypothesis is one that is testable. Testable means that you can perform a test (e.g., experiment) to show how the variables might be related. The results of the test will determine whether you "reject" or "accept" your hypothesis. If you cannot test your hypothesis, then you cannot verify whether or not it is correct.

6. How to write a formalized hypothesis

1. Identify the independent and dependent variables that you are testing. The independent variable is the variable that you, the "scientist" control, and the dependent variable is the one that you observe and/or measure. The dependent variable will change in response to changes in the independent variable. For example, if you are interested in learning how do ecological corridors affect the population size of species X living in fragmented habitat Y, then the ecological corridors is the independent variable, and the population size of species X living in fragmented habitat Y is the dependent variable.

2. Hypothesize how the two variables are related. For example, you might hypothesize that "as ecotourism visitors in area Y increase, the population density of species X will increase". This is a positive direct relationship. You could alternatively hypothesize that "as ecotourism visitors in area Y decreases, the population density of species X will decrease". This is a negative direct relationship. You might even hypothesize that "as ecotourism visitors in area Y increase, the population density of species X will decrease". This is an inverse relationship.

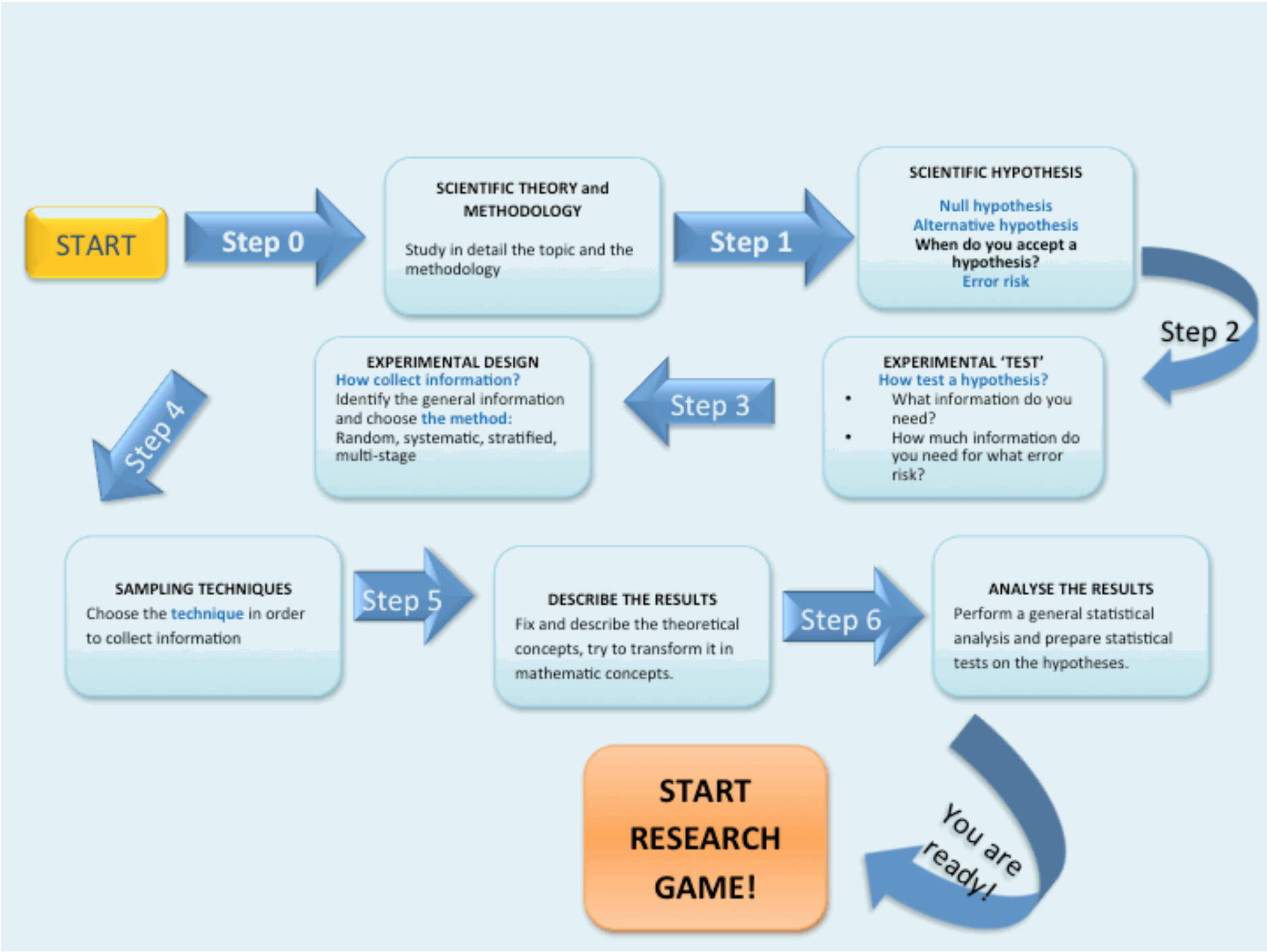
3. Write your hypothesis using an IF/THEN statement. Using the example of the positive relation between ecotourism visitors and population density, you would hypothesize the following: "IF ecotourism visitors increase THEN the population density will increase. IF/THEN statement is only a testable hypothesis if you describe the relation between the variables.

7. Writing a Research Proposal

1. What questions are you trying to answer with your research?
2. Why is this research question important?
3. What made you ask your question in the first place?
4. What work has previously been done on this topic?

5. MAYBE VIA GAMES

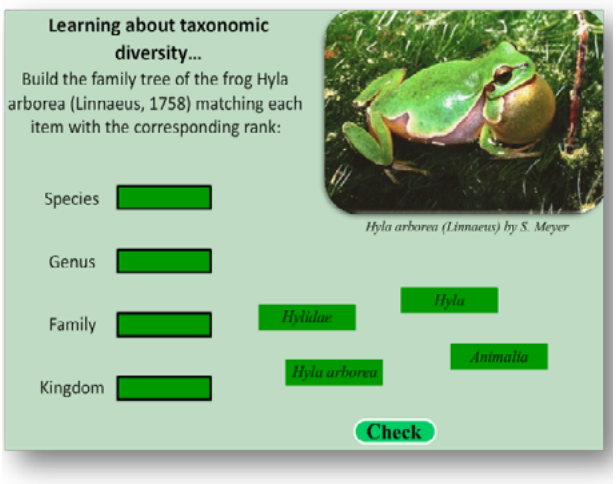
For being capable to do it, students should study hard about the topic they chose.

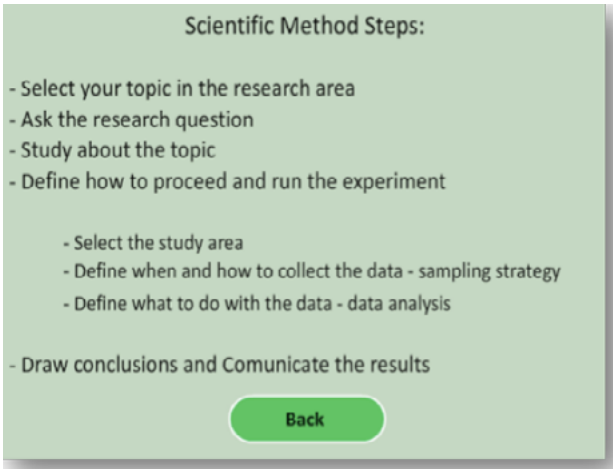

START
Step 0
SCIENTIFIC THEORY and METHODOLOGY
Study in detail the topic and the methodology
Step 1
SCIENTIFIC HYPOTHESIS
Null hypothesis
Alternative hypothesis
When do you accept a hypothesis?
Error risk
Step 2
EXPERIMENTAL 'TEST'
How test a hypothesis?
What information do you need?
How much information do you need for what error risk?
Step 3
EXPERIMENTAL DESIGN
How collect information?
Identify the general information and choose the method:
Random, systematic, stratified, multi-stage
Step 4
SAMPLING TECHNIQUES
Choose the technique in order to collect information
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.
START RESEARCH GAME!
You are ready!

Let's follow these steps in the 'Research Game'

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 rel¬evant to everyone. Studying biodiversity pupils can learn more about the genetic diversity, the diversity in terms of species, the diversity in terms of ecosystems and landscapes.

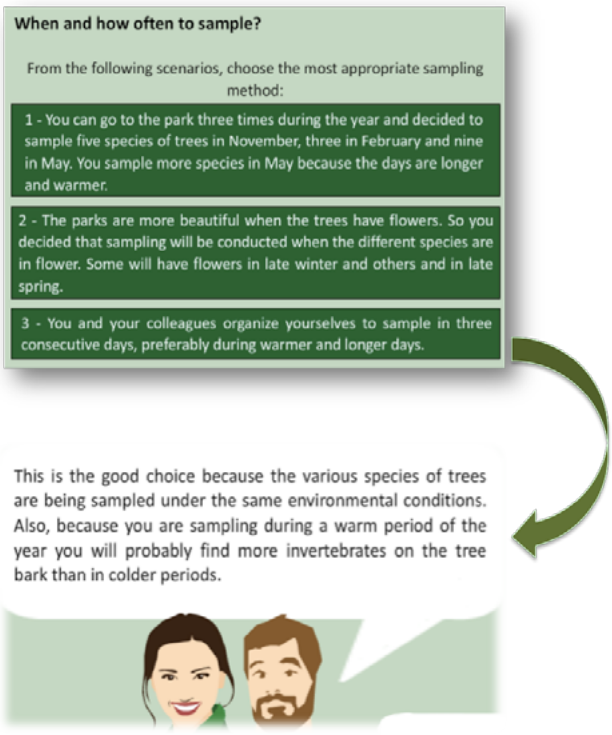
→ Step 0: Students can read on the topic and scientific methodology in order to learn more.



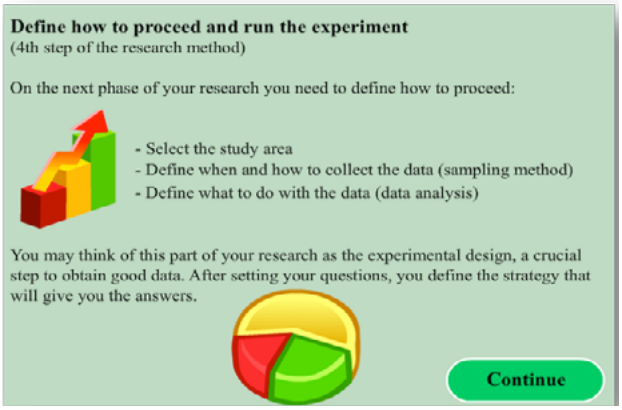


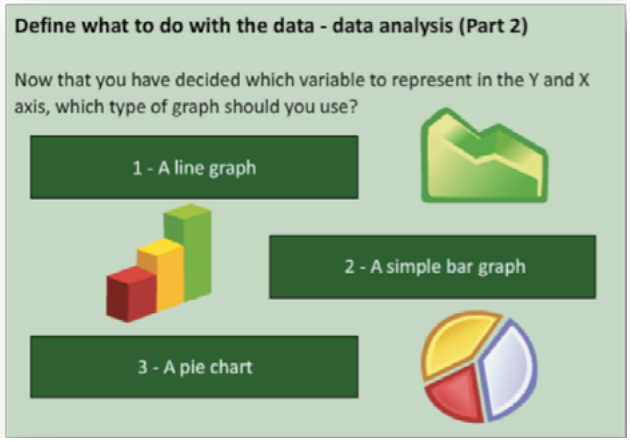
→ Step 1: Students make the scientific hypothesis, null and alternative hypotheses, about the research topic.

→ Step 2: Students test the scientific hypothesis and have to know how much information is necessary to test it.

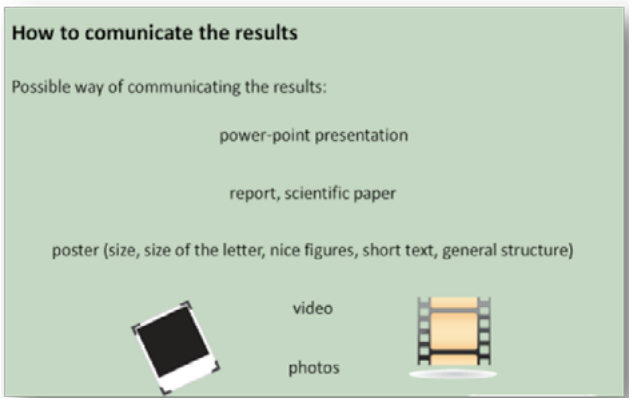


→ Step 3: Students organize the experimental plan on the research work fixing each point to set up.

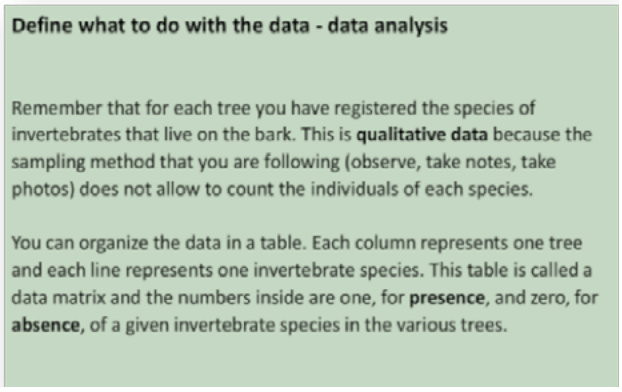




→ Step 4: It is time to go to the field and collect data following the steps decided in the experimental plan.



→ Step 5 and 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.



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