



**ICTeEfs**



# Selecting Subject Areas and Setting Learning Objectives for ICTeEfs

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**Deliverable Number: D3.1**

**Contractual Date of Delivery: 30/05/2019**

**Actual Date of Delivery: 30/05/2019**

**Title of Deliverable: Selecting subject areas and setting learning objectives**

**Work-Package contributing to the Deliverable: WP3**

**Dissemination Level: IL**

**Nature of the Deliverable: R**

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**Version Date Comments & Status Distribution 18/05/2019 initial version**

**Draft 23/05/2019 comments from all project team. Final approval  
by Quality Assurance Group 30/05/19**

## **Project Funding**

Project Full Title: **ICT-enabled In-service Training of Teachers to Address Education for Sustainability**

Project Acronym: **ICTeEfs**

Project number: **598623-EPP-1-2018-1-CY-EPPKA2-CBHE-JP**

EC Programme: **ERASMUS +**

Agreement number: **(2018-3774-001-001)**

Start date: **15<sup>th</sup> January, 2019**

Duration: **3 years**

Budget: **€ 991.711**

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## Executive Summary

ICTs play an important role in advancing Education for Sustainability in three ways: a) by increasing access to educational materials about sustainability (e.g., via distance learning, educational networks and databases); b) by helping to promote new ways of interactive learning addressing sustainable development issues and 3) by opening access to information and knowledge. In this deliverable we provide a rationale for using interactive mind/cognitive tools to support learning and develop new understandings and knowledge in areas of teaching and learning for sustainability, ICTeEfS subjects or themes that could be integrated into the school curricula enabled by ICTs. For example, social, economic and environmental issues can provide meaningful and challenging contexts for developing a wide range of ICT skills. In general, the learning objectives are structured on the basis of:

- 1) engaging and challenging learners;
- 2) stimulating dialogue and social negotiation through new modes of social interaction;
- 3) learning by exploring, discovering, doing and reflecting;
- 4) constructing personal and collective representations of meaning;
- 5) supporting discourse in dealing with real-life problems;
- 6) representing dynamic relationships needed for knowledge construction; and
- 7) developing pupils' understanding of the implications of ICT for working life, society and the environment.

As an example, when considering areas such as cultural diversity and intercultural understanding, health, HIV/AIDS, governance, natural resources, climate change, rural development, sustainable urbanisation, disaster prevention and mitigation, poverty reduction, corporate responsibility and accountability, and the market economy, there is potential to assess the impact of ICTs in these key sustainable development areas. The basic premise is that: the development, deployment and exploitation of ICTs in the field of Education for Sustainability (ICTeEfS) can contribute to and accelerate the integration of ICTs across all school subject areas and in turn have positive effects on socio-economic development process of partner countries. In other words, ICTs alone cannot have an impact on education and societal processes unless pedagogy comes before technology. Using the SMART methodology, we have contextualized ICTs with EfS and EfS with ICTs. This will provide the underpinning conceptualization for revising the undergraduate courses to infuse ICTeEfS and in developing the ICT Coordinators' in- service training.

## The SMART Methodology

The SMART methodology has been chosen to be used for setting the ICTeEfS learning objectives. The acronym 'SMART' stands for Specific, Measurable, Attainable, Relevant, and Timely.



### Specific

Think about exactly what you want to achieve when setting your learning goals and objectives. Be specific about the types of learning and think about the 'who, what, when, why and how' of your goals and that will help you to make them more specific.

### Measurable

Break your learning goals and objectives down into measurable elements and track them at each stage. Think about the result you want to achieve and make you think about why you are aiming to achieve that specific objective.

### Attainable

It is crucial that you set learning goals and objectives that you can realistically achieve, according to your time, energy, commitment and ability.

### Relevant

This relates to the 'why' of your learning goal and objective. A learning goal and objective may be specific, measurable and attainable but if it's not relevant to you and your interests then you shouldn't be pursuing it. Ask yourself the purpose behind the objective and what you hope it will bring in order to gauge how relevant it is.

### Timely

One very important aspect of setting learning objectives is to develop a realistic timeline that you can stick to. You can include specific milestones along the way that will help keep you on track and have a certain timeframe in which you want to fully achieve your goal

## Setting Learning Objectives

Rethinking and revising education to address the knowledge, skills, perspectives and values related to sustainability is of paramount importance to current and future societies. This implies a review of existing curricula in terms of their objectives and content with the aim to develop interdisciplinary and cross-disciplinary understanding and knowledge of social, cultural, economic and environmental sustainability. These include skills for problem-based learning, creative, reflective and critical thinking, using appropriate ICTs and reforming teacher training practices so that transformative lifelong learning is fostered. Problem Based Learning (PBL) is preferred as the methodology because of its compatibility with ESD and the strengths and advantages it offers for supporting teachers' professional development and learning. First, PBL builds on the use of learners' reflective practice in teaching and learning based on real-life and authentic problems and issues (Stewart et al., 2007; Neo & Neo, 2001). Through this, teachers are encouraged to take more ownership of their professional development in a highly creative and stimulating way supported by hypermedia-based cognitive tools (Jonassen et al., 2003; Brush & Saye, 2002).

Through a PBL process, teachers have an opportunity to develop skills in problem definition and problem solving, to reflect on their own learning, knowledge and practices, and develop a deep understanding of the content domain learning. In a PBL approach, the problem is often stated in the form of key questions, such as the following:

- How can I use computerized graphic organizers to teach vocabulary relevant to environmental sustainability issues?
- Have I ever wanted to measure the effect you have on greenhouse gas emissions in your home and school?
- How can I use datahandling tools (e.g. Excel) to construct knowledge and promote learning-based action on ESD local/global issues?
- How can I use ICT to develop my ecological footprint towards sustainable energy or water use, for example?

Dealing with such PBL questions, each can be treated as a self-contained learning module in an e-learning environment, based on a series of interactive phases, including:

- Problem clarification and its challenges
- Brainstorming initial thoughts about the problem
- Exploring the constituencies of the problem
- Constructing meaning and knowledge on the problem
- Reflecting on initial thoughts with revised thinking
- Applying new understandings and knowledge into action

## **An Example**

Let's take, for example, the last question set on the above list: "How can I use ICT to develop my ecological footprint towards sustainable water use?" If we contextualize this problem in a particular context, we may ask the teacher trainee in collaboration with his/her class students to identify the key concepts from the content domain and examine the challenges inherent in these concepts.

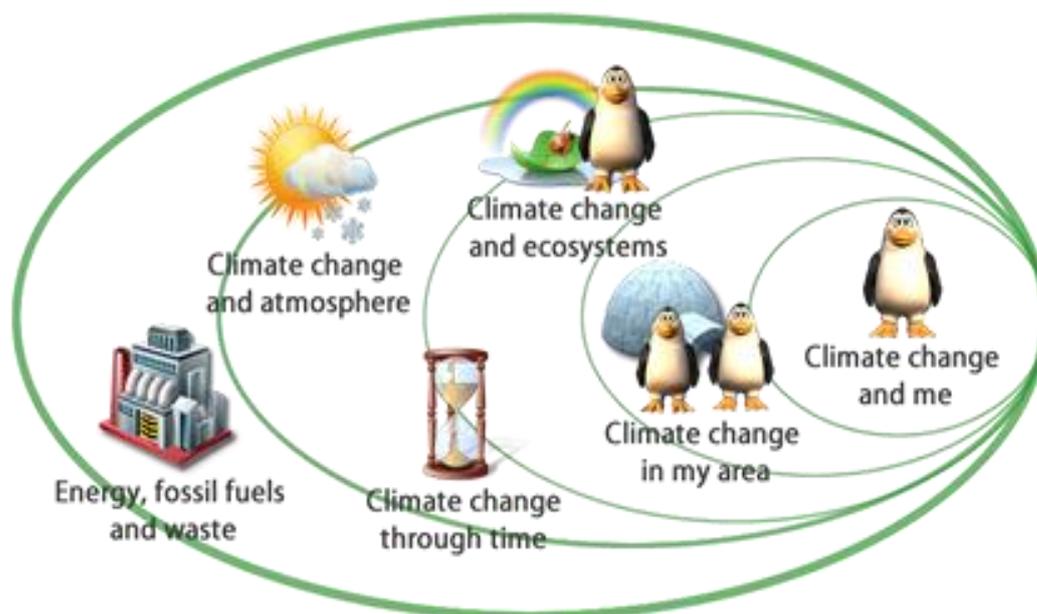
Clarifying the problem and its contextual challenges is intended to situate the trainee teacher and his/her students in the problem context and to begin the process of activating students' relevant prior knowledge. This leads to brainstorming initial thoughts about water use and abuse, posing questions such as: Why do people in the X country use water as though there is an unlimited resource? Are they aware of the water problems in the future, because of their current water consumption practices? How personal water use, and management of water is addressed to avoid dramatic impacts on the environment, the economy and quality of life. Concept maps could also be considered as an effective tool for organizing information and knowledge management tool in online PBL environments. While it is possible to use concept maps as a collaborative tool, it is important to provide training not only in the use of the software but also on how to collaborate using concept maps in an online environment (Canas, Novak, & Gonzalez, 2004).

Initial thoughts and challenges of the water problem should be further elaborated through a process of exploration which helps the trainee teacher and his/her students to gain additional and deeper insights relevant to the concepts inherent in the problem. In this process, they act as researchers to collect additional resources about water use and abuse that will help them to increase understanding of the constituencies of the problem. Integrating critical thinking into the online learning process requires information to be presented from a variety of perspectives that involves both the cognitive and affective learning domains and certain strategies should be followed for critical reflection (Stewart et al., 2007). Within this online environment the non-linear nature of the information structures and the variety of media formats requires the learner to make decisions about where to find supporting information, what kind of information should be selected to support the task, how much information is needed to justify an argument and what strategy approach is best suited for the problem under investigation (Brickell & Herrington, 2006).

## **Curriculum Integration of Subject Areas Enabled by the SMART Methodology**

Let's take the example of an area entitled "Climate Change and Ecosystems" (Makrakis et al. 2012 depicted in (Figure 1).

**Figure 1:** The curriculum areas of the ICT-enabled Climate Change Education



In the area “Climate change and me” children investigate about what climate change has to do with them (their nutrition, health, clothing, environment etc.) and what they can do in their everyday life (in school, home, neighborhood, local area) to face climate change. Then, children can move to the area “Climate change in my area” and investigate how climate change can affect their local society and economy, the employment, the transportation etc. The next area “Climate change and ecosystems” gives children the opportunity to explore their local and national ecosystem and the repercussions climate change brings upon it. In the next area “Climate change and atmosphere”, children learn about the physics of the phenomenon of climate change in the atmosphere. The following area “Climate change through time” gives children the opportunity to learn about climate change in the past, in the present and in the future. They study scenarios and prepare themselves for the future, having the knowledge from the past. Finally, in the area “Energy, fossil fuels and waste”, children investigate about what climate change has to do with energy, fossil fuels and waste. They search for ways to make a sustainable future, using renewable sources of energy and new ways to handle waste. Students can choose any of these units to start with and engage to its activities. In these units, children deal with what climate change brings upon them and their local environment and how children can act in order to protect their environment. Alongside the activities conducted in the classroom, many activities outside the classroom are suggested, referring gradually from the local to national and global level. All units correspond to related Greek curriculum units.

Achieving climate change literacy will require a connected web of disciplinary, interdisciplinary, multidisciplinary and trans-disciplinary approaches. Interdisciplinary is sometimes used interchangeably with multidisciplinary and transdisciplinary (Figure

4). Here, disciplinarity means to focus on one discipline, in contrast to interdisciplinary curriculum where there is involvement of two or more disciplines, while transdisciplinary curriculum refers to an infusion of disciplinary knowledge to create a new hybrid. This curriculum is intended to be flexible, allowing teachers and learners to co-construct activities.

**Figure 2:** The cross-disciplinary structure of the ICT-enabled climate change education curriculum

Curriculum areas	Integration Across School Subjects											Sciences
	Language log writing Environment	Mathematics	Environmental studies	History	Religion	Geography	Arts	Health Education	Physical education	Citizen's education	Sciences	
Climate change and me	✓	✓	✓		✓		✓	✓	✓	✓		Biology
Climate change and me	✓	✓	✓	✓	✓	✓	✓			✓		Biology, Meteorology, Evolution
Climate change and ecosystems	✓	✓	✓	✓	✓	✓	✓					Geology, biology, Meteorology, Evolution
Climate change through time	✓	✓	✓	✓	✓	✓	✓					Physics, Chemistry, Meteorology
Climate change and atmosphere	✓	✓	✓				✓	✓				Physics, Chemistry
Energy and fuels	✓	✓	✓					✓		✓		Physics, Chemistry

The structure of the area “Climate change and ecosystems” as in any of the rest areas is based on three levels: 1st-2nd Grade (6-7 year old), 3rd-4th Grades (8-9 year old) and 5th-6th Grades (10-11 year old).

### 1st-2nd Grade Level Units

1. **Animals and plants of my area:** Children seek and discover the animals and the plants of their area, calling upon their experience, exploring the local environment, reading a case study and searching the web. Then, they explore how climate change can affect the animals and the plants of their area. At the end, they seek measures and activities to protect the animals and the plants of their area from climate change.
2. **My area’s ecosystem:** Children find out about ecosystems and explore their area in order to define the type of their local ecosystem. Then, they explore how climate change can affect their local ecosystem. At the end, they try to motivate others and seek measures and activities and to protect their local ecosystem from climate change.
3. **Weather and climate:** Children observe and write down about the local weather. Then, they explore how typical weather changes can affect local plants and animals. Studying relevant web pages and case studies, they understand the difference between weather and climate. At the end, they explore how climate change can affect local plants and animals.

4. ***Seasons and months:*** Children remember through games the names of seasons and months. Then they study relevant web pages and case studies and explore how the change of seasons and months can affect plants and animals. They also search for Greek traditions about seasons and months. At the end, they seek measures and activities to protect the animals and plants of their local ecosystem from changes in the seasons or months pattern.
5. ***The Greek ecosystem:*** Children explore the characteristics of the Greek ecosystem. Then, they study relevant web pages and case studies and they research climate change consequences at the Greek ecosystem.
6. ***Animals' and plants' families:*** Children explore the animals' and plants' families of their ecosystem and make relevant lists. Then, they investigate which animals' and plants' families will suffer or endanger from climate change. They also visit zoos and local organizations in order to find out what they can do to help the endangered plants and animals. At the end, they form local groups to act locally to protect the endangered plants and animals from climate change.
7. ***Animals' and plants' needs:*** Children explore the animals' and plants' needs. Then they study relevant web pages and case studies and investigate how climate change can affect animals' and plants' needs.
8. ***Animals' and plants' characteristics:*** Children observe different animals and write down their characteristics. Then, they choose one animal or plant and investigate if it could survive after a climate change and why, referring to its characteristics.
9. ***Animals' and plants' distribution to the area:*** Children observe images and investigate how animals and plants are distributed in Earth and why. Then, they investigate about how that distribution would be if a climate change occurs.
10. ***Animals' and plants' contribution to our lives:*** Children find out about what animals and plants offer to people and observe how people treat them. Then, they search for ways to help them towards peoples' abuse and climate change.

### 3rd-4th Grade Level Units

1. ***The natural environment of my country:*** Children observe their country's natural maps and search for geological terms such as planes, mountains, rivers etc.
2. ***Administrative regions:*** Children learn about the administrative regions of their country. They also search for the natural and historical characteristics of their own region. They complete maps and make a presentation of their region. Then, they research which regions of their country could be affected by climate change and propose solutions and activities for their protection.
3. ***Humans' and nature's creations:*** Children make lists with humans' and natures' creations. They investigate which of the humans' creations in their area contribute to climate change and which of the natures' creations in their area are affected by climate change. Then they try to motivate people to act against climate change and propose measures and activities.
4. ***Environmental problems:*** Children explore their area to find out about local environmental problems and what climate change has to do with them. Then they propose strategies to improve and alleviate their area.
5. ***Plants of my area:*** Children find out about the plants of their country and explore how people use them in nutrition, medicine etc. Then, they collect and observe some plants in order to find out about their anatomy and reproduction. They also

make a presentation of a plant they choose before and after a climate change in order to motivate people about climate change consequences on plants.

6. ***Animals of my area:*** Children find out about the animals of their country. They classify them into categories regarding if they are wild or tamed etc and they gather information about how people treat them, if they are in danger etc. Then they investigate what would happen to animals due to climate change. They also learn about vertebrates and invertebrates and animals' reproduction. At the end, they examine which animals could survive a climate change and propose solutions and actions.
7. ***Energy in ecosystems:*** Children learn about the energy flow in ecosystems through food chains and webs. Then they examine how climate change could affect the energy flow in all kinds of ecosystems through food chains and webs.
8. ***Ecosystems of our country:*** Children learn about the kinds of ecosystems that exist in Greece and about their characteristics. Then, they examine how climate change affects these ecosystems. At the end, they take measures and act to protect or save their local ecosystem.
9. ***Green in the cities:*** Children explore the benefits of trees in the cities and search for ways to make cities greener. They make a presentation to show ways to people to make their cities greener.
10. ***Nature in mythology and religion:*** Children learn about gods and goddesses of nature in mythology and try to approach the ancients' way of thinking for nature. Then, they explore the relation of their religion with nature and modern ecological problems, such as climate change.

### 5th-6th Grade Level Units

1. ***Greece's geographical terrain:*** Children observe Greece's geographical terrain and become familiar with terms like coast, peninsula, cape etc. Then they draw in a map the Greek areas that they believe that will be affected from climate change. At the end, they cooperate with the local authorities in order to take measures to protect their region from climate change consequences.
2. ***Plants' functions:*** Children observe graphs and learn about photosynthesis, respiration and transpiration of the plants. Then, they investigate how climate change affects these 3 functions of the plants. At the end, they propose measures and actions to protect local plants from climate change.
3. ***Animal species:*** Children observe pictures and classify animals to species and categories, such as vertebrates or invertebrates. Then, they examine how changes in temperature and climate affect animal species. They also learn about animal evolution and survival through ages. At the end, they propose measures and actions to protect local animals that are in danger from climate change.
4. ***Relations in ecosystems:*** Children explore the relations of organisms in ecosystems. Then, they visit a local ecosystem and investigate what would happen to it and its organisms if a climate change occur. At the end, they propose measures and actions to protect their local ecosystem from climate change.
5. ***Oceans:*** Children investigate what would happen to oceans due to climate change, through a case study regarding the clown fish, the web and the relevant articles. Then, they write a story about the future of oceans and get involve in climate change art activities. At the end, they find out what the sea has to offer to people and they propose measures to preserve its beauties.

6. **Forests:** Children cope with a case study regarding pine trees and learn how they are affected by people's exploitation and climate change. Then, they visit a local forest and make a presentation for its beauties in order to motivate others to take actions to save the forests from climate change.
7. **Natural disasters:** Children investigate the relation of climate change with natural disasters. Then, they cooperate with organizations that deal with natural disasters and become volunteers in order to help wherever is needed. At the end, children participate in a debate, where one team tries to convince others that climate change brings upon natural disasters and another team tries to convince others exactly the opposite.
8. **Religion and environment:** Children explore ideas, myths, fears, rumors etc about the end of the world. They also investigate what Christianity and other religions support on this. At the end, they make their own conclusions about climate change and the scenarios of the end of the world.

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