

Geoscience education through environmental ICT storytelling in primary education across Europe

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Raising awareness for sustainable development and environmental consciousness is an alternative teaching approach of geosciences in primary education. Through our methodology this is achieved by strengthening teachers' profile to effectively coach students to work on several environmental issues. By creating a teacher's guideline handbook, in accordance with the educational targets and regulations of EU countries, teachers acquire a fresh perspective on teaching environmental sciences. They also gain scientific knowledge in five educational topics through the implementation of five mini-projects. An e-book enriched with the pupils' digitalised environmental stories was designed to attract students and motivate them to engage environmental issues. The final product acts as a triggering factor for the much-needed environmental awareness of pupils around Europe.

La sensibilisation au développement durable et à la conscience environnementale est une approche alternative d'enseignement des géosciences dans l'enseignement primaire. Grâce à notre méthodologie, cet objectif est atteint en renforçant le profil des enseignants pour inciter efficacement les étudiants à travailler sur plusieurs questions environnementales. En créant un guide pédagogique, conformément aux objectifs pédagogiques et aux réglementations des pays de l'UE, les enseignants acquièrent une perspective à jour sur l'enseignement des sciences de l'environnement. Ils acquièrent également des connaissances scientifiques sur cinq thèmes pédagogiques grâce à la mise en œuvre de cinq mini-projets. Un livre électronique enrichi des histoires environnementales numérisées des élèves a été conçu pour attirer les étudiants et les motiver à s'engager sur les questions environnementales. Le produit final agit comme un déclencheur de la sensibilisation environnementale indispensable aux élèves de toute l'Europe.

Concienciar sobre el desarrollo sostenible y la conciencia ambiental es un enfoque de enseñanza alternativo de las geociencias durante la educación primaria. A través de nuestra metodología, esto se logra fortaleciendo el perfil de los docentes para capacitar de manera efectiva a los estudiantes para trabajar en varios temas ambientales. Al crear un manual de directrices para profesores, conforme a con los objetivos educativos y las normativas de los países de la UE, los profesores adquieren una nueva perspectiva sobre la enseñanza de las ciencias ambientales. También adquieren conocimientos científicos en cinco temas educativos a través de la implementación de cinco mini-proyectos. Se diseñó un libro electrónico (e-book) enriquecido con las historias ambientales de los alumnos para atraer a los estudiantes y motivarlos a involucrarse en cuestiones ambientales. El producto final actúa como un factor desencadenante de la tan necesaria conciencia medio ambiental de los alumnos de toda Europa.

Introduction

Since the beginning of the 21st century, the vision for sustainable development has undoubtedly laid its foundations in education. A natural consequence has been the integration of the concept of sustainability into the national curriculum of most European countries. Studying the 17 sustainable development goals (SDGs) reveals the strong links tying geosciences and natural environment with sustainability (energy, climate change, biodiversity, geophysical hazards, hydrogeology, etc.) (Gill, 2016). Taking this under considera-

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tion, educating students on issues related to the environment and geosciences is deemed more necessary now than ever before.

Training on the subject of Education for Sustainable Development (ESD) has been absent from the curriculum in primary education (Ham & Sewing, 1988) and remains so even today (Kadji-Beltran *et al.*, 2013). Furthermore, it is observed that teachers misunderstand environmental issues, or lack accurate knowledge on them (Francek, 2013). As a result, teachers have difficulties, do not feel confident, and even avoid the implementation of similar programmes (Ham & Sewing, 1988). According to Kadji-Beltran *et al.* (2013), the way in which teachers will approach the learning process is just as important as the content of teaching. For all of these reasons, teachers' education in natural environment and geosciences is a vital priority (Ham & Sewing,

1988; Kadji-Beltran *et al.*, 2013).

Through the Erasmus+ KA201 project "Environmental Stories for Sustainable Development - EnvStories" our goal is strengthening teachers' profile so that they can effectively coach students to deal with several environmental-geosciences issues. The first step into achieving this goal was the design of the teacher's guideline handbook. The handbook includes methodological tools and teaching approaches proposed for the implementation of ESD programmes, as well as the scientific background for five environmental topics, accompanied by five proposed projects to be implemented. The second step was the implementation of a one-week training school. Teachers and students participated in organised training activities to gain real-world experience and raise their environmental awareness.

In the modern world, in order for anyone

to keep up with the technological advancements and the ever-evolving digital tools, basic knowledge and ability to handle technology and its applications is a mandatory minimum skill (Lim & Oakley, 2013). The benefits of utilising Information and Communications Technologies (ICT) in primary education have been studied thoroughly and are generally acknowledged (Lim & Oakley, 2013).

By utilising ICT in the educational process, students are provided with access in a variety of different sources of information and educational material (Smeets, 2005). ICT also appear to act as a motivation factor for learning, especially for less capable students (Venezky & Mulkeen, 2002). Additionally, ICT can contribute to the better understanding of complex concepts and processes with the use of explanatory multimedia material and simulation software, it can facilitate collective work among the students, and it can act as a tool for them to test their own knowledge (Smeets, 2005). There is also the possibility of easily providing personalised educational material which can be proved extremely useful, particularly in special education. Finally, ICT seems to serve effectively active learning theories that support “experiential learning” instead of a “teaching” method. In such a case the role of the teacher is to merely guide the pupils and provide them with the proper tools that will enable them to learn on their own. The concept of innovative use of ICT has become prominent in educational practices during the last years. It refers to the creative and unconventional use of whatever ICT equipment is available in order to supplement the learning experience in the classroom or outside of it (as e-learning or extra-curricular activities) (Venezky & Mulkeen, 2002).

Within the framework of the EnvStories project 20 e-books were developed by the pupils through the EnvStories online platform. Fueled by the offered training material and the guidance of their teachers, the students created interactive stories related to prominent environmental problems with their respective solutions. These stories are presented in the e-books.

Methodology

Handbook

Educational purpose

Within the framework of the EnvStories project, an experiential approach was chosen for the five environmental topics included in the teachers’ handbook. This

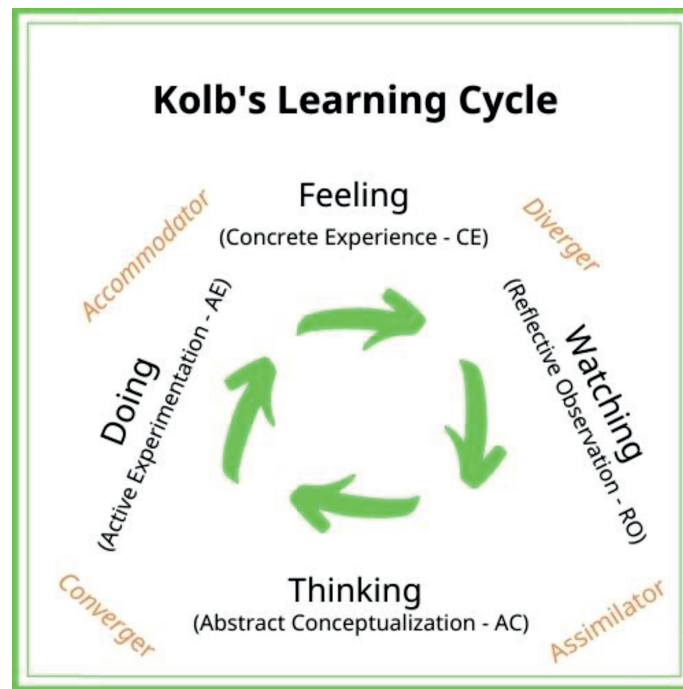


Figure 1 Kolb's learning theory.

approach results from the combined application of the Howard Gardner's theory of multiple intelligences (MI) in the educational process and of the Kolb's learning theory (Figure 1, Table 1). According to the MI theory, all people have at least 7 different types of intelligence equally important, but not equally developed (Table 2). People learn by utilising these different types of intelligence (Gardner & Hatch, 1989;

Griggs, et al., 2009).

According to McFarlane (2011), the MI theory is based not only on acceptance, but also on understanding the value of diversity, making this one of the most effective teaching methodologies of the 21st century. The teacher, under the assumption that a different learning style is appropriate for each student, has the opportunity to prepare his/her teaching in a way that equal oppor-

Table 1: Types of people, characteristics and learning tools, according to the four stages of Kolb's experiential learning cycle.

Types of people	Characteristics	Learning Tools
Accommodator (doing and feeling - CE/AE)	<ul style="list-style-type: none"> • They rely on intuition rather than logic. • They emphasise exploration through experience. • They are spontaneously involved in new experiences. 	<ul style="list-style-type: none"> • “Hands on” activities • Role games • Team games • Labs
Diverger (feeling and watching - CE/RO)	<ul style="list-style-type: none"> • They collect information and process it carefully. • They express opinions only when they are certain of their correctness. • They choose observation from action. • There are many brainstorming ideas when solving problems. 	<ul style="list-style-type: none"> • Projects • Reading • Use of audiovisual interactive media
Assimilator (watching and thinking - AC/RO)	<ul style="list-style-type: none"> • They have developed reasoning ability. • They develop a unified theory for the experience. • They analyse a wealth of information to support their theory. 	<ul style="list-style-type: none"> • Use of audiovisual interactive media • Brainstorming • Projects - Research
Converger (doing and thinking - AC/AE)	<ul style="list-style-type: none"> • They emphasise the facts and use the experiment to draw conclusions. • Strong at finding solutions to problems. 	<ul style="list-style-type: none"> • Projects • Simulating experiments • “Hands on” activities • Case studies • Use of audiovisual interactive media

Table 2: The different types of intelligence according to Gardner, their characteristics and teaching tools.

Types of intelligence	Characteristics	Learning Tools
Linguistic	<ul style="list-style-type: none"> • Ability to use oral and written language correctly. • Proper use of language. • Good memory. 	<ul style="list-style-type: none"> • Writing and narrating • Commenting on events • Speeches • Debate
Logical-Mathematical	<ul style="list-style-type: none"> • Ability to solve mathematical calculations. • Solving logical problems. 	<ul style="list-style-type: none"> • Experiments • Puzzle games • Creating charts • Categorisation of concepts
Bodily - Kinesthetic	<ul style="list-style-type: none"> • Ability to use body as a means to convey meaning. • Kinetic skills. • Kinesis synchronisation. • Physical memory. 	<ul style="list-style-type: none"> • Sports • Dance • Theatrical games • Dramatisation • Sculpture
Musical	<ul style="list-style-type: none"> • Musical sensitivity. • Ability to recognise and synthesise musical patterns. • Rhythm recognition. 	<ul style="list-style-type: none"> • Use of musical instruments • Singing • Musical toys
Spatial	<ul style="list-style-type: none"> • Ability of spatial representations. • Good orientation. • Visual memory. 	<ul style="list-style-type: none"> • Charts and maps • Art - Drawing • Visual representation of concepts • Sculpture
Interpersonal	<ul style="list-style-type: none"> • Ability to recognise and understand the intentions and desires of other people. 	<ul style="list-style-type: none"> • Collaborative activities • Discussion • Theatrical games • Dramatisation
Intrapersonal	<ul style="list-style-type: none"> • Ability to understand himself. • Identification of his weaknesses and strengths. 	<ul style="list-style-type: none"> • Self-awareness and self-concentration exercises • Projects • Individual tasks
Naturalist	<ul style="list-style-type: none"> • Ability to connect with the natural environment and protect it. • Love and interest for the different forms of life on the planet. 	<ul style="list-style-type: none"> • Actions - field trips • Projects • Labs • Arts

tunities to students are provided, resulting in school success (Griggs *et al.*, 2009; Pritchard, 2009). Students who are taught to approach the learning process more efficiently, discovering their strengths at the same time, enjoy similar benefits (Griggs *et al.*, 2009).

The utilisation of MI theory in our programme resulted in the development of the term "EnvironmentART education". This term includes all art forms (visual arts, movement, literature, photography and theatre-music-video). With this term, it is suggested that forms of art may be used by the teacher himself/herself as a tool for the presentation of each topic. It is also proposed that they can constitute a powerful tool for the students, as forms of art may act as the vehicle for new ways for approach, expression and presentation of any environmental topic.

The teacher's guide, apart from the pedagogical approach, includes all the scientific background necessary for the full understanding of the five topics under study.

Additionally, considering the 17 goals of sustainable development as well as the goals of the curriculum of the participating countries, 5 projects were designed with the respective worksheets. These projects are available to be used by any primary school teacher who wishes to implement an ESD programme at their school.

Scientific purpose

The main aim of our novel teaching approach of geosciences in primary education is to cultivate the spirit of environmental consciousness and sustainable development among children of young age. This approach will lead to environmentally conscious citizens who will handle the environment with respect, not contributing to its constant degradation. Through consulting this handbook and implementing it into the teaching process, teachers will acquire a proper background – both educational and scientific – in five modern environmental topics that they are very likely to encoun-

ter in their countries. More specifically, the examined topics are (a) waste management and recycling, (b) natural environment, (c) health and environment, (d) geophysical hazards and (e) natural resources.

In the scientific part of the developed handbook, the aim was to simplify and highlight basic terms that describe each topic, as well as to point out their main effects in human societies and the ecosystems. Basic environmental problems were also presented, alongside with respective response measures, utilising diagrams, colourful pictures and text boxes. The first topic analysed in the handbook is that of "waste management and recycling", which describes the waste management hierarchy and modern waste management techniques, such as recycling, composting, development of landfills and combustion with energy recovery. Secondly, within the framework of the topic "natural environment", terms such as atmosphere, hydrosphere, geosphere, biosphere, flora and fauna are presented and explained. In addition, the water cycle and biodiversity and its preventive measurements are examined. The third topic addressed in the handbook is that of "health and environment". In this chapter air, soil pollution and water pollution are described and important factors contributing to them are listed, in order for the teachers to gain a broader view of the different pollution categories and the various measures that, if applied by the young generation, will lead in the long run to the mitigation of phenomena such as the greenhouse effect and ozone layer weakening. The fourth chapter, "geophysical hazards", includes earthquakes (mechanism, pre- and post-earthquake phenomena and things people must do during and after an earthquake), volcanoes (formation and location, main parts and types), floods (possible causes, effects, things people have to do in case of a flood and preventive measurements), wildfires (types, causes and preventive measurements), landslides (causes, impacts and preventive measurements) and coastal erosion (causes, location of its occurrence and preventive measurements). Lastly, within the framework of the topic "natural resources", the term of natural resources depletion is highlighted and explained, as well as water management practices and soil degradation preventive measures, as human societies rely heavily both on water and territorial resources to develop. The difference between renewable and non-renewable energy sources is also explained, and finally, alternative forms of energy are presented (nuclear and hydrogen combustion).



Figure 2: Outdoor activities.

Training activities

Interactive activities play a significant part in the proposed teaching approach, especially those that take place outdoors. Through those activities, pupils are trained to become more familiar with the geo-environment and geosciences. This way environmental education becomes more meaningful and memorable, enhanced by real-world experiences, rather than being limited by the simple attendance of an instructional programme inside a classroom. In accordance with our methodology, a one-week educational training school was organised in Athens, Greece. All participants – pupils and teachers – had the opportunity to search for ideas and solutions regarding the five environmental issues explored in the teacher's handbook. Various activities were carried out in places of environmental and cultural importance, where the "learning by doing" method was applied. The organised activities are part of the teaching methodology and teachers are encouraged to apply this approach to other environmental subjects.

During outdoor activities, pupils had the time to explore and observe in order to focus on the issues that might be a point of concern for them or the environment (Figure 2). Part of the outdoors activities was the demonstration of issues related to educational objectives such as geology, physical geography, the water cycle, recycling and waste disposal, fossil fuels as non-renewable energy sources and even astronomy in a creative educational way that provides an opportunity for learning in a more entertaining approach. Furthermore, pupils were assigned by the training school instructors to work in groups of 5 to complete learning activities, share ideas and discuss their experiences during the field trip. The multimedia material (images, videos, sounds) gathered by the pupils and

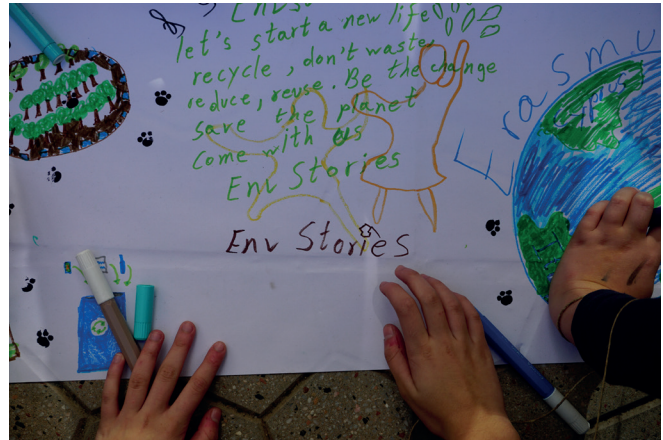


Figure 3: EnvironmentART activities.

their teachers were used for their digital stories (e-books). Pupils were instructed to express their experiences from the training school through any of the art forms (Figure 3) Their imagination and creativity led the pupils to fulfil the assignment in the forms of song writing, paintings and photographs, always supported by their teachers.

EnvStories platform and e-book

During the EnvStories project, 20 different e-books were developed by students, presenting interactive stories related to environmental problems with effective solutions. Teachers assisted pupils to develop these stories using the project's handbook and an online platform for the co-creation of interactive stories (in the form of e-books). Pupils worked collaboratively using the platform in order to produce stories that communicate complex concepts to others, structuring information and data in meaningful and useful ways (storytelling

(Figure 4).

The content of the e-books is specifically defined and relevant to the training topics developed during the project and provides substantial information to pupils. Digital material relevant to the environmental problems and possible solutions was designed and offered for free through the platform to support students' work. Each school was assigned different subjects relevant to local problems. Through activities carried out in places of environmental interest, the participants had the opportunity to make realistic proposals in their stories (e-books) for the protection and conservation of those areas, which could be possible if implemented by many citizens. In this regard, the conservation of each area's environment as well as the promotion of the natural and cultural heritage will let us move towards sustainable development of each region in terms of environment, economy and society. The pupils' stories in the form of interactive e-books and the



Figure 4: EnvStories e-book creation.

teacher's guide will become publicly available at the end of the project.

Results and discussion

The need for an open-minded approach and flexibility in the way of teaching that arises from the use of the MI theory are main demands in education (McFarlane, 2011). In addition, the multitude of ways to approach students through the MI theory constitutes a new challenge for many teachers (Griggs, *et al.*, 2009). The application of these new methods resulted in the successful coverage of a larger percentage of the objectives of the curriculum. This was achieved also by students who could not follow the traditional teaching. Students discovered more about their potential and their limitations as performance anxiety receded. They better understood the value of diversity and learned to work together for a common cause. Reflecting on their

experiences, they cultivated their critical ability, perceived the human-environment relationship from a new angle, and acquired a willingness to take an active part in resolving environmental issues.

During the training school, pupils were requested to fill in evaluation sheets, one for each day of the training school. The purpose of this evaluation was to identify how activities that took place during the training school affected the pupils. Most of the participants pointed to the main characteristics of each activity from which they gained additional knowledge and experience by doing the indicated activities. Pupils got involved in numerous activities, learning each day something new and useful, not only for the purposes of the project but for their everyday life, as they were educated on general science issues. It was an indisputable fact that through the activities, pupils raised their will to learn more about what triggered the most their curiosity. Finally,

the experiential approach of the training school motivated the pupils to participate actively not only on their own, but also in groups, in order to collaborate and share experiences and their cultural background.

Pupils used their imagination to create realistic proposals in their stories (e-books) for the protection and conservation of those areas that have the potential to be implemented by many citizens. Finally, the e-books constitute a powerful tool which serves as an inspiration to even more pupils about learning for the sustainable environment.

Acknowledgement

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