



Green Education for a Sustainable Future

Iro Koliakou¹, Virginia Arvaniti¹, Elias Kalambokis¹, Tharenos Bratitsis²

¹ Anatolia College, Greece

² University of Western Macedonia, Greece

Abstract

Green education can act as a vehicle in order to inspire the next generation of students to pursue a career in science. Empowering youth to create a sustainable future is critical in the process of preserving the planet and in educating future responsible citizens. With a green education curriculum, a science subject which may be considered abstract is put into a familiar context, relevant to the everyday life of the students. Green education connects abstract science concepts to real world technologies that are responding to environmental challenges. Novel fields such as green chemistry, sustainable engineering /robotics and green biotechnology can be implemented into classroom teaching under the umbrella of green education. In order to support teachers around Europe to integrate green education principles in STEM curriculum, the project Green education for a sustainable future-Green Edu has been created. Green Edu is an Erasmus funded project that brings together universities and schools from Poland, Italy, Romania, Turkey and Greece. An online platform is being developed and will act as a repository of STEM Green education resources, focusing on novel fields of Green chemistry, Green biotechnology and sustainable Engineering and Robotics. The platform integrates micro-MOOC (Massive Open Online Courses/Content) – an innovative approach for developing STEM laboratories that will motivate teachers in the creation of flexible personalized teaching/learning paths and to increase students' interest and involvement, due to the innovative methodology; of their learning. This paper focuses on presenting educational resources developed for primary and secondary education and preliminary results from their implementation in the classroom.

Keywords: STEM education , sustainability , Green chemistry , Green education

1. Why Green Education

Green education or sustainable education is an educational approach that aims to provide students, schools and communities with the values and the motivation to take action for our planet in their personal lives within their community and also at a global scale, now and in the future. Green education aims at building awareness and knowledge of sustainability issues, but also at developing students and schools that are able to think critically, innovate and provide solutions towards more sustainable patterns of living.[1,2]

2. STEM and Green Education

Green education can act as a vehicle in order to inspire the next generation of students to pursue a science career. Furthermore, empowering youth to create a sustainable future is critical in the process of preserving the planet and in cultivating future responsible citizens. With a green education curriculum a science subject which may be considered abstract, is put into a familiar context relevant to the everyday life of the students and results in the use of technologies that are solving environmental challenges.[1,3] Novel fields such as green chemistry, sustainable engineering and robotics and green biotechnology can be implemented into classroom teaching under the umbrella of green education. Recent studies identify a shortage of STEM professionals and the need to engage students at all levels in science to boost the supply of STEM workers. The European Union also focuses on education that promotes the building of 21st century skills (transversal and basic skills, STEM related skills, etc.) from children, youth and every EU citizen. Furthermore, green programs draw students and especially female students, toward STEM-related pathways and careers and inspire them to pursue a career or further education in STEM fields.

3. The Green Edu project

Green Education for a sustainable future - Green Edu, is a European program funded by Erasmus+ Action: 2019-1-PL01-KA201-065695. It is a collaboration between 3 Universities and 3 schools, Wyzsza Szkola Biznesu I Nauk o Zdrowiu (Poland-Coordinator), Universita Degli studi di Palermo (



Italy), Panepistimio Dytikis Makedonias (Greece), Altindag Ahiler Ortaokulu (Turkey), Scoala Gimnaziala Nr. 16 Take Ionescu (Romania) and Educational Association Anatolia (Greece).

3.1 Aim of Green Edu

The project aims to support teachers across Europe in integrating green education principles into STEM curricula. An online platform will be developed that will act as a repository of STEM green education resources, focusing on novel fields of green chemistry, green biotechnology and sustainable engineering and robotics. The platform will integrate micro-MOOC (Massive Open Online Courses/Content) – an innovative approach for developing STEM laboratories that will motivate teachers in the creation of flexible personalized teaching/learning paths and to increase students' interest and involvement, due to the innovative methodology. The project objectives include: 1. Support teachers to integrate green education principles in STEM curriculum. 2. Inspire and improve competence of teachers in order to bring novel topics into the classroom. 3. Embed green education principles in school laboratories. 4. Disseminate green education and create a community of green education in Europe. The project will provide access to lesson plans in national languages that cover state of the art science fields and two educational kits will be available to educators to readily use in the classroom.

4 Green Edu Activities

Green Edu activities aim to inspire students to pursue a career in STEM field and help them connect abstract science concepts to real world technologies that are solving environmental challenges and promote responsible citizenship. Activities are designed in a form of lesson plans that include basic theory and laboratory work. Hands on as well as virtual labs will be designed. Topics will cover novel science fields and encompass a real life problem in order to engage learners. Activities will be developed for elementary and middle year school students.

4.1 Chemistry

Green Chemistry is the design of chemical products that reduce the use or generation of hazardous substances. The challenge is to provide society with essential products that are economical, sustainable and high performing. From life-saving pharmaceutical drugs to high-performance materials without chemicals and chemical products, our standard of living would significantly decline. Chemistry curricula should be re-designed to be greener and safer. School labs should be cleared from hazardous chemical substances. By supporting educators and students to teach and learn green chemistry, we can inspire students to become tomorrow's responsible science workforce. [3,4,5,6]

4.2 Biotechnology

The Biotechnology field has developed fast and changed over the last decade. Today biology curricula around Europe do not include novel biotechnology techniques due to lack of teacher resources and training. Furthermore, as technology moves fast there is a gap in training that may result in scientific misconceptions from the public especially in the field of genetic modification. Thus, the activities designed will focus on introducing novel biotechnology concepts and techniques into the classroom. The designed activities focus on molecular biology of the plant cell and present students with novel biology topics, such as functional genomics, proteomics, biofuels, textiles, pharmaceutical substances and production economics. Green biotechnology refers to biological techniques to plants with the aim of improving the nutritional quality, quantity and production economics. [7,8]

4.3 Engineering and Robotics

Green engineering is the design and manufacturing of products and processes that have the least negative impact on the environment possible. From wind turbines and photovoltaic cells to bioclimatic houses, modern technology is a decisive factor in making the world greener. Robotics and automation have a significant role in energy saving and optimizing in production. However, there is still a misconception in our society that robotics do not have a role in a sustainable society and that they deprive people from jobs. Today's educational curricula should include robotics and automation as they will play a major role in the future of production. Activities that connect robotics and automation with sustainable engineering will be developed, aiming at driving students to develop critical thinking skills and becoming the next generation of sustainable engineers. Furthermore, a green engineering and robotics contest will be established. [9,10]



5. Green Edu Activities in the classroom

The COVID-19 pandemic has affected educational organizations worldwide. Activities that were planned to be hands on activities in the classroom had to be transferred to an online environment. We implemented two activities of the Green Edu for elementary school online lessons.

5.1 Green Edu Activity - Biopolymers

Through this lesson plan students learn about green Chemistry and polymers. After an introduction to green chemistry concepts and polymers, students are presented with the problem of plastic pollution. They learn about bioplastics and follow the scientific method to make their own plastic ornaments from milk. The lesson plan was addressed to a total of 75 2nd grade elementary school students that were divided into 3 groups, connected online and with the help of the class teacher, the STEM instructors and their parents, they followed the learning scenario. Students had gathered all materials needed for the experiment and were always under adult supervision.

5.2 Green Edu Activity - Our Earth

Through this lesson plan students learn about green Chemistry, our earth and how human activities can affect the environment. After an introduction to green chemistry and the earth, they are presented to climate change, to human actions responsible for this environmental issue and are motivated to use their imagination and think of ways to save the environment. The lesson plan was addressed to a total of 75 3rd grade elementary school students that were divided into 3 groups, connected online and with the help of the class teacher, the STEM instructors and their parents, they followed the learning scenario. After a short presentation about greenhouse gases and the impacts on climate change, students brainstormed about different uses of plastic bottles and were given instructions on how to make a mini composter in their home kitchen and made observations for a 2 week period. In the end, they shared their observations with the rest of the class.

6. Conclusion

As a result of its innovative character, the Green Edu adds important value as though it: (i) Green Chemistry is combined with STEM, (ii) An online Green educational platform along with a digital repository are created, (iii) Guidelines on Green activities and Green lab establishment are provided, along with educational seminars and in person training, (iv) Detailed lesson plans are provided as well as educational kits and (v) Part of the Elementary School activities were presented online (due to the pandemic) and their impact was recorded using questionnaires and moodle.

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