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INTRODUCTION OF AGROMOTICS AND ECOLOGICAL AGRICULTURE IN PRIMARY EDUCATION.



DOMOTIC SCHOOL GARDEN

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Miguel Hernández University

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Editors:
M^a Teresa Pretel. Dpto. Departamento de Biología Aplicada.
Antonio Ruiz. Dpto. de Ingeniería.
EPSO, Universidad Miguel Hernández, Ctra. Beniel km. 3.2, 03312 Orihuela (Alicante).

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CHAPTER 2

ACTIVITIES RELATED TO SCIENCE WITHIN THE FRAMEWORK OF THE DOMOTIC SCHOOL GARDEN PROJECT

Pretel, M.T.¹, Martínez-Arenes, M.C.², Melián, A.¹ and Ruiz, A.¹

¹CIAGRO. EPSO, Universidad Miguel Hernández, Ctra. Beniel km. 3.2, 03312; ²Departamento Agraria, Instituto de Educación Secundaria “El Palmeral” Avd. Doctor García Rogel, 28, 03300 Orihuela.

ABSTRACT

Among the objectives of the Erasmus+ Domotic School Garden (DSG) Project (2020-1-ES01-KA201-082999) are the increase in motivation and academic performance in arts, sciences, technology, engineering and mathematics. This paper summarizes the experience of the work carried out by the professors of the Miguel Hernández University (coordinators of the Project) on the activities related to science. In the first place, a survey was designed for the schools participating in the Project (St. Kliment Ohridski School in Bulgaria, The Primary School of Mikro Evmoiro in Greece and Circolo Didattico San Giustino e Citerna in Italy), which allowed us to know, among others aspects, the human and material means at their disposal. With the results of the surveys, the initially planned activities were adapted to the material and human resources of the Educational Centers, and various activities related to science were proposed, with a summary of material, objectives and difficulty. After a period of reflection by the teachers of the schools, an online meeting was organized. Finally, after a period of feed-back between all the members of the Project, the professors of the Miguel Hernández University discarded some activities and developed the scripts and all the necessary graphic material for the five most appropriate activities related to science.

Keywords: *STEAM, ERASMUS+, elementary education.*

INTRODUCTION

In the STEM educational approach, the fields of Science, Technology, Engineering and Mathematics are integrated with the skills of daily life. This approach provides people with the skills and competencies necessary for the business world of the 21st century, which is why it is recommended to integrate STEAM education from an early age (karalar et al., 2021).

In order to motivate more young people to engage in science, technology, engineering and mathematics (STEM) related careers, initiatives across Europe started to link science education more closely with the arts and other subjects, using inquiry-based pedagogy, and engaging with a wide range of societal actors and industries (STEAM). While the definition of those competences has not changed

much over the years, the support of competence development in STEAM becomes increasingly relevant and should be reflected in this recommendation (EU, 2018).

The "Domotic School Garden" project consists of the automation of an ecological school garden, developing the skills of the student body in STEAM, linguistic competence (English), and integrating transversal values. The development of these skills requires that the theoretical knowledge acquired in the classes be put into practice, in an environment where learning takes place in a natural and practical way, and where the student body participates in the teaching-learning process. Within the horizontal priorities, the Project seeks for students to understand in a practical way how natural systems work in an environment such as the orchard, and how they are affected by the ecosystems that are generated around them and by the climate, and their importance in sustaining life on the planet. The risks derived from climate change as a global threat are also analyzed, which can be made visible directly from the management of the school garden.

Therefore, some of the needs that justify the project are the reduction of school failure of the student body, the motivation towards learning STEAM, the incorporation of innovation in institutions, the promotion of teacher training, the improvement of self-training capacity in STEAM, the search for new teaching-learning methodologies, involving students in the teaching-learning process, collaborating with other European institutions and sharing experiences, reducing the rurality bias and bringing students closer to global environmental problems, such as climate change, and develop values in the curriculum in a transversal way. In order for these objectives to be carried out successfully, after the award of the DSG Project, a close interaction was necessary between the Project coordinators (Miguel Hernández University) and the participating Educational Centers (Project (St. Kliment Ohridski School in Bulgaria, The Primary School of Mikro Evmoiro in Greece and Circolo Didattico San Giustino e Citeria in Italy). This interaction allowed us to adapt the initially planned science-related activities to the material and human resources of the schools, and to their needs and interests.

According to international research, students need to learn about science and the scientific way of thinking at all educational levels regardless of the studies and profession they are going to practice (DeWitt et al., 2013; Nantsou et al., 2021). Carlone and Johnson (2013) found that when students have positive science experiences in school, they develop their skills and self-confidence, which contribute to their later aspirations in science careers. Elementary teachers play a crucial role in motivating them to actively participate in science (DeWitt et al., 2013). All the activities related to science that are presented in this work, provide tools that allow the teacher to successfully carry out projects related to science around the management of the school organic garden, facilitating the students to interact with the environment through the garden and developing the skills of the student body in STEAM.

DEVELOPMENT OF THE EXPERIENCE

This paper describes in a simple way what has been the experience of the professors of the Miguel Hernández University in the DSG Project, in relation to science activities, from its beginning and during the first months of its development. In the first place, a survey of the schools was carried out to find out the human and material resources available to each school. With the results of this survey, the professors of the Miguel Hernández University adapted the activities initially planned in the Project to the material and human resources of the Centers. Various proposals related to science were developed, with a summary of material, objectives and difficulty.

After a period of reflection of the schools participating in the Project (Bulgaria, Greece and Italy) an online meeting was organized. Once the opinions about the activities of the three participating schools are known and after a period of feed-back, the professors of the Miguel Hernández University develop the scripts and all the necessary graphic material so that the professors of the schools can carry out with success the most appropriate activities of each discipline, among these, five activities related to science.

1. KNOW THE STARTING POINT OF EACH PARTNER EDUCATIONAL CENTER

The teachers of the UMH designed a questionnaire to know the starting point of the educational centers participating in the project, so that it would be easy to fill in by the teachers of the schools and that, at the same time, would provide us with information on how to correctly focus our job. The questionnaire was divided into five blocks: Block 1.- Know the spatial arrangement and inventory material of the educational center., Block 2.- Configuration of the team responsible for carrying out the project. Block 3.- Determination of previous knowledge of organic production. Block 4.- Analysis of the economic and social importance of the agricultural and livestock sector. Block 5.- Technical aspects related to the management of weather stations and Block 6.- Educational activities in the school garden.

In relation to the science activities, the surveys to the schools, allowed us to know the material means they had, for example, availability of laboratories, microscopes or binocular loupes, since this material was necessary for some activities initially planned. The analysis of the results of the surveys allowed us to know that some of the scientific activities planned by the UMH cannot be carried out, since most centers do not have microscopes or they are insufficient to carry them out successfully. For this reason, the UMH teachers adapted the initial proposals to the resources and means of the educational centers. For example, the activity: How do plants protect themselves and where do they exchange gases?, in which the students can observe the epidermis of the leaves and the stomata, and the activity: Where do plants take water and nutrients from minerals?, in which students can observe the root hairs; cannot be performed as microscopes are needed.

After a period of reflection on the results of the surveys, the teachers of the UMH and La Llave Consulting, we designed a work system in GOOGLE DRIVE to facilitate interaction between all the members of the project. The folder of ACTIVITIES OF THE PROPOSAL OF THE UMH included various activities related to science that can be carried out in all schools with the material they have. In this folder, a subfolder was included for each school in which they could comment and suggest modifications to the proposed activities.

2. REFLECTION OF THE UMH TEACHER WITH THE RESULTS OF MEETING ON LINE AND FEEDBACK

The activities related to science that were compatible with the means and materials that the Educational Centers had were included in the folders and presented in an online meeting, in which all the members of the project participated, UMH, La Llave Consulting, St. Kliment Ohridski School in Bulgaria, The Primary School of Mikro Evmoiro in Greece and Circolo Didattico San Giustino e Citerna in Italy. After a period of feedback between the members of the project, it was decided that some activities related to science proposed by the UMH may be difficult to carry out for most students, and other activities are difficult to carry out in the current situation of COVID 19 pandemic. However, other activities were very interesting and the schools asked us for the scripts and the necessary material to develop them.

Based on the results of the online meeting and the feed-back between the members of the Project, some activities were discarded as they may be too complicated for the children. For example, the activities "What are the plants in our garden like? Stems, leaves, flowers and fruits", "How to recognize the main families of plants that grow in our garden" (figure 1^a,b), and the activities "Why do plants need light?" (Figure 1c) and "Calculation of the germination power of a seed sample" (Figure 1d).

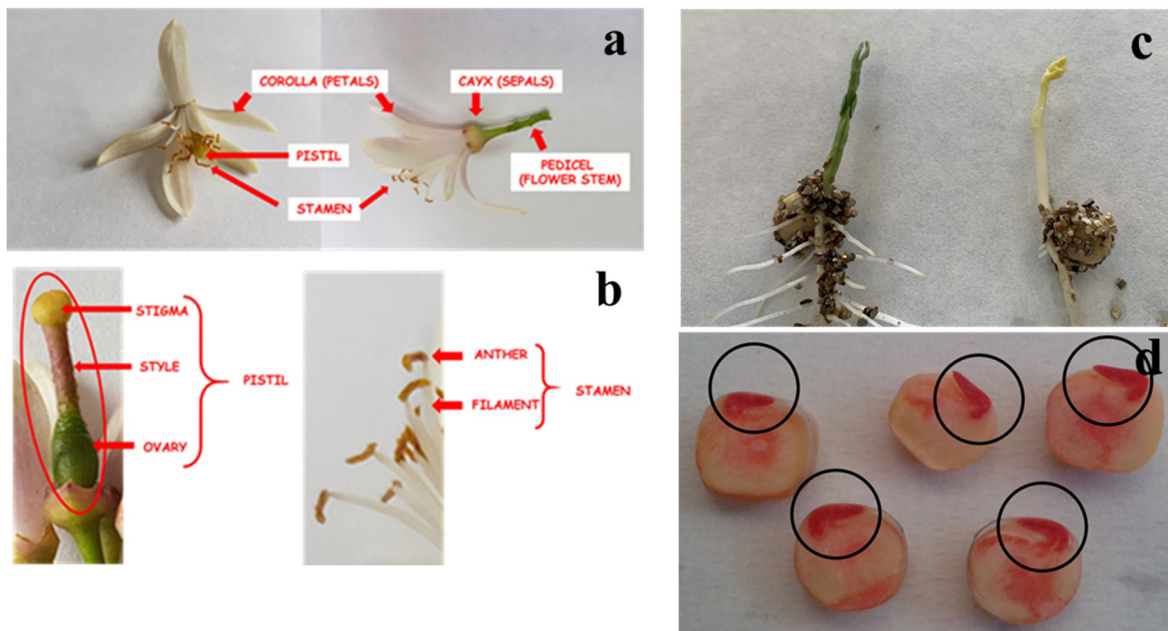


Figure 1: Images of the activities discarded due to their difficulty, after the feedback between the members of the Project and the online meeting: a,b) What are the plants in our garden like? stems, leaves, flowers and fruits; how to recognize the main families of plants that grow in our garden, c) Why do plants need light? d) and the calculation of the germination power of a sample of seeds.

In addition, the activity "Knowledge and collection of traditional seeds of our environment", which tries to collect information on the traditional crops of each area, despite being very interesting, was ruled out due to the current pandemic situation. This activity requires direct interaction between students and farmers (Figure 2).



Figure 2: Activities discarded due to the COVID 19 pandemic situation: Knowledge and collection of traditional seeds from our environment. Photographs of seed exchange of the Week of the Garden of Murcia (2018).

3. PREPARATION OF THE MATERIAL FOR THE DEVELOPMENT OF SELECTED SCIENCE-RELATED ACTIVITIES

Finally, five activities were selected that can be easily carried out in all schools, by all students and planned within the framework of the DSG project: 1.- Preparation of a seed bank for each center that is part of the DSG, 2. - Preparation of a herbarium of cultivated plants for each member center of the DSG, 3.- The Mandalas in the DSG, 4.- Balls of plant life. The birth of a plant and 5.- How do environmental conditions influence plant transpiration?

Next, what each of the five science-related activities consist of and how they are integrated into the educational context of the GSD Project will be discussed.

3.1. Preparation of a seed bank for each center that is part of the DSG

Starting a seed collection in each center with the Domotic School Garden is an interesting and very simple way to start this project. The equipment required is very affordable and requires no specialist knowledge to carry it out. This activity can be started in each center participating in the DSG project, and will continue once the project is finished. All students, teachers and parents of students could collaborate in its preparation and maintenance. The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, social and civic competence. And from STEAM activities, the science activities (Figure 3).



Figure 3: Images of the activity “Preparation of a seed bank for each center that is part of the DSG”. STEAM activities.

3.2. Preparation of a herbarium of cultivated plants for each DSG member center

This activity will be developed continuously from the beginning of the development of the DSG and all students, teachers and parents of students could collaborate in its development and maintenance. It is not a question of each student making their own herbarium, but rather starting the development of a herbarium for each center in the DSG project, which would continue once the DSG is finished (Figure 4). The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, social and civic competence, and Sense of initiative and entrepreneurship. And from STEAM activities, the science activities and technology.



Figure 4: Images of the activity “Preparation of a herbarium of cultivated plants for each DSG member center”. STEAM activities.

3.3. The Mandalas in the DSG

The realization of different mandalas is proposed, for example, with the products collected, or with waste materials from the DSG (Figure 5). Currently, mandalas, made with different materials and colors, are used to achieve different objectives. In the case of the DSG, the realization of the mandalas will serve to enhance personal initiative, creativity and coexistence. The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, social and civic competence, sense of initiative and entrepreneurship and cultural awareness and expression. And from STEAM activities, the science and art activities.



Figure 5: Images of the activity “The Mandalas in the DSG”. STEAM activities.

3.4. Balls of plant life. The birth of a plant

In this activity the students will know the parts of the seed (embryo, endosperm, cotyledons and cover). Students will understand which part of the seed will turn into a plant, which part contributes food to the embryo, and which part serves to protect it. In addition, this activity will work with an ancient form of natural agriculture to propagate the seeds with minimal tillage on the land and with hardly any organic matter added. The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, social and civic competence and learning to learn. And from STEAM activities, the science activities (Figure 6).



Figure 6: Images of the activity “Balls of plant life”. STEAM activities

3.5. How do environmental conditions influence the transpiration of plants?

Plants require atmospheric CO₂ to carry out photosynthesis, which they obtain through the stomata. When the stomata are opened to take in the CO₂, there is an inevitable loss of water through transpiration. This loss of water must be continually replenished by absorbing and transporting more water from the ground. This activity will demonstrate that the intensity of transpiration will depend on environmental conditions. The key european competences worked in this activity are: mathematical competence and basic competencies in science and technology, learning to learn, sense of initiative and entrepreneurship and cultural awareness and expression. And from STEAM activities, the science activities (Figure 7).

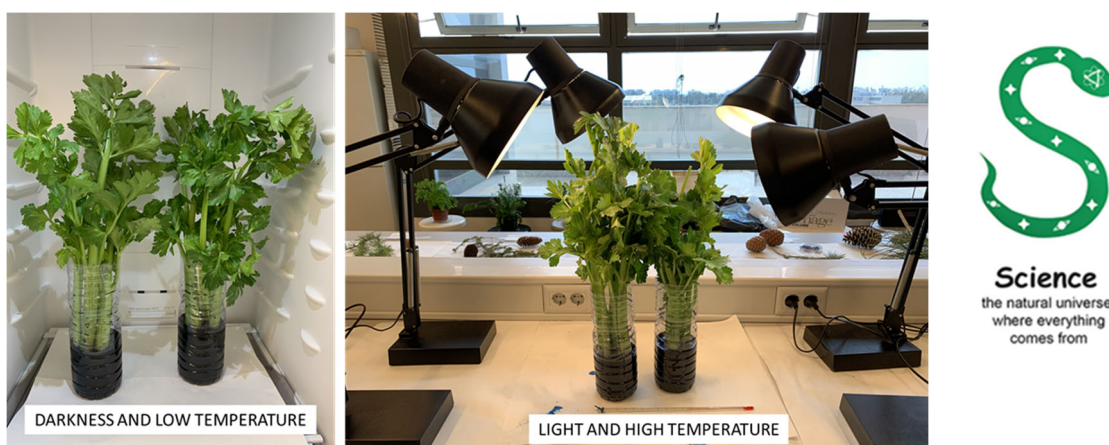


Figure 7: Images of the activity “How do environmental conditions influence the transpiration of plants?”. STEAM activities.

CONCLUSIONS

This work shows an effective work model to develop tools that allow teachers of educational centers to carry out scientific projects around the management of the automated school organic garden. The activities related to science that are presented are aimed at facilitating the students' interaction and understanding of the environment. All the activities developed will allow working through an active and participatory methodology, which invites action-research, in a natural environment outdoors. In all the activities that have been developed, students are motivated to achieve better European skills (STEAM).

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CHAPTER 3

ACTIVITIES RELATED TO AGROECOLOGY WITHIN THE FRAMEWORK OF THE DOMOTIC SCHOOL GARDEN PROJECT

Martínez-Arenes, M.C.¹, Pretel, M.T..², Melián, A.² and Ruiz, A.²

¹Departamento Agraria, Instituto de Educación Secundaria “El Palmeral” Avd. Doctor García Rogel, 28, 03300 Orihuela.

²CIAGRO. EPSO, Universidad Miguel Hernández, Ctra. Beniel km. 3.2, 03312;

ABSTRACT

The Erasmus+ Domotic School Garden (DSG) project (2020-1-ES01-KA201-082999) is a school project whose objectives are to promote a model of sustainable, healthy and responsible consumption in the earliest stages of education. Therefore, in the implementation of this project, activities related to agroecology, the protection of biodiversity, food sovereignty have been addressed in the school gardens of the participating schools (St. Kliment Ohridski School in Bulgaria, The Primary School of Mikro Evmoiro in Greece and Circolo Didattico San Giustino e Citerna in Italy). After a period of feedback between all the members of the Project and led by the team from the Miguel Hernández University of Elche, five agro ecological activities were chosen to be carried out "in situ" in the school garden of each educational center. The teaching team of each school had autonomy to adapt the proposed activities to the required level of the chosen students. Likewise, it was proposed that STEAM skills be worked on transversally in each activity, as well as the Sustainable Development Goals most in line with the proposed activity.

Keywords: *STEAM, ERASMUS+, ODS, agroecology.*

INTRODUCTION

Planet Earth has endured human actions that have triggered unsustainable development and have compromised the durability of natural resources, affecting future generations. It is considered that an effective education for sustainability must start at the earliest stages of teaching children, accompanying them throughout all their formative stages until they achieve a deep understanding of environmental problems and acquire personal and professional skills in matters of sustainability. The implementation of school projects that generate changes in attitude towards a sustainable model of consumption, responds to the climatic emergency situation in which we find ourselves.

The practice of agroecology in school gardens, understood as living pedagogical spaces, is highly recommended for carrying out multidisciplinary and/or transversal activities in the outdoor spaces of educational institutions. Moreover, an adequate diet allows young people to grow up healthy,

a balanced diet, and the way of producing the food that we consume in our lunch will allow students to understand the importance of our territory not being depleted or polluted. Since the erasmus+ domotic school garden (DSG) project (2020-1-es01-ka201-082999) began in times of a pandemic, travel was restricted and the most appropriate way to meet the objectives had to be decided. For this reason, a methodology was designed to develop the objectives set forth in it, so that all the necessary information related to the school gardens of each educational center could be extracted. For this reason, activity 0 called collage was proposed. This activity raises the need to know the environment of both the school and the city, to learn about its culture linked to the rural and forest world. This information was crucial since it facilitated the selection of agroecology activities, as well as advice on the care of plants in the school garden to the teachers of the participating centers. The meaning of Sustainable Development Goals in the Domotic School Garden project is that fostering this kind of activities we would be applying the Sustainable Development Goal at the same time, that is to say, in a cross way. In this part of project a few SDG have been chosen in order to be applied in each activity.

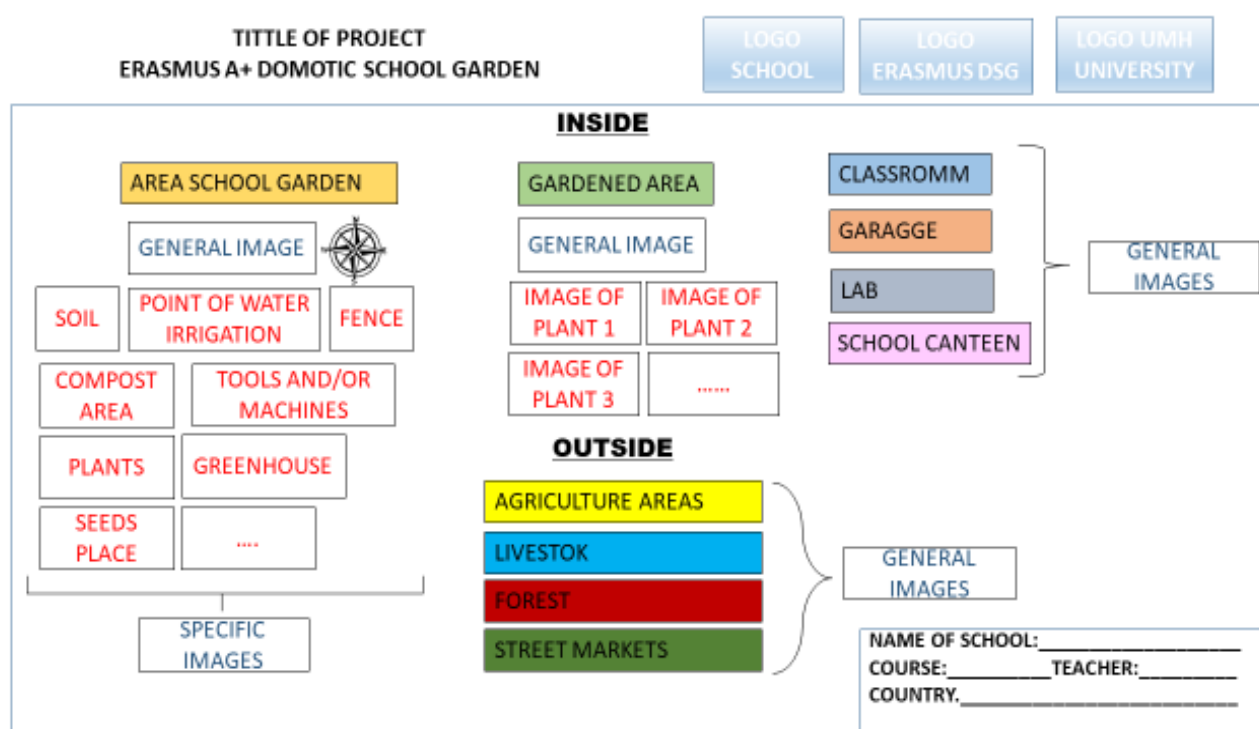


Figure 1: Conceptual map of activity number 0: Collage

DEVELOPMENT OF THE EXPERIENCE

1. PREPARATION OF THE MATERIAL FOR THE DEVELOPMENT OF SELECTED AGROECOLOGY ACTIVITIES

Finally, five activities were selected that can be easily carried out in all schools, by all students and planned within the framework of the DSG project:

- 1.- Taking care the auxiliary fauna and control pest insects in the dsg: insects hotel
- 2.- To make tea of compost
- 3.- Crop associations and rotations
- 4.- Land preparation and simple soil analysis
- 5.- Different types of organic farming

2. TAKING CARE THE AUXILIARY FAUNA AND CONTROL PEST INSECTS IN DSG: INSECTS HOTEL

We tend to think that most of the insects in the garden are harmful to crops. Nevertheless, most of them are interesting pollinators or predators of other insects which could be a pest in our crops. With this activity, students can build a hotel where they will be able to make their home.

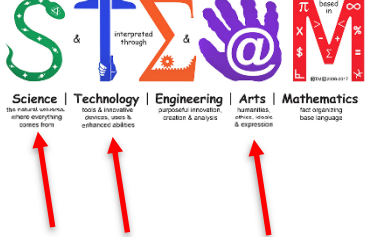



Figure 2: Images of activity “Some examples of insect hotel”.

The aim ideas that students should have learned eith this activity:

- The more biodiversity: plants and animals are present in our garden, the less chemicals will be needed.
- The fewer chemicals we use, the healthier our products will be
- Insect hotels are artificial recreations of nature, in fact insects like to take refuge in the vegetation and natural spaces that surround them.

Table 1: European conceptual goals and key competencies, STEAM competencies and Sustainable Development Goals which can be applied in the activity number 1.

EUROPE CONCEPTUAL GOALS AN KEY COMPETENCIES	STEAM COMPETENCIES	SUSTAINABLE DEVELOPMENT GOALS
<p>1.- Communication in mother tongue.</p> <p>2.- Communication in foreign language.</p> <p><u>3.- Mathematical competence and basic competencies in science and technology.</u></p> <p>4.- Digital competence.</p> <p>5.- Learning to learn.</p> <p><u>6.- Social and civic competence.</u></p> <p><u>7.- Sense of initiative and entrepreneurship.</u></p> <p>8.- Cultural awareness and expression.</p>		

3. TO MAKE A COMPOST TEA

Compost tea is a high-quality liquid compost extract that contains beneficial microorganisms and nutrients that give crops vitality and strength to cope with diseases and pests. It is about avoiding and reducing the use of fungicides, herbicides, pesticides and chemical fertilizers. In this activity the students will learn how they can take care of the plants using liquid compost which they will be able to prepare in order to avoid chemical pesticides.



Students should have learned:

Recycling vegetable remains is very important to make compost and to be able to feed our crops. Not depending on other companies to feed the crops, we have it at our fingertips and we can manufacture it ourselves.



Figure 3: Images of activity “To make compost tea”

Table 2: European conceptual goals and key competencies, STEAM competencies and Sustainable Development Goals which can be applied in the activity number 2

EUROPE CONCEPTUAL GOALS AN KEY COMPETENCIES	STEAM COMPETENCIES	SUSTAINABLE DEVELOPMENT GOALS
<p>1.- Communication in mother tongue.</p> <p>2.- Communication in foreign language.</p> <p>3.- Mathematical competence and basic competencies in science and technology.</p> <p>4.- Digital competence</p>	 <p>↑</p>	

4. CROP ASSOCIATIONS AND ROTATIONS

From the point of view of the conservation of the soil in good conditions, it's strongly recommended to plan a crop rotation throughout the course, it is to say, to do one timetable in order to avoid repeating the same plants in the same place. Moreover, it is often believed that several plants could help themselves if they are cultivated together. In this activity, students could learn the differences between families of plants, characteristics of the roots, and they may also understand that crop rotations and associations depend on the usable part of the plant in most cases.

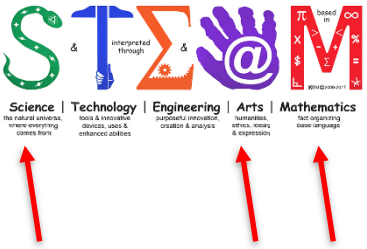

Students should have learned:

Consuming seasonal products is less polluting for the planet, because they are local products. There are several groups of vegetables and it is convenient to plant them depending on their eaten part.



Figure 4: Images of activity “Associations and rotations”.

Table 3: European conceptual goals and key competencies, STEAM competencies and Sustainable Development Goals which can be applied in the activity number 3.

EUROPE CONCEPTUAL GOALS AN KEY COMPETENCIES	STEAM COMPETENCIES	SUSTAINABLE DEVELOPMENT GOALS
<p><u>1.- Communication in mother tongue.</u> <u>2.- Communication in foreign language.</u> <u>3.- Mathematical competence and basic competencies in science and technology.</u> <u>4.- Digital competence.</u> <u>5.- Learning to learn.</u> <u>6.- Social and civic competence.</u> <u>7.- Sense of initiative and entrepreneurship.</u> <u>8.- Cultural awareness and expression.</u></p>	 <p>Science Technology Engineering Arts Mathematics <small>the natural universe, where everything comes from</small> <small>tools & innovative devices, jobs & enhance abilities</small> <small>products, innovation, creation & analysis</small> <small>humanities, social, news & expressions</small> <small>logic, organizing base language</small></p>	

5. SIMPLE SOIL ANALYSIS

Following the method of Professor Marisol Garrido (Doctor in Agricultural Engineering and an expert in Edaphology). It is about analyzing the texture of the soil in an eminently practical way. The students learn what soil texture is, and why it is important, as well as the amount of sand that the land has where we are going to cultivate.

In this way, it will be possible to cultivate and work the land properly, avoiding problems in the crop as well as protecting the soil, adjusting the crops to the characteristics of the soil.

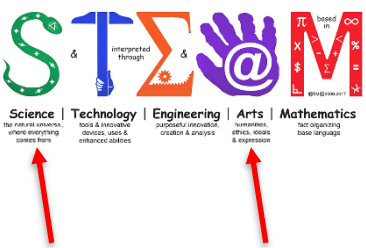




Figure 5 Images of activity “Different types of agriculture”.

Students should have learned:

- Plants need air and water in the soil in order to feed themselves.
- The percentage of sand is very important to choose what kind of plant we can cultivate.

Table 4: European conceptual goals and key competencies, STEAM competencies and Sustainable Development Goals which can be applied in the activity number 4.

EUROPE CONCEPTUAL GOALS AN KEY COMPETENCIES	STEAM COMPETENCIES	SUSTAINABLE DEVELOPMENT GOALS
<p><u>1.- Communication in mother tongue.</u></p> <p><u>2.- Communication in foreign language.</u></p> <p><u>3.- Mathematical competence and basic competencies in science and technology.</u></p> <p><u>4.- Digital competence.</u></p> <p><u>5.- Learning to learn.</u></p> <p><u>6.- Social and civic competencies</u></p>	 <p>Science Technology Engineering Arts Mathematics</p>	 

6. DIFFERENT TYPES OF AGRICULTURE

It is convenient for teachers to know several kinds of agriculture. In this activity they will be able to understand the differences between all of them and for instance, you could decide which one they want to develop in your Domotic School Garden.

- Agroecology means to close the cycle of sustainability, in this way it is possible to teach how you can obtain your own seeds, fertilizers, etc.
- Organic farming is one kind of agriculture which has to respect the legal Europe framework
- Permaculture is an agricultural system or method that seeks to integrate human activity with natural surroundings so as to create highly efficient self-sustaining ecosystems

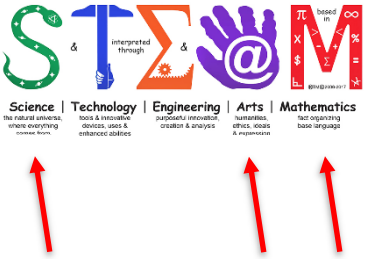

Students should be learn:

- Identify the logo of Europe Union for organic agriculture
- The difference between organic agriculture and agroecology
- Design of permaculture flower



Figure 6 Images of activity “Different types of agriculture”.

Table 5: European conceptual goals and key competencies, STEAM competencies and Sustainable Development Goals which can be applied in the activity number 5.

EUROPE CONCEPTUAL GOALS AN KEY COMPETENCIES	STEAM COMPETENCIES	SUSTAINABLE DEVELOPMENT GOALS
<p>1.- <u>Communication in mother tongue.</u> 2.- <u>Communication in foreign language.</u> 3.- <u>Mathematical competence and basic competencies in science and technology.</u> 4.- <u>Digital competence.</u> 5.- <u>Learning to learn.</u> 6.- <u>Social and civic competence.</u> 7.- <u>Sense of initiative and entrepreneurship.</u> 8.- <u>Cultural awareness and expression.</u></p>		

CONCLUSIONS

If the activities proposed, all of them were applied, those are the little pills of agroecological knowledge which could be learned by the students:

- **INSECTS HOTELS:** They help to improve the biodiversity in the Domotic School Garden
- **COMPOST TEA:** Feed the soil and at the same time it will feed our plants and we are recycling waste vegetables.
- **ASSOCIATION AN ROTATIONS CROPS:** Take awarenesses about local food consumption of vegetables and classification
- **ANALISIS SOIL:** Depending on the composition of the soil, some crops or others can grown and to take care of the soil because it is alive
- **DIFFERENT KINDS OF AGRICULTURE:** Difference between organic food and agroecology, and identify the logo of organic europe products.

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INTRODUCTION OF AGROMOTICS AND ECOLOGICAL AGRICULTURE IN PRIMARY EDUCATION. DOMOTIC SCHOOL GARDEN

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CHAPTER 4

ACTIVITIES RELATED TO SUSTAINABILITY AND CIRCULAR ECONOMY WITHIN THE FRAMEWORK OF THE DOMOTIC SCHOOL GARDEN PROJECT

Melián, A.¹, Martínez-Arenes, M.C.², Pretel, M.T.¹ and Ruiz, A.¹

¹CIAGRO. EPSO, Universidad Miguel Hernández, Ctra. Beniel km. 3.2, 03312; ²Departamento Agraria, Instituto de Educación Secundaria “El Palmeral” Avd. Doctor García Rogel, 28, 03300 Orihuela.

ABSTRACT

Different international organizations have highlighted the importance of education and awareness of the young population in matters related to the conservation of natural resources, climate change or responsible consumption. Teacher training on this problem and the treatment of these issues in school classrooms should be a priority, and its effectiveness is all the greater when it is carried out from an early age. In fact, a better educated society is also a safer society. This paper summarizes the experience of the activities proposed within the framework of sustainability and circular economy within the Erasmus+ Domotic School Garden (DSG) project (2020-1-ES01-KA201-082999) coordinated by the Miguel Hernández University (Spain), and its application and approach in four Educational Centers of three European countries (Bulgaria, Greece and Italy).

Keywords: *bioeconomy, educational skills, responsible consumption, teaching-learning,*

INTRODUCTION

The reality in which we currently live forces us to understand the way of teaching as the creation of environments that lead students to reflection and also to internalize not only knowledge but also processes, ideas and values. Respect for the environment, the planet and natural resources is undoubtedly the philosophy that has made us carry out this project. The reasons to choose these activities was to raise awareness among children of the importance of caring for the environment. And present in a fun and positive way not as just any other task.

From all educational centers and not only at the national level, we have a duty to comply with the Sustainable Development Goals (SDGs).

This chapter focuses on making some of these goals visible in the natural environment of our students. Raising awareness of the need to act together with the empirical demonstration that the personal work of each one counts, have been the aspects placed at our point of attention. For this reason, from the “Sustainability and Circular Economy” approach, we have proposed different activities so that primary school students from schools in different countries can carry out in their educational center and

in their homes. One of the bases with which the activities have been developed is gamification since it facilitates learning and makes generalization easier while what is acquired lasts longer over time.

Emphasis is placed on those aspects related to organic agriculture, reuse, the promotion of a second use of the different products, the reduction of waste through responsible consumption and selective recycling, so that the subsequent treatment given to the themselves, both in economic and environmental costs, is lower. Despite the particular characteristics of each experience, as they have been developed in various countries (with specific regulations on this matter), the activities aim to provide common guidelines. The work developed and the positive results for students at primary education levels are exposed.

DEVELOPMENT OF THE EXPERIENCE

1. SELECCIÓN DE LAS ACTIVIDADES A DESARROLLAR EN EL ÁREA DE AGRICULTURA Y SOSTENIBILIDAD

This experience is based on the implementation of the activities carried out within the framework of the Domotic School Garden (DSG) project financed within the Call 2020-EAC/A02/2019 (Erasmus+ Program, 2019/C 373/06). Regulation (EU) 1288/2013 of the European Parliament and of the Council, of December 11, 2013, creates the "Erasmus+" program for education, training, youth and sport in the Union, and this project requested it is included within the modality KA2 - Cooperation for innovation and exchange of good practices, KA201 - Strategic associations for school education.

The project, as described in another chapter, has been coordinated by the Miguel Hernández University and La Llave Consulting, and Primary schools from three European countries (Greece, Italy and Bulgaria) have participated in it. The project works in four specific areas: science, agriculture, technology and domotic, and circular economy and sustainability.

The activities of the area Food and Sustainability aim to promote in students the sustainable use of resources and their valorization, discovering critical thinking and assuming by students a proactive role that causes an increase in their values and respect for the environment and planet Earth.

Finally, five activities were selected that can be easily carried out in all schools, by all students and planned within the framework of the DSG project:

- 1.- Circular economy and recycling. The 3 R's of ecology,
- 2.- What is this?,
- 3.- What do you prefer?,
- 4.- Visit to the supermarket and
- 5.- Rol playing.

The planned activities were adapted to the resources and means of the Centers in sustainability and circular economy areas. These activities work towards the Sustainable Development Goals (SDGs) (Figure 1).

The United Nations Organization (UN, 2015) indicates that education is one of the most important non-structural variables to be taken into account in dealing with climate change. Along the same lines, the Intergovernmental Panel on Climate Change (IPCC, 2014) in its fifth report stated the importance of education as one of the main actions for the adaptation of society to climate change, since a better educated society is a safer society, in the face of the consequences of the current global warming process.



Figure 1: Sustainable Development Goals (SDGs).

Table 1 shows the correspondence between the proposed activities and the Sustainable Development Goals that are being worked on. The Sustainable Development Goals most worked on in these activities are: Goal 12. Responsible consumption and production, Goal 13. Climate action, as well as Goal 3. Good Health and well-being, Goal 4. Quality education, Goal 1. No poverty, Goal 2. Zero hunger, and Goal 15 Life on land.

Table 1: Correspondence between proposed activity and SDG

The 3 R's of ecology	What is this?	What do you prefer?	Visit to the supermarket	Rol playing
SDG 12	SDG 3	SDG 3	SDG 12	SDG 1
SDG 13	SDG 4	SDG 15	SDG 13	SDG 2
SDG 4		SDG 13	SDG 11	SDG 12

The STEAM competences (Figure 2) developed in these activities are: Science, Technology, Arts and Mathematics). According to Karalar et al. (2021) work is done on them to integrate them from an early age, and be more effective in lifelong learning.

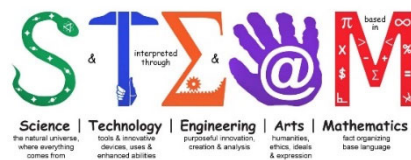


Figure 2: STEAM activities.

The five activities are focused on the study of: the three R's of the circular economy, reduction, reuse and recycling (Figure 3); to the valorization of ecological agricultura, an agricultura that respects the environment; and to the reduction of food waste; and the search for food sovereignty as a right of humanity.



Figure 3: Three R's (reduce, reuse, recycle).

The development of three R's activities of each center is an interesting and very simple way to start this project. The aim is to avoid the waste of products, giving a second use to those who may have it, thus improving the carbon footprint. Students will be prompted to think about what actions can be taken to reuse or reduce consumption in their normal hábitat.

The necessary equipment is very affordable and does not require specialized knowledge to carry it out. This activities can will continue after the end of the project. All students, teachers and parents of students may collaborate in its preparation and maintenance.

2. PREPARATION OF THE MATERIAL FOR THE DEVELOPMENT OF SELECTED SUSTAINABILITY AND CIRCULAR ECONOMY RELATED ACTIVITIES

Next, what each of the five sustainability and circular economy related activities consist of and how they are integrated into the educational context of the GSD Project will be discussed.

2.1. Preparation of a circular economy and recycling. The 3 R's of ecology for each center that is part of the DSG

We will start the activities with a game based on previous knowledge of recycling. In each country they will adopt the colors of the containers according to their regulations and previously the correspondence between the container and the material to be recycled will have been worked on. A series of images will be required to associate with the balls depending on the ages and abilities of the students who are going to carry it out. Basket and separate (Recycled) require three boxes of the relevant color will be organized simulating the recycling container for paper, metal and glass. The students will have different balls to throw in each container depending on the image that is presented on the screen.

1st.- Review the concepts of the 3 R's: teachers will explain to students the difference between recycling, reusing and reducing, as well as the environmental advantages of applying each of these actions.

2nd.- Paint three boxes the color of the three recycling bins in your country. Present different images for the students to throw the ball into the box that is the color corresponding to the container in which the product in the image would be recycled.

3rd.- Think about reuse and reduce. Find examples of reuse and reduce. It can be done in an individual tab or in groups.

4th.- We share the ideas of each group or individually, the important thing is that it is shared with the rest of the students so that everyone can complete their list with the ideas of others.

5th.- And what do I do? Taking into account the previous list, think about what actions each one can do both in their personal life and in their family nucleus and identify them with a color (re-use, reduce).

6th.- Here and now. Propose a series of actions with the 3 R's that will be carried out in the school by all the students who have participated in the project.

The equipment required is very affordable and requires no specialist knowledge to carry it out. This activity can be started in each center participating in the DSG project, and will continue once the project is finished in the daily life of each student. All students, teachers and parents of students could collaborate in its maintenance. The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, social and civic competence, cultural awareness and expression. And from STEAM activities, the science activities, arts and technology (Figure 4).

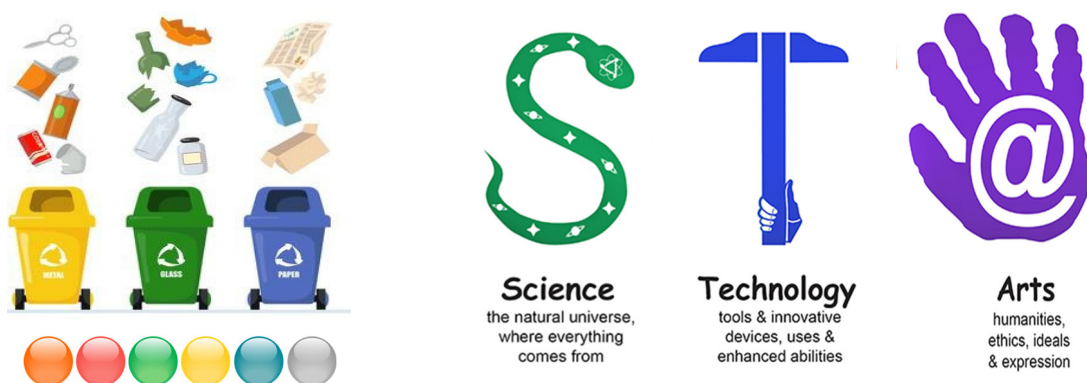


Figure 4: Images of the activity “Preparation of a circular economy and recycling. The 3 R's of ecology”. STEAM activities.

2.2. Preparation of activity What is this? for each DSG member center

This activity will be developed continuously from the beginning of the development of the DSG and all students, teachers and parents of students could collaborate in its development.

This activity is intended for students to perceive the fruits and vegetables of their area through their senses. To do this, an activity will be carried out with different indigenous products that students must guess through their senses (touch, smell, taste) (Figure 5). The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, cultural awareness and expression. And from STEAM activities, the science activities and technology.



Figure 5: Images of the activity “Preparation of activity what is this? for each DSG member center”. STEAM activities.

2.3. What do you prefer?

With this activity it is intended that students perceive through their senses the difference that exists between fruits and vegetables grown organically and those that are not. For this, an activity will be carried out with different indigenous products (ecological and non-ecological) that the students will compare through their senses (touch, smell, taste) (Figure 6). The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, cultural awareness and expression. And from STEAM activities, the science activities and technology.

1st.- I look, smell, touch, taste and compare. Have students look at, smell, touch and taste an organic vegetable grown in the local garden and do the same with a similar one from a non-organic store. You have to compare the sensations of both products and guess which of the two is organic. Do this with different plant products

2nd.- Which one do I like the most? After you have experimented with plant products, you can fill in a form similar to the following to determine which of the two you like best. Relate these aspects to organic production (Table 2).

Table 2: Sheet to fill in activity “What do you prefer?”

PRODUCT	A	B
Appearance (color, gloss, uniformity)		
Smell		
Taste		

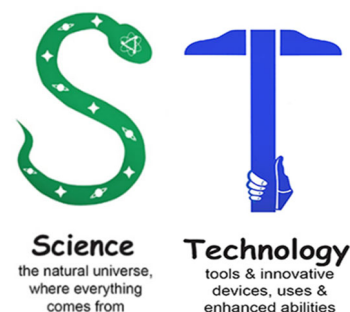


Figure 6: Images of the activity “What do you prefer?”. STEAM activities.

2.4. Visit to the supermarket

With this activity it is intended that students visit a supermarket or local market (alone or accompanied by their tutors) and visualize the presentation and packaging of fruits and vegetables for sale to the public.

Analyze the way in which they are stored and displayed, distinguish between plant foods that require or do not require some conservation treatment. Become familiar with the labeling of the products, the different ways of presenting the price (per kg, per unit, per bag- packaging pack) and the origin of the foods consumed in bulk. The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, social and civic competence, cultural awareness and expression. And from STEAM activities, the science activities and mathematics (Figure 7).

- 1st.- Go to a supermarket (or failing that, local market): younger students accompanied by their parents, tutors or teachers and older students individually or in small groups.
- 2nd.- Observe the presentation and distribution of food in a supermarket. Take notes or take a photograph to make a small sketch of the distribution by large blocks of food (note that the food is grouped and in differentiated sections from other products such as cleaning supplies).
- 3rd.- Locate the fruits and vegetables. Observe its presentation (in bulk, in small containers, bagged, cut, refrigerated, previously cooked, etc.). Choose and photograph the labels of some processed products (fruits, vegetables and vegetables) to analyze later.
- 4th.- Make a diagram, sketch or drawing of the criteria for grouping fruits and vegetables. (If photography is allowed in the premises, the mobile can be used to photograph the distribution of food).
- 5th.- Observe the labeling of foods (product, price, in those that are sold in bulk, price per kg, and origin of the foods and nutritional composition and / or date of preferential consumption or expiration in those of fourth range and transformed). It would be convenient to take a photograph of at least one product of each type.
- 6th.- Choose 10 products (among fruits, vegetables, nuts, seeds, sprouts), write down their name, origin, and price (€ / kg, € / piece, € / bagged package, etc.) and represent them in a table.
- 7th.- Indicate which are the vegetable foods typical of your community, those that have traditionally been cultivated and have constituted the typical dish of the gastronomy of the area where the school is located. Explain how they are consumed (raw, cooked, etc.). You can attach a photo.
- 8th.- Select the two or three fruits that you like the most and the two or three vegetables that you prefer to eat.
- 9 th.- Find other products that come from transformed vegetables and that are sold in the supermarket (preserves, juices, ...). List at least three products. Could you explain how they are made? Discuss the importance of preserving food (Table 3).

Table 3: Sheet to fill in activity “Visit to the supermarket”

Transformed product	Original base ingredients (Fruits and Vegetables)
1.- Crushed tomato.....	1.- Tomato, water, preservative E-xxx
2.- Canned olives	2.- Olives, salt, sodium hydroxide and water
3.- Orange juice.....	3.- Orange pulp, water, sugar, acidulants, preservatives



Mathematics



Science
the natural universe,
where everything
comes from

Figure 7: Images of the activity “Visit to the supermarket”. STEAM activities

2.5. Rol playing

There will be a role playing simulating inequalities in access to food. Subsequently, an analysis of the feelings and sensations experienced will be carried out and in a round table there will be an exposition of the ideas of each one. The key european competences worked in this activity are: communication in mother tongue, communication in foreign language, learning to learn, social and civic competence, cultural awareness and expression. And from STEAM activities, the science activities and technology (Figure 8).

1st.- Restaurant customers: Choose two students to be the users of a restaurant, also choose another student to play the role of waiter. The rest of the students become diners in a community dining room. Each group is explained what the role playing consists of.

2nd.- Rol playing 1. On one side, a couple of students will simulate a visit to a select restaurant, they will have a table and a waiter who will give them all the appropriate attention. They will be able to choose from the menu of food and drinks, the portions will be abundant and the waiter's attention will be very exclusive.

3rd.-Rol playing 2. On the other hand, but keeping the table from role-play 1 in view, the other students will line up to sit at long tables where only half of those there will have a seat. They will only be served by the waiter at the other table when the other diners do not need it and they will also serve food from a community container without the possibility of choosing, and with rather meager portions so that everyone can eat. They will be given a bit of a hurry so that their companions can come in to eat as well. Meanwhile at the other table you will be serving everything they ask for from the menu and as soon as they ask for it.

4th.- At the round table we share after doing the role-playing sessions, a round table will be held to express how they have felt being characters at one table or another. It is important to guide them in their reflection on inequalities, the precarious diet in certain populations, the need for empathy and the awareness that food should not be wasted and the possibility of having a healthy and healthy diet must be appreciated.

5th.- And what do I do? Taking into account all that has been seen, could a change be made in the type of diet of each person?



Figure 8: Images of the activity “Rol playing”. STEAM activities.

CONCLUSIONS

The project works developing normally, and the feedback from teachers is very positive. The activities related to the circular economy and sustainability, that have been presented, have allowed us to work through an active and participatory methodology that has been very well accepted.



All the experience gained will allow us to continue working and improving th activities tan remain for the complete development and conclusión of the project, as well as to present the request for a new project.

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CHAPTER 5

DEVELOPMENT OF AN AUTOMATED AGROMETEOROLOGICAL STATION FOR TEACHING ECOLOGICAL AGRICULTURE IN URBAN ORCHARDS FOR PRIMARY SCHOOL STUDENTS

Ruiz, A¹, Pretel, MT¹; Martínez-Arenes, MC², Cuevas, C³, Haya, B³, Melián, A¹

¹CIAGRO. EPSO, Universidad Miguel Hernández, Ctra. Beniel km. 3.2, 03312; ²Departamento Agraria, Instituto de Educación Secundaria “El Palmeral” Avd. Doctor García Rogel, 28, 03300 Orihuela. ³La Llave Consulting. C/ Blasco Ibañez, 56 1 B. 02004 (Albacete).

ABSTRACT

An automated agrometeorological station for teaching primary school students is shown. The platform for use of this station is BBC micro:bit, a complete sensor data collection and management system that is widespread globally. The main objective of using this agrometeorological station is to use the initial teaching material of the BBC micro:bit platform applied in a school garden. Additionally, this weather station will be used in different local agronomic practices. The use of this device is intended for students and teachers of primary schools and higher levels, as well as for those responsible for school gardens. Using the BBC micro:bit learning platform it is possible to adapt and customize the device to local needs. This paper summarizes the experience of the work carried out by the professors of the Miguel Hernández University on the design of activities, and the coordination of the project with its partners, La Llave Consulting and the Educational Centers St. Kliment Ohridski School in Bulgaria, The Primary School of Mikro Evmoiro in Greece and Circolo Didattico San Giustino e Citerna in Italy and developed with funds from the Erasmus+ Program. This communication details the fundamentals of the automated agrometeorological station and the activities related to the device applied to a school organic garden.

Keywords: *BBC micro:bit, Domotic, ERASMUS+, ICTs.*

INTRODUCTION

An automatic weather station (AWS) is defined as a “weather station at which observations are made and transmitted automatically”. Despite the increasing number of AWS deployed, many remote areas are not yet covered by surface observations. The lack of trained local personnel and availability of

funds to manage the instrumentation, together with the risks associated with the safety of the equipment in remote and possibly insecure areas, represent the most relevant limitations. All national meteorological services, public agencies, national organizations share these problems, which are more acute in developing countries (DC).

A low-cost agrometeorological station is presented that has been used in the Erasmus+ project "Domotic School Garden", coordinated by the Miguel Hernández University of Elche (Spain) and in collaboration with the primary schools "St.Kliment Ohridski" (Bulgaria), Circolo Didattico'Bufalini' di San Giustino e Citerna (Italy) and the Mikro Evmoiro Xanthi (Greece), together with the consulting firm La Llave Consulting SL (Spain).

A hardware and software system (low-cost agrometeorological station) adapted to schools will be generated, which will be used by the students of the collaborating centers and exportable to any educational center that wishes to implement it in their classrooms.

This generated material allows students to build an agrometeorological station that includes a sensor node using basic electronic components that are easy to access and low cost. Based on this, students can develop an agronomic irrigation design to regulate the cultivation of plants in a school garden, through several basic parameters: humidity and temperature, and soil moisture. This project covers the need for schools to reinforce basic technological skills, in robotics and programming. The main parts of the agrometeorological station are described in this communication.

MATERIAL AND METHODS

This communication presents the experience of assembly and installation of the meteorological station in the collaborating schools, together with the associated activities.

Regarding the assembly and installation, an installation manual was generated for the assembly together with the user manual of the agrometeorological station.

1. INSTALLATION MANUAL

The document includes different parts of the assembly of the agrometeorological station.

1.- Installation of the sensor support. The assembly of a support that holds the anemometer, vane and rain gauge of the agrometeorological station is included. Its appearance is shown in figure 1.



- (1) Metallic pipe
- (2) Side mounting bracket
- (3) Central mounting bracket
- (4) Pluviometer
- (5) Vane
- (6) Anemometer
- (7) Metallic flange

Figure 1: DSG agrometeorological station sensor support installation kit.

2.- Installation of the photovoltaic panel support. This section describes the energy supply part of the agrometeorological station device. An example is shown in figure 2.



Figure 2: Installation kit for the photovoltaic panel of the DSG agrometeorological station.

3.- Installation of the control panel. It includes all aspects of mounting the control panel together with the rest of the sensors of the DSG agrometeorological station. Some details are indicated in figure 3.



Figure 3: Some aspects of the installation of the control panel of the DSG agrometeorological station.

4.- Panel transmitter programming. This section is used to program the station control panel.

5.- Installation of the receiver. With this section, the devices described in figure 5 would be installed.

The next phase is 6.- Receiver programming. This point includes the sequence of icons necessary to program the receiver as shown in figure 2 with the module programming language of the micro:bit platform.

The last step would be the programming of the data collection system in the cloud (Thinkspeak), in section 7.- ThinkSpeak registration and configuration. This platform makes it possible to collect data in real time and obtain certain environmental indicators. The aspect of the application is reflected in figure 7, in the upper right part, where the graphs of the main agrometeorological variables are reflected.

The more specific aspects of the agrometeorological station are described in the station's user manual. An introduction is included, along with a description of the main components, along with the main microcontrollers. Subsequently, the sensors associated with the station and the energy supply system are detailed.

2. SCHOLAR ACTIVITIES ASSOCIATED WITH THE AGROMETEOROLOGICAL STATION

The activities associated with the agrometeorological station are described in this section.

A first activity tries to detail the concepts of the school garden together with the agricultural sensors. The objective of this activity is based on the basic concepts in sensory. This will include the concept of a sensor. In addition, the difference between analog and digital signal will be presented. Subsequently, the management of a signal and the activation of sensors will be taken into account. In addition, the use of programming software for the configuration of a sensor will be presented with some examples. For this, a well-known learning platform will be used. The BBC micro:bit platform is a complete sensor data collection and management system. Finally, in each center specific applications in DSG on agricultural sensors will be developed.

The ultimate goal of this starter activity and analogous activities is to use an agricultural weather station and agricultural sensors in a school garden. This DSG weather station will be used for different local agronomic practices. In addition, it will be used by students and school teachers, as well as by those responsible for small gardens.

This activity will include knowledge of a DSG sensor, its use, and programming software. The BBC micro:bit learning platform will be the link to learn these concepts.

The following associated activity is a quick tutorial on the BBC Microbit platform. The BBC micro:bit platform is a complete sensor data collection and management system. Finally, the first applications of this platform will be developed in each center.

The ultimate goal of this activity is to use the initial teaching material from the BBC micro:bit platform in a school garden. This purpose will be the introduction for the use of the DSG weather station in different local agronomic practices. In addition, it will be used by students and school teachers, as well as by those responsible for small gardens.

The BBC micro:bit learning platform will be the link to learn these concepts.

A third activity corresponds to the determination of evapotranspiration by the Penman-Monteith method using the agrometeorological station. From the data obtained with the starting meteorological station in a school garden of different origin (commercial, from a network of meteorological stations, built from sensors, among others), the procedure for calculating the reference evapotranspiration by Penman-Monteith medium and its applications for its application in determining the irrigation dose.

A DSG weather station is used in different local agronomic practices. In addition, it will be used by students and school teachers, as well as by those responsible for small gardens.

A brief introduction on the concept of evapotranspiration and its application is developed.

One last activity is related to irrigation planning in the school garden based on moisture measurements from soil sensors. From the data obtained with humidity sensors of the starting soil in a school garden, the procedure for calculating the determination of the irrigation dose is detailed. It starts from the previous knowledge of the reference evapotranspiration by means of Penman-Monteith.

It will be used by students and school teachers, as well as by those responsible for small gardens.

An introduction is developed on the concepts of plot irrigation management, methodology applied to plot irrigation, irrigation programming, climate and soil monitoring, data interpretation and example.

To date, the first two activities have been carried out together with the installation of the stations in the associated educational centres. Not all centers have been able to install the stations to date. The last two activities have not been carried out to date since it is necessary to install the agrometeorological station. The project was approved in September 2020 and will end in September 2022.

These results show the potential that this type of teaching initiative could have in the environmental field and the 2030 agenda. The use of sensors in the agri-environmental sector and other types of related IoT technologies make it possible to meet technological objectives in primary education. Among them, increase motivation towards learning and academic performance in the arts, sciences, technology, engineering and mathematics competitions.

The company Telenatura EBT, S.L. has collaborated in the technical and material advice of this educational initiative.

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CHAPTER 9

DEVELOPMENT OF AN AGROMETEOROLOGICAL STATION FOR PRIMARY SCHOOLS BASED ON THE BBC MICROBIT PLATFORM

Ruiz, A.¹, Pretel, M.T.¹, Martínez-Arenes, M.C.², Melián, A.¹

¹CIAGRO. EPSO, Universidad Miguel Hernández, Ctra. Beniel km. 3.2, 03312; ²Departamento Agraria, Instituto de Educación Secundaria “El Palmeral” Avd. Doctor García Rogel, 28, 03300 Orihuela.

ABSTRACT

An automated agrometeorological station for teaching primary school students is shown. The usage platform for this station is BBC micro:bit. The BBC micro:bit platform is a comprehensive sensor data collection and management system that is globally deployed. The main objective of the use of this agrometeorological station is to use the initial teaching material of the BBC micro :bit platform in a school garden. Additionally, this weather station will be used in different local agronomic practices. The use of this device will be for students and teachers of primary schools and higher levels, as well as those responsible for school gardens. Using the BBC micro:bit learning platform it is possible to adapt and customize the device to local needs.

Keywords: *BBC micro:bit, ERASMUS+, domotic, organic school garden.*

INTRODUCTION

An automatic weather station (AWS) is defined as a “weather station at which observations are made and transmitted automatically”. Despite the increasing number of AWS deployed, many remote areas are not yet covered by surface observations. The lack of trained local personnel and availability of funds to manage the instrumentation, together with the risks associated with the safety of the equipment in remote and possibly insecure areas, represent the most relevant limitations. All national meteorological services, public agencies, national organizations share these problems, which are more acute in developing countries (DC).

A low-cost agrometeorological station is presented that has been used in the Erasmus+ project "Domotic School Garden", coordinated by the Miguel Hernández University of Elche (Spain) and in collaboration with the primary schools "St.Kliment Ohridski" (Bulgaria), Circolo Didattico 'Bufalini' di San Giustino e Citerna (Italy) and the Mikro Evmoiro Xanthi (Greece), together with the consulting firm La Llave Consulting SL (Spain).

The main sensors measure soil temperature, air temperature, soil moisture, air temperature, relative humidity, atmospheric pressure, wind speed, and precipitation. They include a wide range of low-cost commercial sensors (Fig. 3).

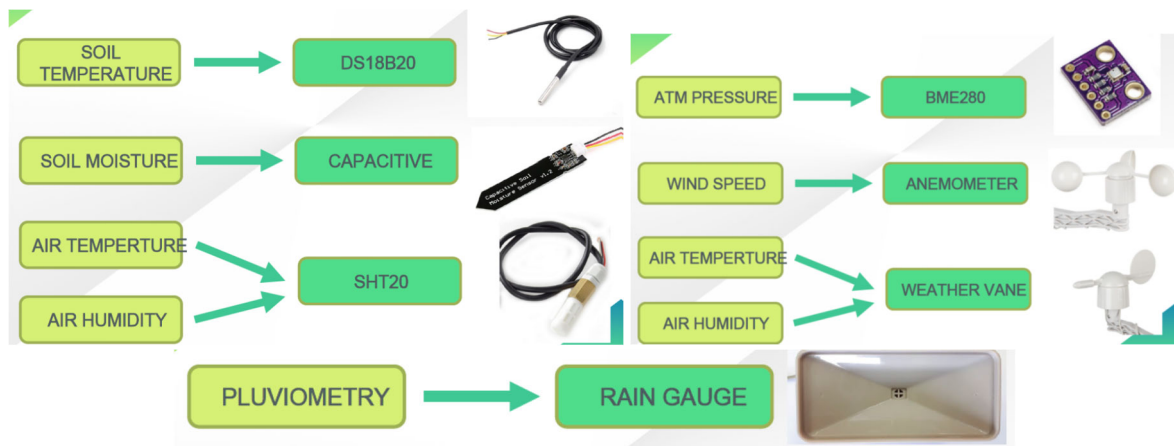


Figure 3: Main sensors of the DSG agrometeorological station.

It includes a field station that is composed of the Micro:bit microcontroller and the sensor board, as shown in figure 4.

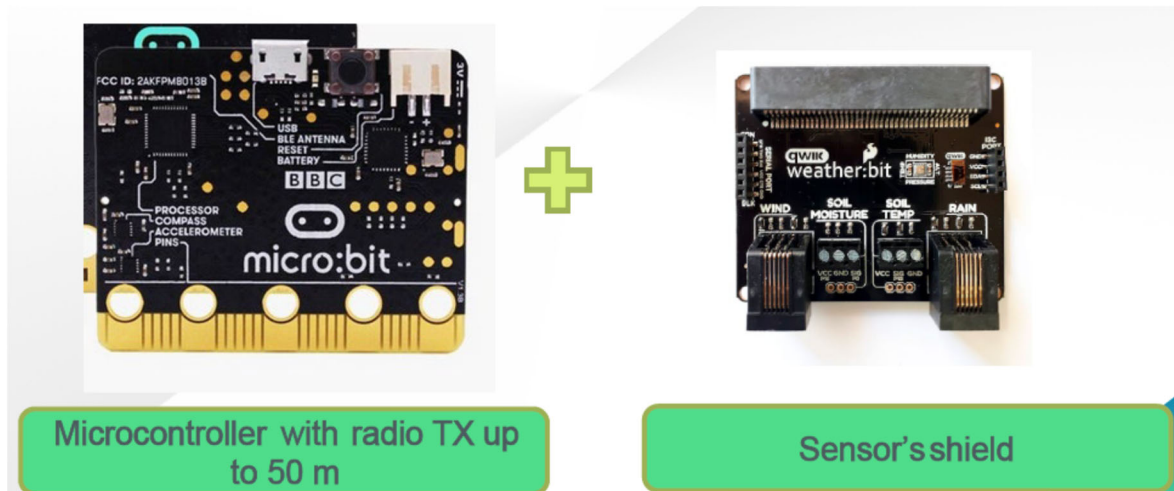


Figure 4: Main components of the field station of the DSG agrometeorological station.

The receiver unit is made up of another microcontroller, along with the Wi-Fi board (Figure 5).

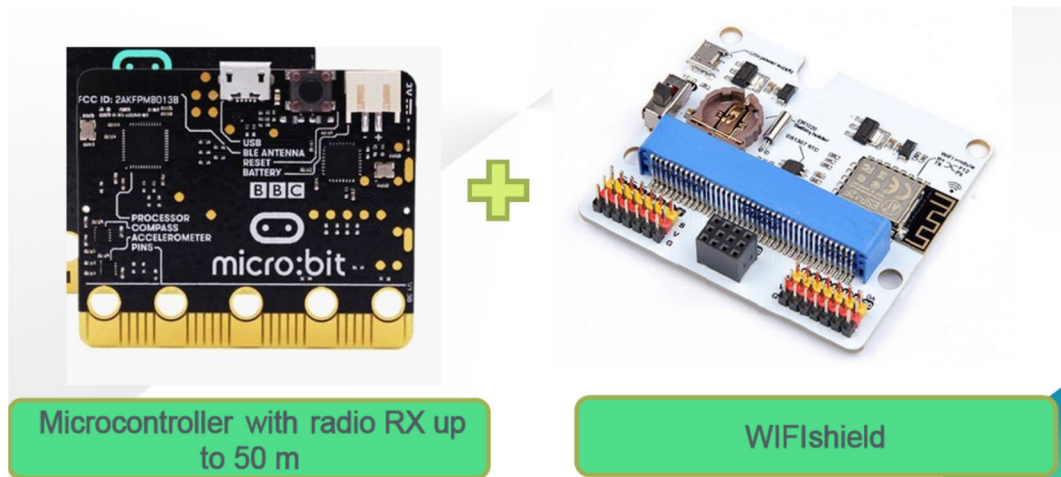


Figure 5: Main components of the receiving unit of the DSG agrometeorological station.

All this is complemented by the power supply installation (Figure 6).

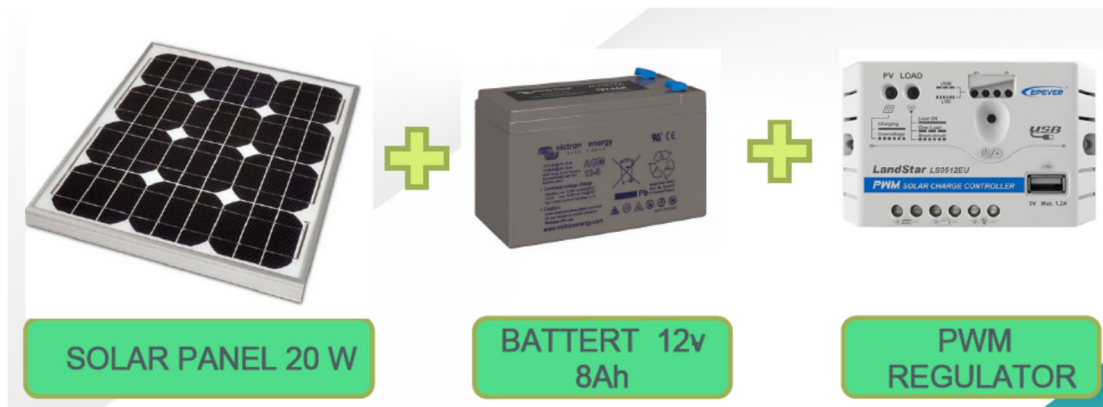


Figure 6: Componentes principales de la instalación de suministro de energía de la estación agrometeorológica DSG.

The data is collected on a screen (PC, tablet or mobile) through the thinkspeak application and recorded in csv files that can be processed for further calculations. the Penman-Monteith ETo is calculated with the radiation obtained from the temperature.

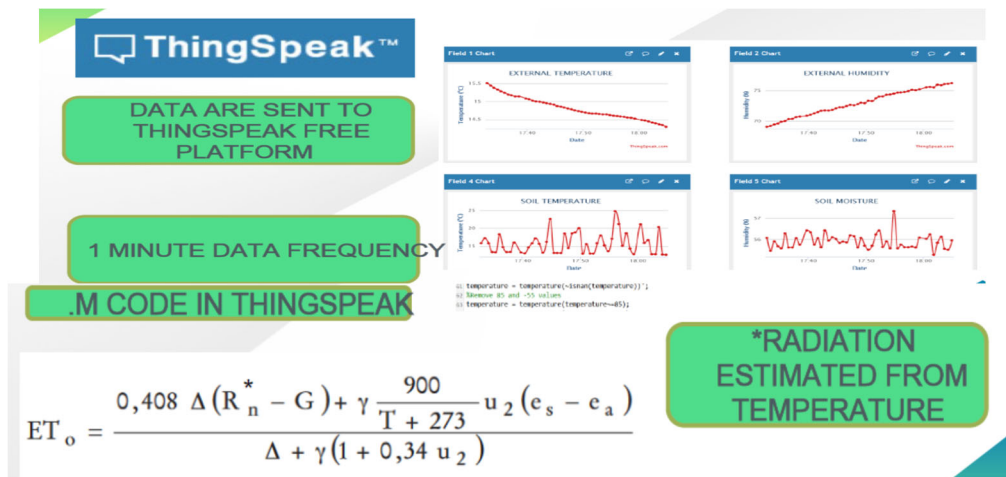


Figure 7: Data screen using the Thingspeak application of the DSG agrometeorological station. Calculation of ETo by Penman-Monteith.

Although the Project has not yet finished, our experience so far has been very positive and the experience described in this work can help other similar projects.

CONCLUSIONS

These results show the potential that this type of teaching initiative could have in the environmental field and the 2030 agenda. The use of sensors in the agri-environmental sector and other types of related IoT technologies make it possible to meet technological objectives in primary education. Among them, increase motivation towards learning and academic performance in the arts, sciences, technology, engineering and mathematics competitions.

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