MODULE 2.2: THE 4 CREATIVE SCENARIOS

CODESKILLS4ROBOTICS: Promoting Coding & STEM Skills through Robotics: Supporting Primary Schools to Develop Inclusive Digital Strategies for All

IO2: CODESKILLS4ROBOTICS Dual Digital Educational Back Pack for Primary Schools

Partners: Emphasys Center, Cyprus, N.C.S.R. "Demokritos", Hellenic Mediterranean University, Regional Directorate, Greece, Halsinglands Education Association, Sweden

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ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

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CODESKILLS
4ROBOTICS

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1. Educational Robotics and Education

1.1. 21st Century Education: The Role of Skills and Educational Robotics

For the last twenty years, 21st century skills have been at the heart of significant educational reform efforts in several countries around the world (USA, Australia, Finland, etc.). Organizations such as P21 (https://www.battelleforkids.org/networks/p21) describe the teaching framework of 21st century skills in 4 sections: skills regarding cognitive and thematic of 21st century, learning and innovation skills, information skills, skills in media and technology, and personal and professional life skills. Other organizations, such as ATc21s (http://www.atc21s.org/), classifies the necessary skills for the 21st century in the following 4 categories: ways of thinking, ways of working, working tools and lifestyles. Among the suggested skills for the 21st century, critical thinking, problem solving, communication, collaboration, digital literacy, creativity and innovation are the core skills for students' future success in life.

Many researchers support the teaching of 21st century skills from the first grades of primary school to both formal and informal education (DeJarnette, 2012; Voogetal., 2013). In addition, the application of active learning methods supports and facilitates self-regulated learning and helps students develop the aforementioned skills (Bell & Kozlowski, 2008). Nevertheless, most standard primary and secondary education curricula do not place much emphasis on applied skills development practices and actions, such as creativity, problem solving (Pellegrino & Hilton, 2012), and digital competence. Given that changes in formal education are slow, the implementation of new teaching and learning methods is a critical factor regarding the renewal, enrichment, empowerment of both formal and non-formal education.

In the last twenty years, various researches in the field of educational robotics (ER) in primary and secondary education show that the involvement of students with educational robotics applications can help in transmitting and cultivating basic skills that future citizen must have as well as empowering them in the so-called "21st century skills" (Eguchi, 2013; Afari & Khine, 2017). Students develop their personal skills, such as self-confidence, they become better at problem solving, communication, at selecting and evaluating the information, they become more creative, they make decisions and improve features of teamwork (Khanlari, 2013, Hussainetal., 2006; Nugentetal., 2010; Arleguietal., 2008; Demetriou, 2011).

However, it should be taken into account, as mentioned by Alimisis (2013), that while educational robotics is popular with students of all ages, it finds scope mainly in informal educational environments and conditions (educational programs of organizations, festivals, competitions, etc.).

1.2. Educational Robotics in Primary School

Robotics training programs are becoming increasingly popular in most developed countries and are spreading to the developing world. Robotics is used to teach problem solving, programming, design, physics, math even music and art to students at all levels of their education. As with robotic systems used in research, there is ongoing development and upgrading of hardware, software, and evaluation strategies that can be used to determine the extent to which students benefit from robotics programs (B. Siciliano, O. Khatib, 2016).

Over the last decade robotics has attracted the high interest of teachers as a valuable tool for the development of cognitive and social skills for students from Preschool to High School and for the support of learning in science, mathematics, technology, computer science and other school subjects or interdisciplinary learning activities. Many ideas on this topic were presented during a special panel discussion held during the International Workshop on "Teaching Robotics, Teaching with Robotics" (TRTWR, 2012), which focused on the current state of educational robotics at European level and examined ways for the community and robotic trend to move forward in education.

Published papers such as Alimisis (Alimisis, 2013) discuss existing problems and new challenges and present proposals for aligning robotic technology with learning theories, mainly constructivism, promoting collaboration and networking of researchers, and teachers but also building the educational robotics community in Europe.

The literature mentions three different approaches to Educational Robotics in formal education (Eguchi, 2010):

- Curriculum approach based on topics: Curriculum areas are integrated around a specific learning topic and are studied mainly through research and communication (e.g. Detsikas & Alimisis, 2011; Litinas & Alimisis, 2013).
- Project-based approach: students work in groups to explore real-world problems. This is for example the case proposed in the methodology developed by the European project TERECoP, Teacher Training in an Enhanced Robotic Construction Pedagogical Method (www.terecop.eu) (Alimisis, 2009).
- Targeted approach: children compete in challenges in robotics tournaments that take place mainly outside of school, such as FIRST® LEGO® League (https://www.firstlegoleague.org/), RoboCupJunior (http://www.robocupjunior.org), Trophées de robotique in France (http://www.planete-sciences.org/robot), World Robotics Olympiad in Greece (http://wrohellas.gr) and other.

At the same time, actions and events are developed in educational environments to support and promote educational robotics: thematic workshops (e.g. "Teaching

Robotics, Teaching with Robotics"), regional conferences (e.g. "Robotics in Education", www.rie2013.eu), regional or national tournaments, seminars for teachers such as:

- TERECoP (https://terecop.eu/)
- Roberta Teacher Training (https://www.iais.fraunhofer.de/robertateacher-training.html)
- local or regional networks
- π.χ. Robot@scuola in Italy (https://www.scuoladirobotica.it/en/RobotAtScuola/index.html),
- ENTROBOT in Austria and Slovakia (http://www.centrobot.eu) etc.

Although there is no systematic introduction of robotics in school curricula in European school systems (Alimisis, 2013), a report states that at least 18 European countries have included it in their curricula. (European Schoolnet, 2015). With its introduction, the respective states want to improve computational and logical thinking, interest in technology and programming, and generally students' ICT skills in general. Coding and programming are mandatory, for example, in Bulgaria, the Czech Republic, Slovakia, Finland, Portugal and partly in the United Kingdom. Countries that combine coding and robotics in their education are, among others Slovakia, the Czech Republic, Spain, Estonia and Malta.

Regarding the involvement of coding-robotics and STEM in primary schools' curricula of the specific program partners and based on what is mentioned in the comparative report of the program (Codeskills4Robotics, 2019) we can observe the following:

In **Greece**, Educational Robotics is not an autonomous subject taught in public primary schools. Teachers, however, apply robotics training activities and incorporate them into their teaching based on their personal interest and knowledge regarding the subject. Nevertheless, there is a reference to Robotics in the new curriculum for Computer Science in primary education, which is taught by a computer science teacher as a separate subject in all primary school classes for one (1) teaching hour per week. Learning objectives include "Modeling with concept diagrams" and "Computer programming". At the same time, the concepts of robotics are presented in the individual sections of the curriculum for the 5th and 6th grade.

Recent modifications made by the Ministry of Education, Robotics and STEM / STEAM are included in the "Skills Laboratories" that will be piloted in the country from the next academic year 2020-2021 and are included in the thematic cycle "Create and Innovate" (Creative thinking and initiative-Build new ideas, give new solutions).

In **Sweden**, since autumn 2018 programming is included in primary schools, especially in the field of mathematics and technology. In addition, many teachers have used educational robotics in their teaching, but all indications point to the fact that their skills need reinforcement.

In **Cyprus**, primary school curricula do not consider ICT as a separate subject but as a tool that has the potential to improve teaching and learning. However, robotics has been introduced since 2009 and today is part of the "Design and Technology" in the official curriculum (2 periods per week in the 5th and 6th grade for elementary school), in the section "System and control technology", with the prospect of increasing in the near future. In All-Day Primary Schools ICT (and, in some cases, robotics) is taught as an extracurricular subject.

In **Belgium**, for the Flemish community, ICT is considered to provide opportunities in all subjects and fields of study at primary level. Therefore, ICT is not taught as a separate subject, but is integrated into the school curriculum as one of the three interdisciplinary final objectives. In the French-speaking community of Belgium, technology education is regarded, in a relatively broad sense, as a course based on the idea of technology as a field that contributes to the overall training of young people, as do courses of general education. In the German-speaking community, the field of "Science and Technology" is included in the defined main objectives of the primary school curricula, which is directly related to STEM. In this context, technology courses aim to develop skills that will allow students to solve technical problems of everyday life, as well as to develop their creativity and increase their interest in technology-oriented professions. However, only 30% of teachers in the French and German-speaking communities use digital devices in the classroom. Therefore, the use of educational robots in primary schools is far from widespread.

A variety of robotic construction tools created and developed since the 2000s with improved and friendlier designs (LEGO Mindstorms NXT, Arduino, Crickets and more) have prepared the ground for the popularity of robotics in students of all ages. The pioneering efforts in school over the last decade have shown that children enthusiastically participate in robotic projects that achieve learning goals and / or develop new skills (π.χ. Detsikas & Alimisis, 2011; Litinas & Alimisis, 2013).

Moreover, a lot of research is evolving in Europe and in the world, on Educational Robotics in Primary Education, with emphasis on the connection of the four courses: Science, Technology, Engineering and Mathematics (STEM), and sometimes of Art (Art) (STEAM) (indicatively: Stergiopoulou et al., 2017, Ruiz Vicente et al., 2020) as well as in a wider context (Misirli et al., 2019).

What is certain is that Educational Robotics in Primary School can prove to be an important tool for achieving the abovementioned goals, but also to develop the motivation of students to actively participate in learning.

1.3. Pedagogical Framework of the Educational Robotics Approach

Educational robotics is an innovative teaching environment in which an active process of learning and knowledge building takes place through experiences and not through the memorization of concepts, facts and universal truths (Κόμης, 2004). Therefore, educational robotics is based on modern learning theories that focus on the interior of the cognitive system and the interpretation of the role of cognitive processes of the human mind, providing the appropriate theoretical background on which educational robotics builds a modern, creative and engaging learning environment.

In order to achieve the didactic goals of educational robotics, the constructive learning theories are mainly used (constructivism), and more specifically, the theory of constructivism of Piaget (1974) as well as the constructionist approach of learning according to Papert’s principles (1991).

According to **constructivists**, knowledge is built in interactive and cooperative learning environments and new learning is constructed on prior knowledge through students’ active participation and engagement, in meaningful and authentic ways. The teacher’s role is to facilitate active learning, empowering students to become active participants and be in charge of their own learning. The learning process takes place within a specific social context and the interactions students have with their peers and their teachers become an integral part of it. The construction of new knowledge is more effective when students are engaged in the creation of products meaningful to them (Papert, 1993).

S. Papert, the inspirer of constructionism, also argues that building knowledge occurs best when people are actively involved in the design and construction of real objects, meaningful to them or others around them, such as sand castles, Lego constructions, computer programmes, or a theory of the universe (Papert, 1991).

The methodological system and techniques used designing activities in the field of educational robotics are in agreement with teaching methods, as they aim at problem-solving, engaging students in learning how to build and operate a machine in order to complete a task. Students are involved in problem posing activities, which help them identify and resolve complex, authentic and open-ended issues.

Bruner's discovery learning, according to which any subject can be taught to any child at any age, as long as it is presented to him/her in an appropriate and effective way (Bruner 1973), is one of the main cognitive learning theories.

Educational robotics is also based on L. Vygotsky's social constructivism, according to which knowledge development takes place in collaborative environments, through communication and joint implementation of activities. Sociocultural Theory focuses on the learner as being part of a social group, indicating that learning takes place through social interaction and cognitive development is socio-culturally determined.

Humanistic Learning Theory is another approach to learning. Carl Rogers, one of the main proponents of humanistic theory argues that the individual learns when he takes the initiative to be fully engaged and the teacher assumes the role of a coach or facilitator, whose main purpose is the student's self- actualization.

In conclusion, educational robotics supports and is supported by constructive, sociocultural and collaborative learning theories, helping students through research and interactive problem-solving processes to transfer the knowledge acquired and apply their learning to real-world problem-solving situations.

There is no doubt that the above learning theories act together in the educational robotics environment, as the teacher adapts and readjusts his teaching, applying the methods and teaching approaches according to the goals and needs of the group.

1.4. Educational Robotics: Teaching and Learning Support

Exploring people’s perception for robots as effective support tools in the learning process is becoming more urgent nowadays, due to the constant technological advancement and the expanding role of educational robotics. The educational community shows more and more interest in the use of robotic technologies, as they rapidly develop, to support teaching and learning (Gorakhnath & Padmanabhan, 2017; Socratous & Ioannou, 2019; Anwar et al, 2019). Using robots we encourage teachers and improve learning, making teaching more engaging and students more motivated (Khanlari & Kiaie, 2015). Many researchers have studied the ways in which this can be achieved (Gorakhnath & Padmanabhan, 2017, Socratous & Ioannou, 2019 & 2020, Mubin et al. 2013, Afari & Khine, 2017, Faisal, Kapila & Iskander, 2012, Anwar et al, 2019). They claim that using robots effectively has a lot to offer in education.

Robots can take on different roles and participate in the learning process at different levels depending on the content, the teacher, the type of the student and the nature of the learning activity. On the one hand, they can take on a passive role and be used as a learning tool or a teaching aid. This is true especially in the field of educational robotics, where students build, create and programme robots. On the other hand, a robot can take on the role of a teacher, a partner or a peer in the learning process (Mubin et al, 2017) and supports students’ spontaneous participation and reflection in active ways (Okita, Ng-Thow-Hing & Sarvadevabhatla, 2009). Educational robotics can be employed in education as an innovative educational tool, within a social constructivism and constructionism spirit, to support teaching and learning through hands-on activities in an inviting and supportive learning environment (Socratous & Ioannou, 2019), Mubin et al. 2013) and as a valuable tool to help students develop both cognitive and social skills at different school levels (Lathifah, Budiyanto & Yuana, 2019, Alimisis, 2013, Afari & Khine, 2017). Mastering Robotics has a potential impact on student's learning in different subject areas (Science, Technology, Engineering and Mathematics). Furthermore, there is a wide variety of options to include robotics in the curriculum within an interdisciplinary framework. (Alimisis, 2013, Afari & Khine, 2017). For example, students can create and use robots to help them understand the characters and the plot of the books they read. In addition, they also promote personal development, including cognitive, metacognitive and social skills, meeting the needs of the 21st century workplace (Afari & Khine, 2017). Authentic activities give the students the opportunity to understand real world problems and apply learning and skills into real-life situations (Afari & Khine, 2017).

Not many fields of knowledge incorporate creativity and fun simultaneously. Studies have shown that robotics promotes both. Moreover, hands-on learning activities enhance concentration and attention levels, because the more students learn physical skills, through topics that are interesting and relatable to them, the more they participate during lesson (Faisal, Kapila & Iskander, 2012). They learn to move forward with determination and persist in a not simple programming process that incorporates a range of skills, thus promoting a learning environment for people with different talents and learning styles (Faisal, Kapila & Iskander, 2012), arouses their interest and curiosity (Rubenstein, Cimino, Nagpal, & Werfel, 2015) and promotes a culture of teamwork. It can also be used to help students who may have difficulty in understanding abstract concepts (Eguchi, 2014) or struggle to learn in traditional classroom settings (e.g. there are robots developed to help autistic students). Most robotics programmes are based on problem solving, they are practical and encourage students to think, to be creative and increase their self-confidence (Mubin et al. 2013).

Over the past decade, several researchers and educators have used, in various contexts, educational robots as learning tools, in effective and constructive ways, to pass on particular knowledge or to support learning, highlighting transversal skills, such as problem solving, decision making, adapting to change, critical thinking, computational thinking, creativity, collaboration, communication and teamwork ability, essential skills to create a complete social, individual and professional profile (Khanlari & Kiaie, 2015, Socratous & Ioannou, 2019, 2020). Many studies have focused on analysing their influence on the development of transversal competences, but not on metacognitive skills, a domain that has only relatively recently given rise to some research. (Socratous & Ioannou, 2019).

The results of a recent research (Socratous & Ioannou, 2020) suggest that educational robotics activities can improve students' metacognitive skills. In particular, the study showed that students developed their metacognitive skills, especially adjustment and self-control skills, such as planning, monitoring and identifying errors. Based on these results, it appears that educational robotics activities can be the key to the development of metacognitive skills in primary education, although further research is needed, according to researchers. Similar results have been reported in several other studies. Lin and Liu (2011) found that students involved in educational robotics activities are highly motivated and use a variety of learning strategies in the activities they implement. La Paglia et al. (2010) analysed the process of building and programming robots as a metacognitive tool in their study, where 12 primary school students (aged 8-10 years) worked in groups. They found that robotics activities may be used as a new metacognitive environment allowing students to reflect on their own learning.

Robotics helps students improve skills which may be difficult to develop in a traditional classroom learning context, but are key scientific and engineering practices (Gura 2012). Asking questions, formulating and defining problems, planning and conducting research, and engaging in argument from evidence are some of the skills developed (Gorakhnath & Padmanabhan, 2017). Students with special needs and abilities develop their own personal learning experience and can have access to information and educational content, following a pathway that suits their interests, needs, preferences and learning styles.

In brief, educational robotics provides opportunities for:

- development of transversal competences, essential skills both socially and professionally, and thinking skills through students' questioning, problem solving and designing solutions, that value in real life situations.
- teamwork - students practice listening, communication and collaborative skills.
- engaging students in programming-they learn to control a robot following precise instructions.
- Multisensory learning - learning is stimulated by naturally engaging students on multiple levels.
- building skills, essential for students' future career. They not only learn how to develop and control technology and complex knowledge structures, but also how to practice basic skills required in the future workplace.

Robots can create an interactive and exciting learning experience for children. However, the educational learning design, the usability and availability of appropriate learning activities and content still remain the important factors that determine whether robotics is likely to be useful in teaching. (Gorakhnath & Padmanabhan, 2017).

In the future, it is quite possible to use educational robotics for additional purposes, such as mediated communication or supported group learning. (Gorakhnath & Padmanabhan, 2017).

To sum up, educational robotics is repeatedly proven to be a powerful teaching and learning tool, that has tremendous potential to improve classroom teaching in Primary Schools as well (Khanlari & Kiaie, 2015), including supporting the education of students with disabilities, having a variety of learning styles, who may lack motivation or have lost interest in science or technology (Anwar et al, 2019). In fact, based on research results, appropriate guidance techniques and teamwork with clearly defined roles in order for everyone to have a clear purpose is suggested, as well as scaffolding and supporting activities to enhance students' problem-solving skills effectively and encourage them to solve problems independently. In this way, students take the initiative, they enrich their imagination and the creation of a strong metacognitive environment is promoted (Atmatzidou, 2018).

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2. The 4 Creative Scenarios

2.1. History Scenario

Title

Talos: From the Legend to Modern Robots

Description

In this scenario, students will be introduced to the legend of Talos. They will construct and program a Robot just like the mythical guardian of Crete. Finally, they will discuss issues related to the protection and preservation of important cultural sites.

Relevant Subject

History

Target Group

This scenario addresses pupils of the last 3 years/classes of Primary School.

Other Relevant Competencies

Teamwork, Creativity

Facilities/Equipment Needed

For this scenario, you will need 3-4 Lego Boost kits and tablets that are compatible with them. Pupils will be divided into groups and instructions will be given to them.

Pre-requisites

Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the basic movements of robots, loop commands, the use of sensors, following the line programs, detecting sounds and the use of remote control.

(Chapters 1.2, 1.3, 1.4, 1.6, 1.7 and 1.8).

Learning Objectives

Pupils will:

- be introduced to the legend of Talos and the geomorphology of Crete
- calculate the perimeter of the island of Crete and the speed of Talos
- construct the robot
- learn simple movement commands
- get familiar with the sensors of the robot and how to use them
- develop their imagination and creativity through the construction of the robot

- develop team working skills

Duration

Estimated Time: 8 Teaching hours

- 2 hours for starting point (introduction), questions, drawing
- 3 hours for the construction of Vernie
- 2 hours for programming the robot and the carrying out of the assignments
- 1 hour for the completion of the assignments, video recording of the proceedings, discussion, analysis of the project and suggestions for new assignments/activities

Theoretical Questions

Watch this video and answer the following questions:

https://www.youtube.com/watch?v=SNg4KZKG96o&t=1s

1. How do you imagine that Talos, the robot that Zeus sent to protect Crete, would look like?

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2. How fast do you think it moved?

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3. If Talos moved around Crete three (3) times (Crete perimeter: 1000 km) in one day, could you calculate his speed?

____
____

4. Could he run at this speed? What other means of movement would you suggest?

Main Activities

Activities:

1. Design a robot model for Talos. Think of the features that you will give him as well as the means (equipment) it needs to protect Crete from enemies.
2. Draw a map of Crete on a big piece of paper where Talos will be placed (Draw the perimeter of the island in bold black so that the light sensor recognizes it). You can decorate it with designs from the Minoan Palaces of Knossos, Phaistos, etc.

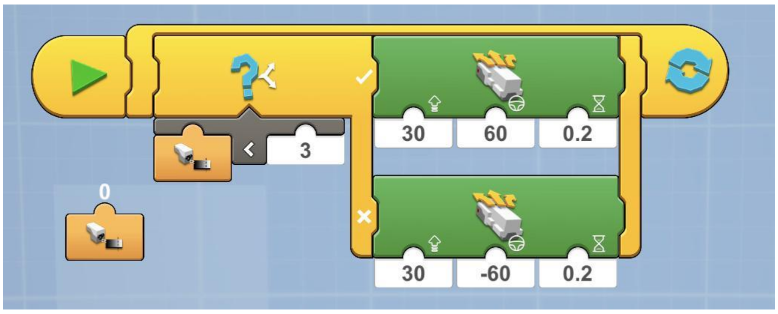
Constructions:

1. Construct the Vernie robot. This robot represents Talos. After you construct it according to the given instructions, you can decorate it as you would like your Talos to look like.
2. Construct enemies and ships that attack the island of Crete (both internally and externally i.e. from the sea). You can use the remaining LEGO pieces or construct them using paper.

Programming:

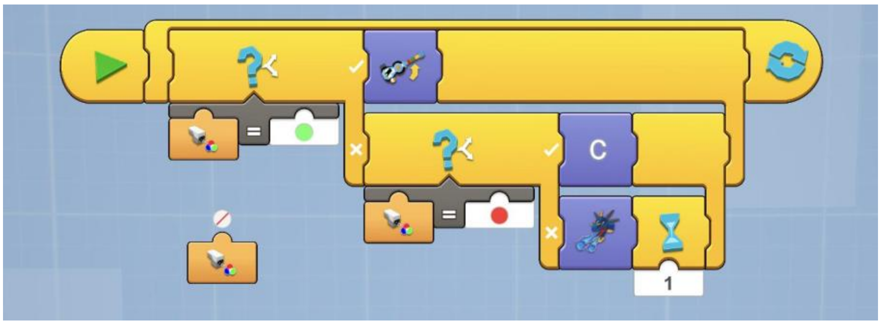
1. After you have designed your own model (maquette) of Crete, calculate its perimeter using your ruler.
2. Program the robot to move on the inside of the island so that it controls and guards it with simple movement commands (approximately).

3. Remove the distance-color sensor from Vernie. Place an extension in the front of the robot where you will attach the distance-color sensor facing downwards. Program the robot to follow exactly the coastline of the island using the “follow the line” method.



4. Record the sounds: “Welcome to Crete” for friends and “Entrance is prohibited” for enemies.

5. Using the color sensor, create a border controller as a barrier (e.g. Green color: Friend of the island, Red Color: Enemy of the island and if it doesn’t see a color then he should say “Enter your password”).



6. Draw or construct the Minoan Palaces of Crete (Knossos, Phaistos, Malia, Zakros). Use Talos as the tour guide who will provide useful information about the Minoan culture and who will take us to the corresponding castles.

7. Construct the Vernie robot 4.2 with the hockey stick. Place two (2) enemies anywhere inside the island. Using the remote control block, try to hit the enemies.

8. Continuing the previous mission, place the enemies again and try to create a block of commands so that the robot exterminates all the enemies.
9. Construct the Vernie robot 2.1 with the arrow launcher. Place hostile ships (which can be constructed using LEGO or any other material) anywhere outside the island, and try to hit them.

Discussion/Conclusion

1. Why do you think Zeus offered Talos as a gift to Minoas, the King of Crete?

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2. Are there any robots nowadays that perform the same tasks as Talos?

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3. Which parts of Crete would you protect, if you had such a robot?

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Further Activities

Can you think of any new activities/assignments for Talos? Note them down and try to complete them in the classroom in collaboration with your classmates.

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2.2. Space Scenario

Title

Robot from Earth to Space

Description

In this scenario, pupils will get to know the planets of our Solar System and program the robot in order to explore them. Finally, they will discuss issues related to space exploration, the difficulties, the changes that such an action will bring about and its impact on humanity.

Relevant Subject

Astronomy

Target Group

This scenario addresses pupils of the last 3 years/classes of Primary School.

Other Relevant Competencies

Teamwork, Creativity

Facilities/Equipment Needed

For this scenario, you will need 3-4 Lego Boost kits and compatible tablets. Pupils will be divided into groups and instructions will be given to them.

Pre-requisites

Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the basic movements of robots, the use of sensors, detecting sounds and the use of the remote control.

(Chapters 1.2, 1.4, 1.6, 1.7 and 1.8).

Learning Objectives

Pupils will:

- get to know the planets of the Solar System
- calculate the distances between them and the difficulties of traveling to another planet.
- build the robot
- learn simple movement commands
- get to know the robot sensors and how to use them
- develop their imagination and creativity through the construction of the robot
- develop teamwork skills

Duration

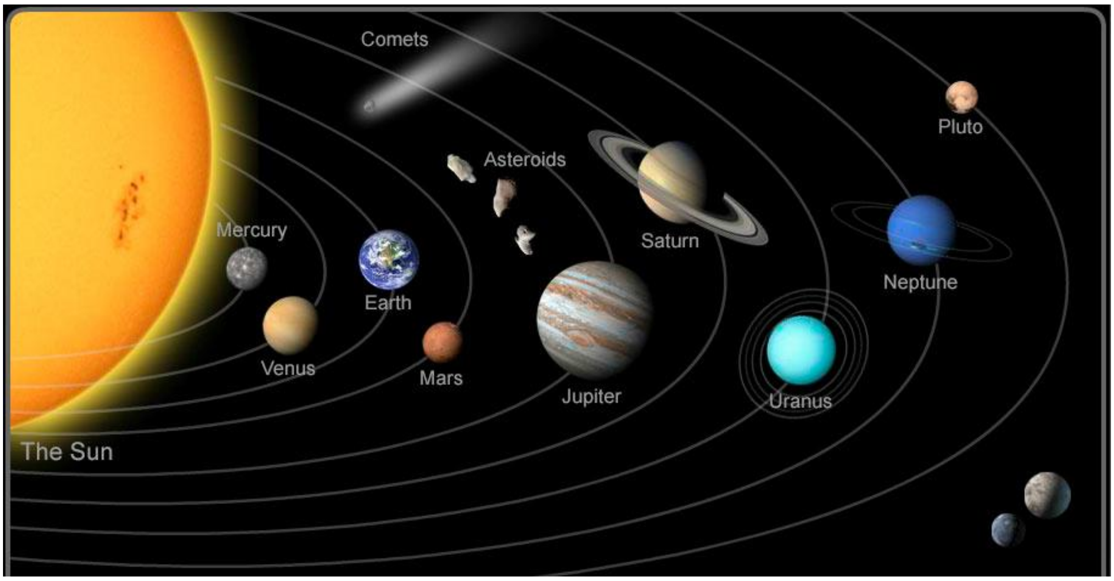
Estimated Time: 5-6 Teaching hours

- 1 teaching hour, starting point (introduction), presentation of planets, discussion.
- 2-3 teaching hours, construction of the robot.
- 2 teaching hours, programming, project analysis.

Theoretical Questions

Watch this video and answer the following questions:

https://www.youtube.com/watch?v=libKVRa01L8&t=36s



1. What is the difference between a star and a planet?

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2. How many planets are there in our Solar System?

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3. What is the largest planet?

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____

4. What is the characteristic of Saturn?

5. Which planet is the warmest and which is the coldest in the Solar System?

Main Activities

Activities:

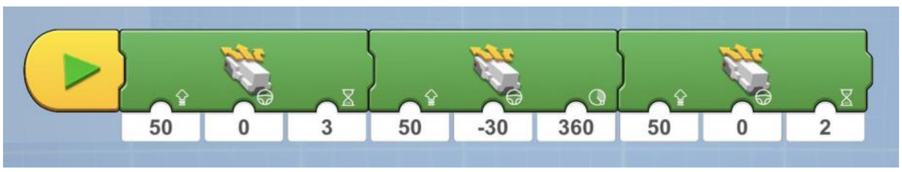
1. Design the Solar System and think of ways to make the planets you build spherical. Put them at relative distances from the Sun.
2. Draw on paper the spaceships we will send in order for the humans to inhabit other planets.

Constructions:

1. Build the M.T.R.4 robot. This robot will represent the spaceship. Once built according to the instructions, you can decorate it, as you would like your own unique spacecraft to look like.
2. Build asteroids and comets that will hinder the robot to reach other planets. You can use the remaining LEGO parts or make them from paper or other materials.
3. Build a satellite that the robot will fly out in order to repair during the missions.
4. Build a space-based home for Mars residents to stay.

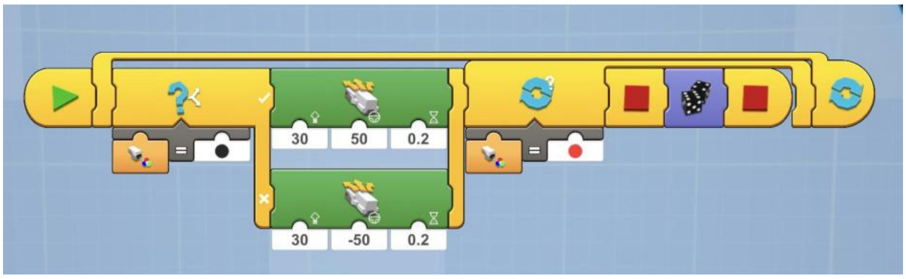
Programming:

1. Once you have created the model of the Solar System with the planets, measure the distances between them with the ruler and write them down in a notebook.
2. Place the robot-spaceship on the Sun and schedule it to reach Earth.



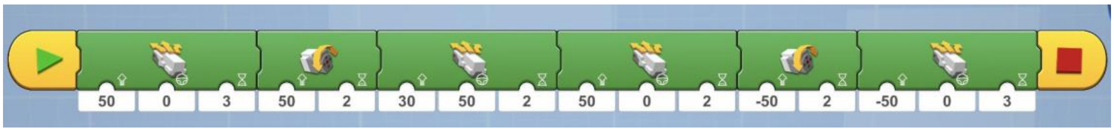
3. Put the distance sensor on the front of the robot and program it to move. When it comes across a planet program it to stop and make a sound.

4. Put the color sensor downwards and schedule the robot to follow the line that you have drawn. When it reaches Mars (red planet), make it stop and say, "I have reached Mars!!!"



5. Record new sounds for planets and depending on the color of the planet then the same color should appear in the hub.

6. Place the satellite somewhere on the model and program the robot to go towards that direction to repair it (in order to repair it the robot must grab the satellite and place it elsewhere).



7. Program the robot in order to move the "base" that humans will inhabit, from Earth to Mars.

Discussion/Conclusion

1. What do you think are the difficulties for humans to reach other planets?

2. If you could travel to Mars, would you like to leave Earth and live on the red planet?

3. What abilities/skills should people who will travel to Mars have in order to survive?

4. What kind of robots should we send to Mars in order to help humans (what actions should they perform)?

Further Activities

Can you think of any new activities/assignments for the Space robot? Note them down and try to complete them in the classroom in collaboration with your classmates.

2.3. Environment Scenario

Title

The Environmental Facility

Description

Students aged 9 to 12 learn about the environment and the importance of sorting the waste that humans create. The Swedish National Agency for Education declare in the syllabus for grades 4-6 the following formulation as a steering document for teachers:

Nature and society

“Human dependence on and influence on nature and what this means for sustainable development. Ecosystem services, such as degradation, pollination and purification of water and air.”

The students will build the robots Vernie and M.T.R.4 for inspiration and use them in different activities concerning the scenario environment.

Relevant Subject

Biology, Social Sciences

Target Group

Students aged 9-12 (Grades 4-6)

Other Relevant Competencies

Teamwork, Creativity

Facilities/Equipment Needed

For this scenario, you will need 4-6 Lego Boost kits and compatible tablets, depending on the number of students in the class. You will need an extra for the teacher. Pupils will be divided into groups and instructions will be given to them. Preferably gender mixed groups.

Pre-requisites

Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the basic movements of robots, loop commands, the use of sensors, detecting sounds and the use of the remote control.

(Chapters 1.2, 1.3, 1.4, 1.6, 1.7 and 1.8).

There are also general education prerequisites: Students should be able to understand what recycling means, how people recycle and what is the expected impact. Students may make a study visit to the local recycling station.

Learning Objectives

The students will:

- be introduced to the recycling scenario
- construct the Robot
- learn simple movement commands
- get familiar with the sensors of the robot and how to use them
- develop their imagination and creativity through the construction of the robot
- develop team working skills
- learn about recycling stations and how waste products are transported to the station

Duration

Estimated time for the scenario will be 540´

- Student´s study visit to the local environmental station, 120´
- Two groups building Vernie, 120´
- Simultaneously two groups building M.T.R.4, 180´
- Programming the robots, 120´
- Activities such as sorting waste products, 60´
- Finalizing the scenario 60´

Theoretical Questions

1. How can household waste be reused in a good way?

   ____
   ____
   ____
   ____

2. How can we humans change our way of life so that we reduce the use of the earth's resources?

   ____
   ____
   ____
   ____

Main Activities

Activities:

1. Let the students work in groups (mixed gender if possible) and have the students construct a recycling center. Remember to create the logistics in the form of access roads, landfills and plants to create biogas. Students can build the recycling centre by

using different materials, for example papier mache. Buildings and plants can be constructed of cardboard or Lego building blocks. The landfills can be built from different types of fabrics. The roads in the facility should be designed so that the vehicles move without risk of contact with each other. There should be separate collection areas depending on the type of waste.

2. Program the robots so that they move forward, backwards and can swing in either direction.

Constructions:

Build the robots Vernie and M.T.R.4.

Vernie will act as an information center at the environmental facility. He should be able to utter where the vehicles should deposit their waste.

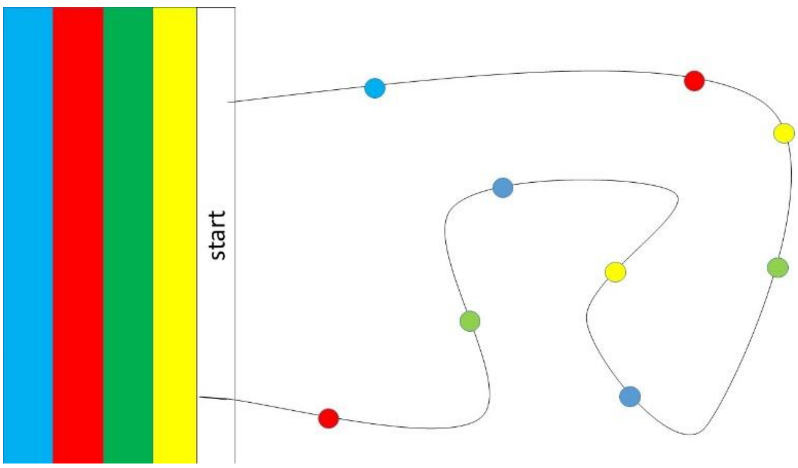
M.T.R.4 shall represent different types of vehicles that are present at the Environment Center, such as trucks, tractors and passenger cars with trailers.

Programming:

Vernie will be programmed to use color sensors to distinguish between different types of rubbish. Combustible waste can be stained yellow. Waste to be deposited is stained orange. Material that can be reused, such as plastic will be stained red, glass will be stained blue and paper will be stained green.

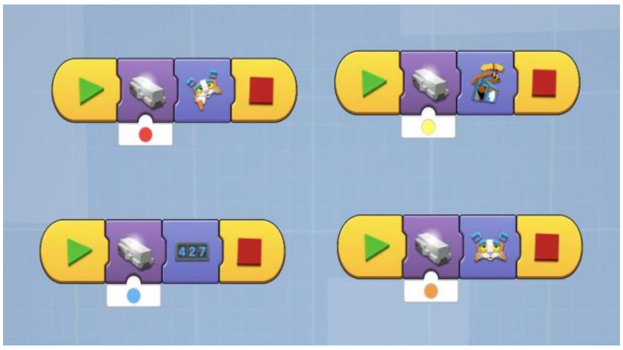
1. Remove the distance-color sensor from Vernie. Place an extension in the front of the robot where you will attach the distance-color sensor facing downwards.

2. Prepare a line or a track across the road, which the robot can follow and locate the waste.

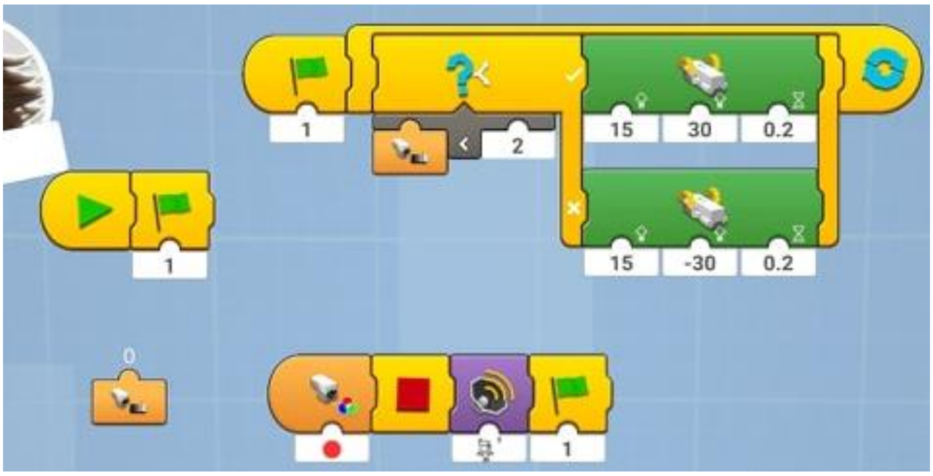


The play mat should look like the picture above. The robots must start from the start area.

3. Record new sounds for different types of rubbish (Combustible waste, waste to be deposited, etc.)

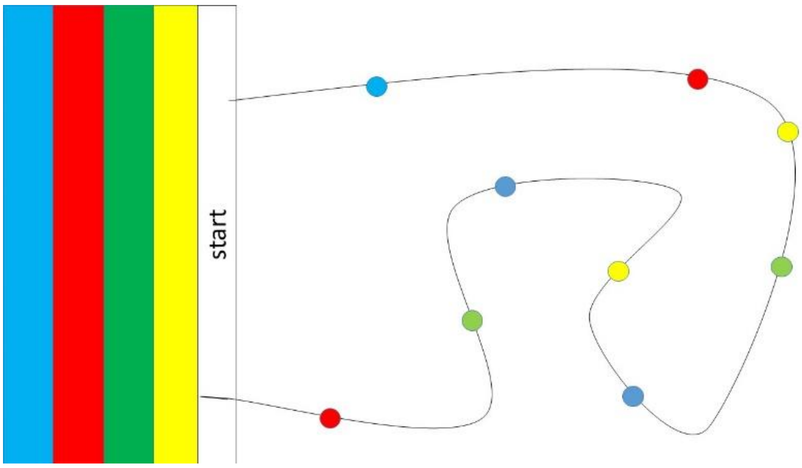


4. Program the robot to follow the line you have drawn across the roads and identify any waste it finds. When Vernie identifies something, he should shout the type of waste he has found.



M.T.R.4 will be programmed to follow the road and dispose of the rubbish.

5. Prepare a road or a track where the robot M.T.R.4 can fetch and deliver waste.



(The play mat should look like the picture above. The robots must start from the start area.)

6. Program the color sensor to pick up plastic (red).
7. Program M.T.R.4 to lift the plastic.

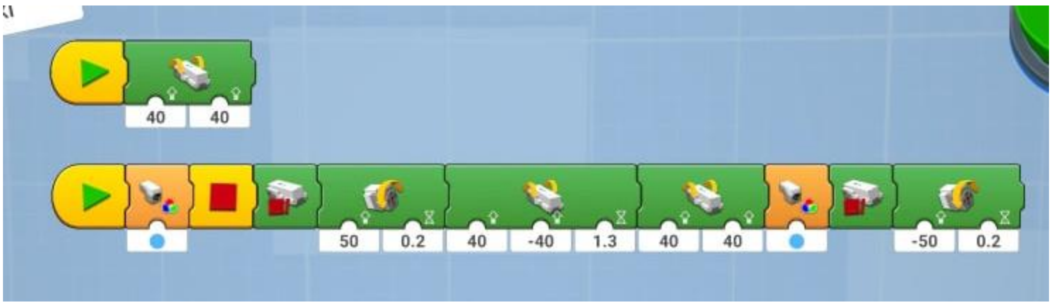
8. Program M.T.R.4 to leave the plastic at the red area.

(The robots must start from the start area and in line with the waste that we want to pick up and transfer to a specific area.)

9. Program the color sensor to pick up glass objects (blue).

10. Program M.T.R.4 to lift glass objects (blue).

11. Program M.T.R.4 to deliver the glass objects to another location this time (blue area).



12. Program M.T.R.4 to retrieve paper (green) and deliver it to a specific location (green area).

13. Program M.T.R.4 to retrieve waste (yellow) and deliver it to a specific location (yellow area).

Discussion/Conclusion

1. Research has shown that man contributes to soiling nature. How can we state with our senses that this happens?

 ____

 ____

 ____

 ____

2. How can we prevent pollution of the seas?

 ____

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 ____

 ____

Further Activities

Have the students make their own biogas by blasting and applying heat.

2.4. Culture Scenario

Title

Form your own Robot Guitar Band!

Description

We want our students to make a simple melody by building the robot Guitar. We intend to find out what the possibilities of the Robot Guitar are. Can the students create and play a simple tune with the help of the Robot Guitar? Can we add rhythm instruments to support the melody loop? Can we find chords that fit the melody loop? Is it possible, with the help of the guitar, to arouse interest in the origin of music and how people created simple instruments that then evolved into what we today recognize as modern musical instruments? Can the Robot Guitar stimulate students' curiosity for increased knowledge of today's synthetic music?

We also want to investigate how folk music originated. The Sami people in northern Europe have their own, special way of singing - the Joike. Here are two examples of Joiks:

Song 1 | Song 2

Relevant Subjects

Mathematics, Music, History

Target Group

Primary School Students aged 9-12 (Grades 4-6)

Other Relevant Competencies

Creativity, Teamwork, Develop knowledge about Music history, Develop knowledge about Musicality.

Facilities/Equipment Needed

For this scenario, you will need 4-6 Lego Boost kits and compatible tablets, depending on the number of students in the class plus an extra for the teacher. Pupils will be divided into groups and instructions will be given to them. Preferably, gender mixed groups.

Pre-requisites

Students should be familiar with the educational material of Module 1 and more specifically with the chapters, which are related to the use of sensors and detecting sounds. (Chapters 1.4 and 1.7).

Students should have basic knowledge of note learning. What does the C major scale look like?

Students should also know about the regional folkmusic in the area and traditions connected to the music.

Learning Objectives

Students learn about:

- the history of musical instruments. They see the connection between The Robot Guitar and modern synthetic music
- notes, minor and major chords
- folk music in different countries

Duration

Music/Culture scenario, 480 minutes

- Building the Robot Guitar, 180 minutes
- Programming the Robot Guitar, 120 minutes
- Music history, Folk music 180 minutes

Theoretical Questions

1. Make a list of different types of music.

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2. What is sound?

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3. How do you get instruments to sound different?

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Main Activities

Constructions:

1: Build the Robot Guitar 4000

2: Investigate what sounds you can get out of the guitar

Activities:

Step 1: Inform the students what the different notes correspond to on the guitar.

Step 2: Show students the notes that apply to the simple tune we have chosen. Suggest a melody that children in different countries know, for example Brother John.

Step 3: Students get to code the guitar tone by tone by moving the "finger" on the guitar's neck so that the simple melody appears. It becomes a form of analog programming.

Step 4: Teach students to distinguish between major and minor chords. Train them to code the chords.

Step 5: When the student has learned how to play the simple melody, a friend may be given the task of finding the simple chords that fit the melody.

Step 6: Have the students use the violin sound on the robot, as violin is the most common instrument in Swedish folk music.

Step 7: The students code the robot to play the melody on a well-known folk song, for example Hårgalåten.

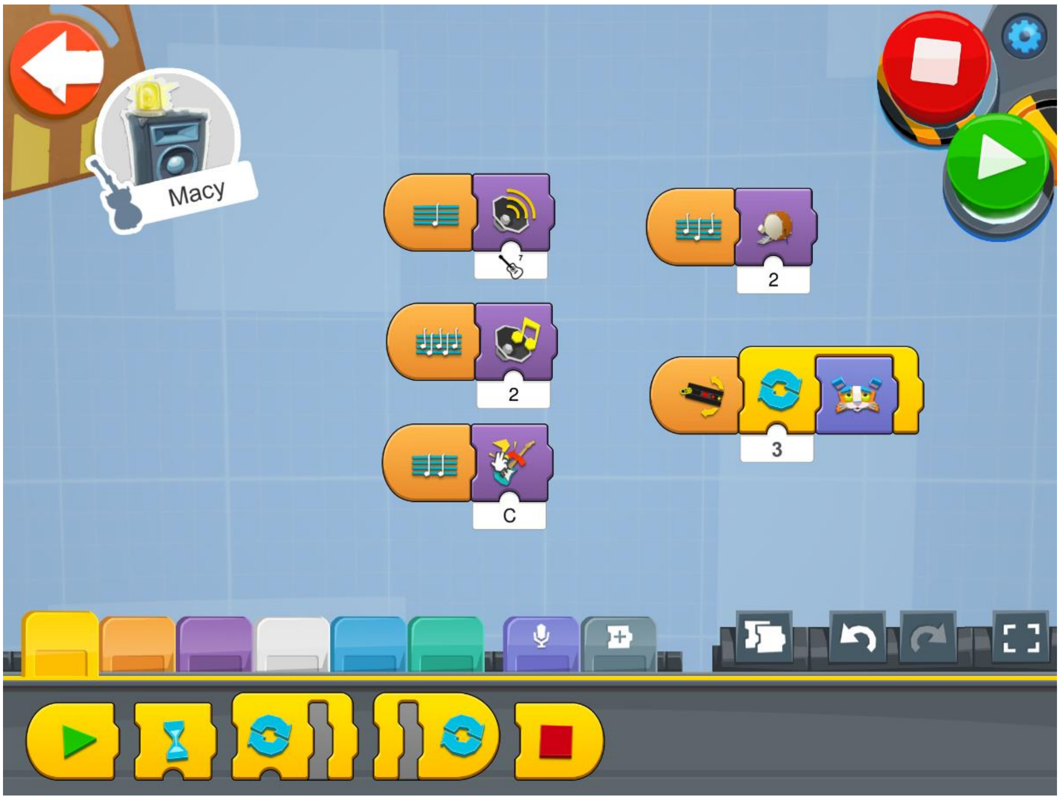
Programming

1. Start a discussion how to create a simple melody. What does it contain? Listen to melodies and use them to find different parts in the melody: intro, verse, chorus and outro, tempo and pulse.

2. Find out the possibilities that the Robot Guitar 4000 provides. What can it sound like? What instruments can it imitate? Give instructions concerning programming functions: Start blocks, loops, instruments, the instruments' different notes and chords.


Nya
C
Dm
F
Em
G
1
1


Stephanie
2
4
C
Dm
Em
C
C
Dm
Em
C



3. The students will now code the Robot Guitar to create and play their own simple melody. The setting should contain:

- A lead guitar that plays the melody
- A background beat / rhythm that is looped and repeated
- An instrument that plays a chord loop with at least two different notes / chords.

Discussion/Conclusion

1. Why is music featured in many movies?

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2. List different kinds of dances.

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Further Activities

Divide the class into four groups.

Group 1 is given the task of finding out what is meant by folk music. The group can make a presentation and play examples of folk music.

Group 2 defines what is called classical music and plays an example of classical music.

Group 3 tells about music played during the 60's and plays a song of the Beatles.

Group 4 finds out what is meant by synth music and plays a piece of a well-known synth group.