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TEACHING UNITS

of the ERASMUS+ project

“LEGO® MINDSTORMS® EV3 IN STEM EDUCATION”

2019-1-PL01-KA229-065800

Coordinator School:

- Szkola Podstawowa w Kozminie – Brudzew - POLAND (OID number: E10037004)

Partner schools:

- Şcoala Gimnazială Elena Farago – Craiova - ROMANIA (OID number: E10202121)
- IES Ausiàs March Gandia-Valencia- SPAIN (OID number: E10154646)

THE SITE OF THE PROJECT:

https://erasmus-lego-stem.weebly.com/

INTRODUCTION

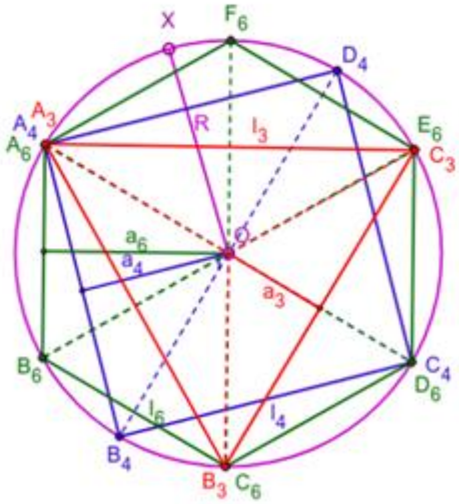
The didactic units and lesson plans presented in this educational resources booklet are the result generated during the implementation of the Erasmus+ project on Robotics carried out during three academic years in three secondary schools in Poland, Romania and Spain. At the beginning of the project, a fundamental objective was to know the basic concepts of Robotics and programming of blocks that are used for the Lego EV3 robot. However, this project is meant to lead us to the permanent incorporation of Robotics in our classrooms. In this project, the cooperation between the three countries and the collaboration between the different departments of each school has been fundamental.

From this interdepartmental collaboration, twelve didactic units or didactic lessons have been designed. They have been shared between the countries and that served as a starting point for teaching Robotics. These units have been successfully experimented within the classes for the last three years among students and it is expected that the partner schools will allow their continuity in the coming years, obtaining other new didactic units. Each country has designed four units. The first four correspond to Romania, the next four to Spain and the final four to Poland.

UNITS & LESSON PLANS INDEX

Didactic Unit "Geometric Figures and the LEGO EV3 Robot"

Authors: teachers Sorina Cojocaru, Cristina Ungureanu and Ana-Iulia Chiva



1. PRESENTATION AND NORMATIVE FRAMEWORK

Robotics can provide a captivating and fun way to teach math, computer science or technology. Using robots, children become creative and train their critical thinking to solve real-world problems.

As a practical field, Robotics has as object of study the methods of design, construction and management of robots. As a school subject, Robotics aims to form skills for multidisciplinary use of knowledge in physics, mathematics and computer science, to develop elementary skills and technical creativity. The achievement of this goal is reached by designing and assembling robot models and developing algorithms and controlling programs with them in simulated work environments. Overall, Robotics as a school subject contributes to the formation and development of the students' personality, the emphasis of training being on the development of technical creativity, logical thinking and algorithmic thinking, on the formation and development of skills for modeling, creating algorithms and programming of algorithms for conducting with cybernetic systems which include mechanical, electromechanical, electronic, optical, computer components.

In the design of the teaching unit the basic curriculum for both Mathematics and ICT is taken into account for the sake of interdisciplinary activities within a STEM project.

2. CURRICULUM ELEMENTS

2.1 AREA OBJECTIVES

Within the lower secondary education the aim is to reach the following objectives:

1. Integrating knowledge in mathematics, physics and computer science in order to design and build robots.
2. Building simple models of robots.
3. Creating simulated working environments for building the robot models.
4. Manual, automatic and manumatic control of the robot models.
5. Elaborating of driving programs for robot models.
6. Obeying safety, ergonomic and ethical rules in the construction of robot models, in their management and programming.

2.2 THE FORMATIVE VALUE OF ROBOTICS

It consists in:

- developing of fine motor skills and abilities, attention, precision, spatial imagination;
- developing creativity and technical thinking;
- developing skills for building, algorithmizing, programming and efficient use of cyber systems;
- developing practical skills for the use of program products intended for driving with robots;
- achieving efficient interaction between humans and cybernetic systems;
- increasing the motivation for studying real life fields;
- orienting students towards performance in achieving the desired goals;
- developing teamwork skills.

2.3 OVERAL LINGUISTIC OBJECTIVES

1. To be able to understand general and specific information in oral messages in various communicative situations, adopting a respectful and cooperative attitude.
2. To be able to speak and interact effectively and adequately in common communicative situations and with some level of autonomy within and outside the classroom.
3. To be able to read and understand texts of an appropriate level taking into account the abilities and interests of the students
4. To be able to extract general and specific information from a written text and use reading seeing it as pleasurable and useful.
5. To be able to write simple texts for different purposes about different issues using appropriate language.

6. To be able to appropriately use the basic structural and functional components of the foreign language in different communicative contexts.
7. To be able to develop autonomy in learning, reflect on the own learning processes and on the functioning of the language and transfer knowledge acquired in other languages to the foreign language.
8. To be able to use learning strategies and all the teaching resources at their disposal, including ICT, to obtain, select and present information both orally and in writing.
9. To be able to see the foreign language as a way to access information and a tool for learning various contents.
10. To be able to value the foreign language and languages in general, as a means of communication and understanding between people of different backgrounds, languages and cultures to avoid any type of discrimination
11. To be able to gain confidence and self-confidence in learning ability and foreign language use.

2.4 VALUES AND ATTITUDES

In the process of studying the Robotics in school, the following values and attitudes will be formed and developed:
1. Expressing a creative way of thinking in structuring and solving work tasks;
2. Awareness of the social, economic and moral impact of using robots;
3. Having a favorable attitude towards science and knowledge;
4. Doing objective evaluation of one's own activities and learning outcomes.

3. CONTENT BLOCKS

3.1 CURRICULAR CONTENTS

Regular polygons

In Euclidean geometry, a **regular polygon** is a polygon that is equiangular (all angles are equal in measure) and equilateral (all sides have the same length).

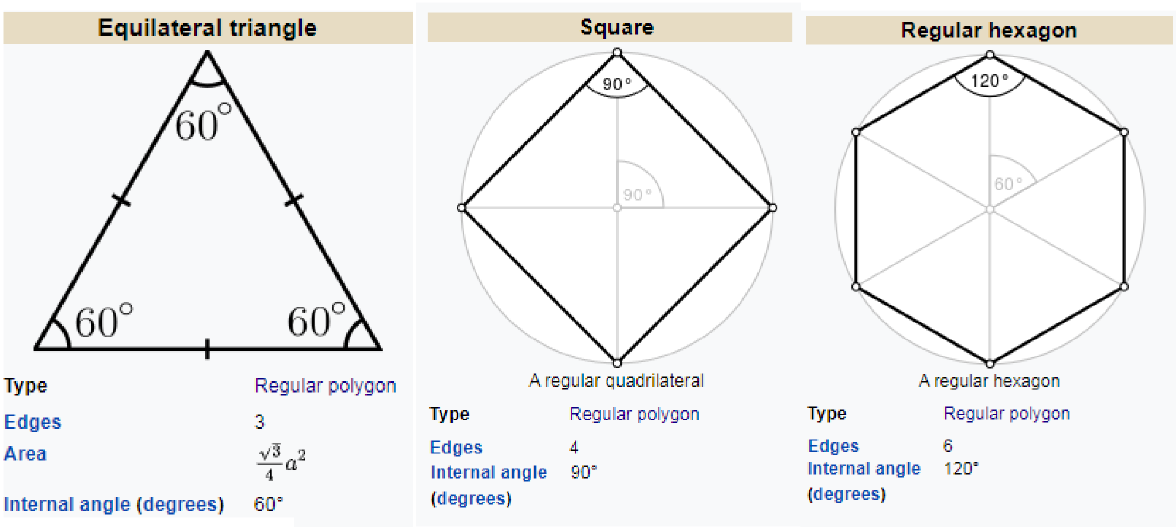
For a regular convex *n*-gon, each interior angle has a measure of:

$$\left(1-\frac{2}{n}\right)\times 180 \text{ degrees, or equivalently } \frac{180(n-2)}{n} \text{ degrees;}$$

Equilateral triangle measures as much as the angle of (1-2/3)*180^o= 60^o

The square measures as much as the angle of 90^o.

The hexagon measures as much as the angle of 120º.



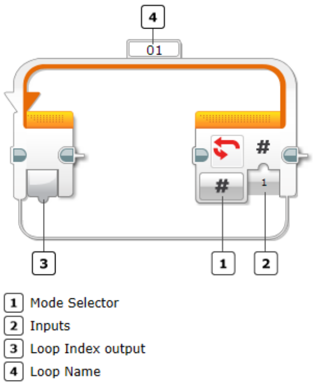
3.2 ICT CONTENT

- Use of computers to program, search, select and analyze information.
- Virtual environments with interactive exercises.
- Basic operations in coding.
- Basic process operations with Lego robot EV3.
- Use the Loop block to repeat a series of actions

The basic move function of the Lego robot EV3 are:

-Steering Motors are controlled together. Direction is changed directly and is indicated by the arrow on the block. Backwards movement is achieved by using a negative number in the power variable on the block.
-Tank Driving Each motor (wheel) is controlled independently. Direction is changed by adjusting the power of the respective motors. Backwards movement is achieved by using a negative number in the power variable on the block.
Note: For continuous square programs, exact numbers will vary based on size of robot and wheels. For example, it may take 360˚ or even 720˚ rotation to get the robot to make a 90˚ corner, as opposed to the 180˚ shown in the solution.

Students explore repetition in programming and the idea of making code more efficient by using the computer programming structure of loops. Both definite and indefinite loops are introduced and explored using some of the loop blocks. Students increase their understanding of programming logic by combining sequential programming with loop structures in various ways to create programs for Lego robot EV3.



The Loop block is a container that can hold a sequence of programming blocks. It will make the sequence of blocks inside it repeat. You can choose to repeat the blocks forever, a certain number of times, or until a sensor test or other condition is True.

Only the blocks inside the loop will repeat. After the loop ends, the program will continue with the blocks that are after the loop.

Use the Mode Selector to control how the loop will repeat. The different modes specify what condition will make the loop end. For example, you can make the loop repeat a certain number of times, repeat until a sensor data value reaches a certain threshold or repeat forever. The Inputs available will change depending on the mode.

You can enter a name for the loop in the Loop Name field on the top of the Loop block.

Blocks inside the loop can use the LoopIndex output to tell how many times the loop has repeated.

4. EVALUATION CRITERIA

4.1 CURRICULUM EVALUATION CRITERIA

- Know the definition of the regular polygon.
- Identify the types of regular polygons and differentiate their angles and sides.
- Being able to build regular polygons: an equilateral triangle, a square, a hexagon Convert the distance to travel in the rotations of the wheels of a Lego robot.
- Converting the distance to travel in the rotations of the wheels of a Lego robot;
- Convert an angle expressed in degrees to rotations of a wheel.

4.2 ICT EVALUATION CRITERIA

- Development of repetitive control algorithms with robot models;
- Graphic programming of repetitive driving algorithms with robot models;
- Introducing code and program basic operations (advance, stop, turn) with the Lego robot processor;
- Using information and communication technologies to produce texts and collect and transmit information;
- Using information and communication technologies to access, obtain, discriminate and interpret information and as an instrument to learn and share knowledge.

The current / formative evaluation will be done in various ways: observing the student's behavior, analyzing the results of the student's activity, discussions / conversations, presentations of individual activity projects. Through the current / formative assessment, the teachers inform the student about the level of performance; motivate them to get involved in the training and development of skills.

The summative evaluation is performed at the end of each topic based on the simulation in the Robotics labs of a problem situation from various simulated contexts, which requires the student to demonstrate the competence formed. Teachers will develop tasks that will guide student behavior to demonstrate the system of knowledge and skills. For this purpose, the performance indicators and descriptors of the process and the product made by the student will be clearly established.

4.3 METHODOLOGIC SUGESTIONS

Starting from the multidisciplinary and applicative characteristics of Robotics, the active-participatory methods are recommended to be used as much as possible in the teaching-learning process. The training and development of the expected competencies is done through activities of design, assembly, and elaboration of algorithms and programming of robot models. The most appropriate form of elementization of such activities is teamwork, with explicit tasks assigned to each member of the team. The time allotted for the presentation of theoretical subjects must be as short as possible.

The theoretical part should be taught and learned while solving practical problems, which appear in the while building and programming robot models. It is in such contexts that the teacher will facilitate the integration by students of the fundamental knowledge that they have acquired in the process of studying mathematics, physics and computer science. The activities proposed to the students by the teacher will aim to encourage students to think creatively, to analyze situations and to use critical thinking to solve problems in the real world. Teamwork and cooperation will be the basis of any robotics project proposed by the teacher. Students will be taught that it is acceptable to make mistakes, especially if this leads to better solutions. Robotics will be presented as a captivating and fun way to intuitively and thoroughly acquire more knowledge in mathematics, physics, computer science, natural sciences. Recommended teaching-learning activities for the school subject Robotics include: identifying and analyzing problems.

5. ACTIVITIES

5.1 MAKING THE ALGORITHM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF AN EQUILATERAL TRIANGLE

1. Listen & Speak: Warm-up, the properties of the equilateral triangle

   Work in pairs to find the properties of the equilateral triangle. You have 5 minutes to deliver your list of proprieties to the teacher and you can search in dictionaries or Internet.
2. Speaking: Differentiate between

   a) Reflect individually for 2 minutes on different types of triangles. What do you understand by each of these concepts? Write your answer on the back of paper.

   b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of triangles. Write previously in the paper these questions you are going to ask them. Then write down examples requested.
3. Challenges

   - Move 3 rotations and then stop

   - Move for 3 seconds and then stop

   - Move on the trajectory of an equilateral triangle of any dimensions.

   - Move continuously on the trajectory of an equilateral triangle of any dimensions. Groups should complete all of the above challenges by the end of the lesson. If there is still time, groups may proceed to the following challenges.

   - Move in a triangle that has all sides equal to one meter.

-If they were using steering move blocks, have them switch to tank and repeat the challenges, or vice versa

5.2 MAKING AN ALGORITHM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF A SQUARE

1. Listen & Speak: Warm-up, the proprieties of a square

Work in pairs to find the proprieties **of a square**. You have 5 minutes to deliver your list of proprieties to the teacher.

2. Speaking: Tell the difference between different types of quadrilaterals.

a) Reflect individually for 2 minutes on quadrilaterals. What do you understand by the concept? Write your answer on the back of paper.

b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of quadrilaterals. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

3. Challenges

- Move 4 rotations and then stop
- Move for 4 seconds and then stop
- Move on a trajectory of a square of any dimensions
- Move continuously on a trajectory of a square of any dimensions

Groups should finish all of the above challenges by the end of the lesson. If there is still some time left, the groups may proceed to the following challenges.

- Move on the trajectory of a square measuring one meter for each side.

5.3 MAKING THE ALGORITHM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF A HEXAGON

1. Listen & Speak: Warm-up, the proprieties of a hexagon

   Work in pairs to find the proprieties of a hexagon. You have 5 minutes to deliver your list of proprieties to the teacher and you can search in dictionaries or internet.

2. Speaking: Tell the proprieties of the hexagon

   a) Reflect individually for 2 minutes on hexagons then tell your partner.

   b) Get up and walk around the classroom by asking in English at least 3 classmates to talk about how to construct a hexagon. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

3. Challenges

- Move 6 rotations and then stop

- Move for 6 seconds and then stop

-Move on a trajectory of a hexagon of any dimensions

-Move continuously on a trajectory of a hexagon of any dimensions

Groups should finish all of the above challenges by the end of the lesson. If there is still some time left, the groups may proceed to the following challenges.

- Move on the trajectory of a hexagon measuring one meter for each side.

6. ASSESSMENT

Through the activities of the unit a student (he) can get:

	Outstanding	**Very good**	**Pass**	**Failure**
Curricular	He knows the proprieties of all regular polygons. He is able to recognize them without any problems. He identifies the importance of the use of the regular polygons and their properties in everyday life.	He knows the proprieties of regular polygons. He is able to draw most of them as well as recognize them. He identifies the importance of the use of the regular polygons and their properties in the everyday life.	He knows some of the proprieties of regular polygons. He is able to recognize and draw some of them but finds it difficult to express them in an orderly way. He can complete his tasks with help.	He doesn’t recognize the regular polygons. He does not know the properties of regular polygons and can’t draw them correctly.
TIC	He can find information easily on the web. He has a high command of computer coding of Lego robot EV3.	He can find information easily on the web. He has command of ICT tools that allows him to make complex process operations with Lego robot EV3.	He can browse the web without difficulty but in certain cases he does not know how to use it correctly. He has command of ICT tools that allows him to make basic process operations with Lego robot EV3	He has a hard time surfing on the web and he does not know how to use it. He does not have sufficient command of the blocks needed to program a robot.

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Didactic Unit "OPEN ROBERTA LAB"

Authors: teachers Marian Vlad, Sorina Cojocaru and Ana-Iulia Chiva

1. PRESENTATION AND NORMATIVE FRAMEWORK

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As a practical field, Robotics has as object of study the methods of design, construction and management of robots. As a school subject, Robotics aims to form skills for multidisciplinary use of knowledge in physics, mathematics and computer science, to develop elementary skills and technical creativity. The achievement of this goal is reached by designing and assembling robot models and developing algorithms and controlling programs with them in simulated work environments. Overall, Robotics as a school subject contributes to the formation and development of the students' personality, the emphasis of training being on the development of technical creativity, logical thinking and algorithmic thinking, on the formation and development of skills for modeling, creating algorithms and programming of algorithms for conducting with cybernetic systems which include mechanical, electromechanical, electronic, optical, computer components.

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It consists in:

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5. To be able to appropriately use the basic structural and functional components of the foreign language in different communicative contexts.
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2.4 VALUES AND ATTITUDES

In the process of studying the Robotics in school, the following values and attitudes will be formed and developed:
1. Expressing a creative way of thinking in structuring and solving work tasks;
2. Awareness of the social, economic and moral impact of using robots;
3. Having a favorable attitude towards science and knowledge;
4. Doing objective evaluation of one's own activities and learning outcomes.

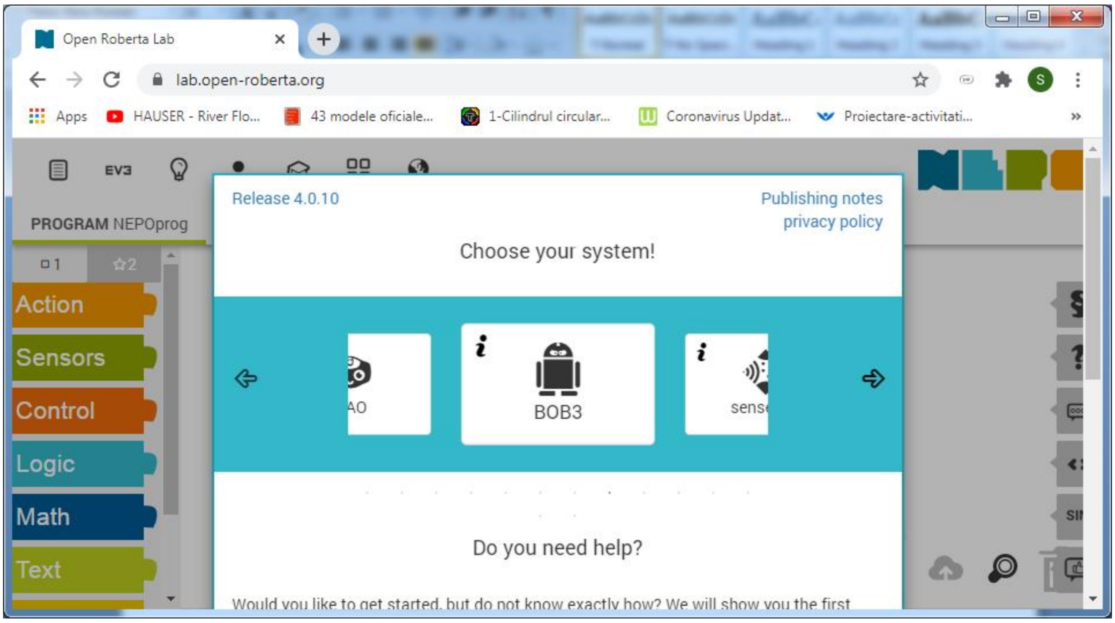
3. CONTENT BLOCKS

3.1 CURRICULAR CONTENTS

Open Roberta Lab

The Open Roberta Lab is a cloud-based integrated programming environment that enables children and adolescents to program easily different robot/microcontroller systems.

It is an open-source programming platform developed by Fraunhofer IAIS within the initiative “Roberta – Learning with Robots”



The OPEN ROBERTA LAB platform, through the NEPO language offers the possibility to program both virtual robots, using the integrated simulator, and real ones if you have the robots you need. The platform integrated simulator allows the virtual programming of a simple 2D robot model on a computer with basic configuration, connected to the Internet. This makes teaching educational robotics in all schools from Romania possible by using the current resources of the schools, without additional extra costs, using only computers equipped with computer labs and Internet connection.

• The OPEN ROBERTA LAB simulator offers the 2D robot already equipped with all the sensors of a real robot to schools that do not have kits at all or do not have enough kits for all students;

• OPEN ROBERTA LAB programs can be transferred to real robots of different types. Schools may choose, depending on costs, for the purchase of a certain type of robot;

• NEPO blocks are intuitive, switching to programming in line of code, according to the programming languages provided in the school curriculum, is much easier;

• NEPO blocks are similar to those in Scratch and can benefit from the experience of programming from previous classes;

• Compared to the Scratch environment, OPEN ROBERTA LAB is dedicated to robot programming.

3.2 ICT CONTENT

• Using a virtual environment for programming robots with the purpose of teaching, visualization and the use of the values read by the robot's sensors virtual (an ultrasonic sensor for obstacle detection, a color sensor, a pressure sensor, a microphone, an infrared sensor, a gyroscopic sensor, a compass, etc.)

• Use of Open Roberta platform to program Lego robot EV3

• Searching, selecting and analyzing information.

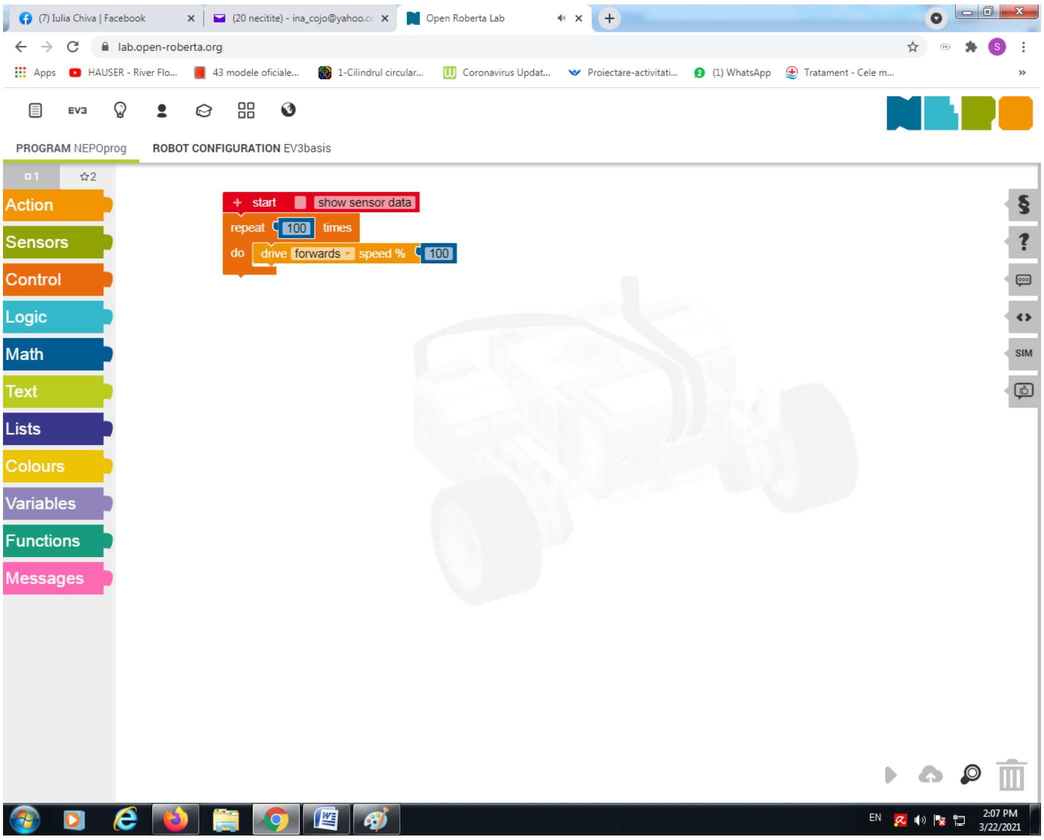
• Solving interactive exercises inspired from real life activities.

• Basic operations in coding.

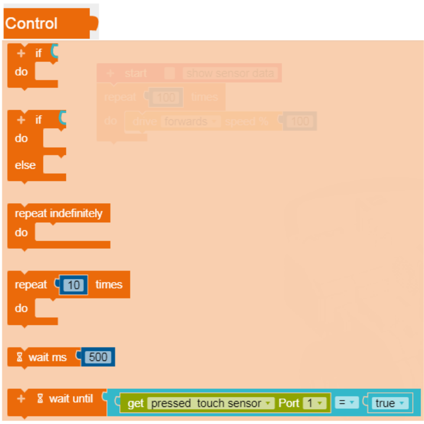
• Basic process operations with Lego robot EV3 within the Open Roberta platform.

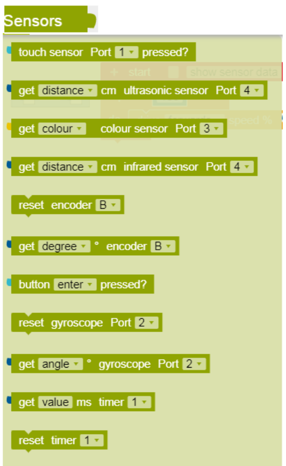
• Elaborating of the source code for the control of the virtual didactic robot by using and interpretation of data received from its sensors: avoidance of obstacles, maintaining balance, specific reactions to light detection or identifying a marked route etc.

NEPO controls are grouped in categories like: Action, Sensors, Control, etc.



Each set of controls contain blocks:





4. EVALUATION CRITERIA

4.1 CURRICULUM EVALUATION CRITERIA

- Knowing and using the interface of Open Roberta platform.
- Identify the types of robots we can program in Open Roberta Lab.
- Being able to program the EV 3 using the NEPO language.
- Solving math problems using Open Roberta platform.

4.2 ICT EVALUATION CRITERIA

- Development of repetitive control algorithms with robot models;
- Graphic programming of repetitive driving algorithms with robot models;
- Introducing code and programmed basic operations (advance, stop, turn) with the Lego robot processor;
- Using information and communication technologies to produce texts and collect and transmit information;

The current / formative evaluation will be done in various ways: observing the student's behavior, analyzing the results of the student's activity, discussions / conversations, presentations of individual activity projects. Through the current / formative assessment, the teachers inform the student about the level of performance; motivate them to get involved in the training and development of skills.

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4.3 METHODOLOGIC SUGESTIONS

Starting from the multidisciplinary and applicative characteristics of Robotics, the active-participatory methods are recommended to be used as much as possible in the teaching-learning process. The training and development of the expected competencies is done through activities of design, assembly and elaboration of algorithms and programming of robot models. The most appropriate form of performing such activities is teamwork, with explicit tasks assigned to each member of the team. The time allotted for the presentation of theoretical subjects must be as short as possible.

The theoretical part should be taught and learned while solving practical problems, using the simulator. It is in such contexts that the teacher will facilitate the integration by students of the fundamental knowledge that they have acquired in the process of studying mathematics, physics and computer science. The activities proposed to the students by the teacher will aim to encourage students to think creatively, to analyze situations and to use critical thinking to solve problems in the real world. Teamwork and cooperation will be the basis of any robotics project proposed by the teacher. Students will be taught that it is acceptable to make mistakes, especially if this leads to better solutions. Robotics will be presented as a captivating and fun way to intuitively and thoroughly acquire more knowledge in mathematics, physics, computer science, natural sciences. Recommended teaching-learning activities for the school subject Robotics include: identifying and analyzing problems.

5. ACTIVITIES

5.1 MAKING THE PROGRAM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF AN EQUILATERAL TRIANGLE

1. Listen & Speak: Warm-up, the properties of the equilateral triangle

   Work in pairs to find the properties of the equilateral triangle. You have 5 minutes to deliver your list of proprieties to the teacher and you can search in dictionaries or Internet.

2. Speaking: Differentiate between

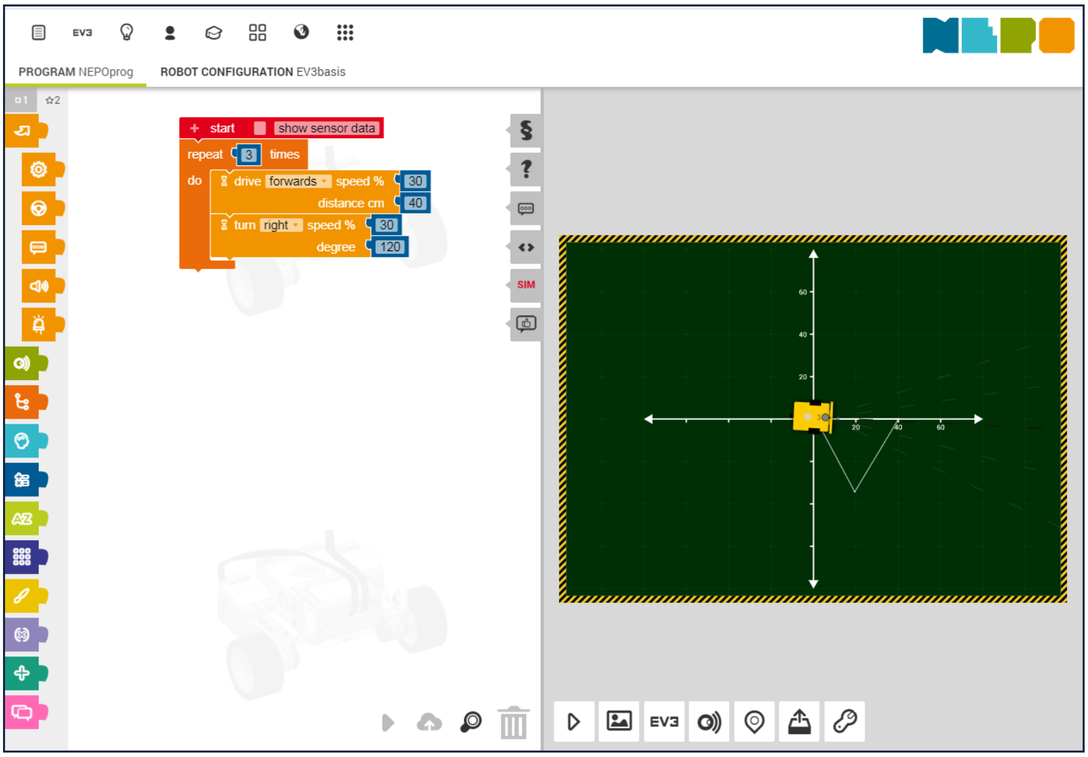
   a) Reflect individually for 2 minutes on different types of triangles. What do you understand by each of these concepts? Write your answer on the back of paper.

   b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of triangles. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

3. Challenge

   - Create a circle around the triangle.

   Groups should complete the challenge by the end of the lesson.



5.2 MAKING AN ALGORITHM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF A SQUARE

1. Listen & Speak: Warm-up, the proprieties of a square

Work in pairs to find the proprieties **of a square**. You have 5 minutes to deliver your list of proprieties to the teacher.

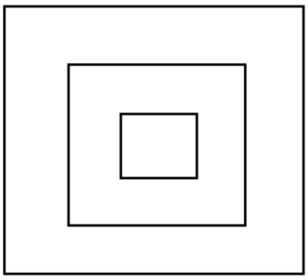
2. Speaking: Tell the difference between different types of quadrilaterals.

a) Reflect individually for 2 minutes on quadrilaterals. What do you understand by the concept? Write your answer on the back of paper.

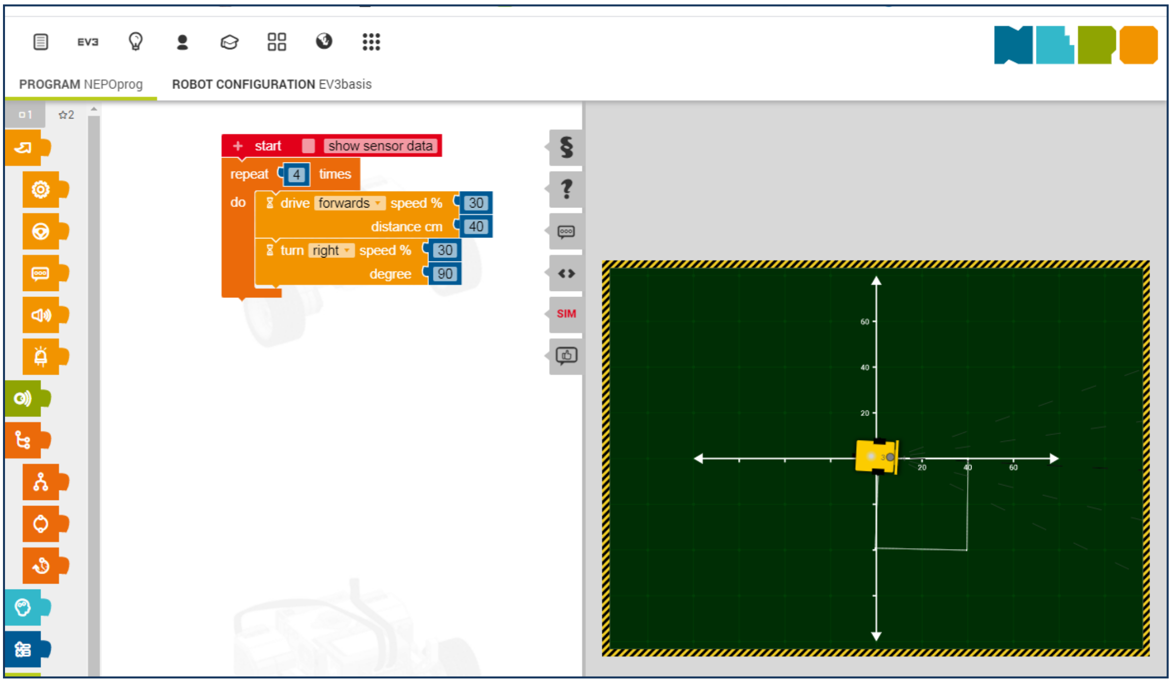
b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of quadrilaterals. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

3. Challenges

- Create 3 squares of different dimension and the same center.



Groups should finish the challenge by the end of the lesson.



5.3 MAKING THE ALGORITHM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF A HEXAGON

4. Listen & Speak: Warm-up, the proprieties of a hexagon

   Work in pairs to find the proprieties of a hexagon. You have 5 minutes to deliver your list of proprieties to the teacher and you can search in dictionaries or internet.

5. Speaking: Tell the proprieties of the hexagon

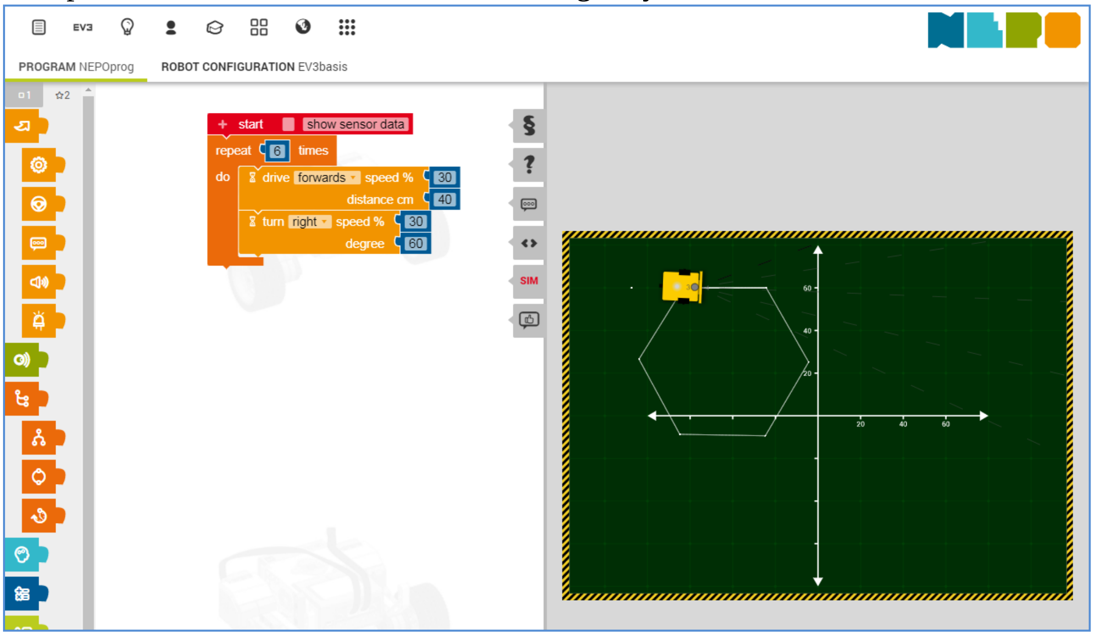
   a) Reflect individually for 2 minutes on hexagons then tell your partner.

   b) Get up and walk around the classroom by asking in English at least 3 classmates to talk about how to construct a hexagon. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

6. Challenges

- Create a circle around de hexagon.
- Create a symmetrical hexagon in the first quadrant of the axis.

Groups should finish all of the above challenges by the end of the lesson.



9. ASSESSMENT

Through the activities of the unit a student (he) can get:

	Outstanding	Very good	Pass	Failure
Curricular	He knows the proprieties of all regular polygons. He is able to recognize them without any problems. He identifies the importance of the use of the regular polygons and their properties in everyday life.	He knows the proprieties of regular polygons. He is able to draw most of them as well as recognize them. He identifies the importance of the use of the regular polygons and their properties in the everyday life.	He knows some of the proprieties of regular polygons. He is able to recognize and draw some of them but finds it difficult to express them in an orderly way. He can complete his tasks with help.	He doesn't recognize the regular polygons. He does not know the properties of regular polygons and can't draw them correctly.
TIC	He can find information easily on the web. He has a high command of computer coding of Lego robot EV3.	He can find information easily on the web. He has command of ICT tools that allows him to make complex process operations with Lego robot EV3.	He can browse the web without difficulty but in certain cases he does not know how to use it correctly. He has command of ICT tools that allows him to make basic process operations with Lego robot EV3	He has a hard time surfing on the web and he does not know how to use it. He does not have sufficient command of the blocks needed to program a robot.

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1. Joiţa Elena, coord.; Ilie Vali, Mogonea Remus ş.a. Profesorul şi alternativa constructivistă a instruirii. Editura Universitară, Craiova, 2007

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8. http://mindstorms.lego.com/en-us/News/ReadMore/Default.aspx?id=351333;

Didactic Unit "The science of symmetry"

Authors: teachers Sorina Cojocaru, Nicoleta Sima and Ana-Iulia Chiva

1. PRESENTATION AND NORMATIVE FRAMEWORK

Robotics can provide a captivating and fun way to teach math, computer science or technology. Using robots, children become creative and train their critical thinking to solve real-world problems.

As a practical field, Robotics has as object of study the methods of design, construction and management of robots. As a school subject, Robotics aims to form skills for multidisciplinary use of knowledge in physics, mathematics and computer science, to develop elementary skills and technical creativity. The achievement of this goal is reached by designing and assembling robot models and developing algorithms and controlling programs with them in simulated work environments. Overall, Robotics as a school subject contributes to the formation and development of the students' personality, the emphasis of training being on the development of technical creativity, logical thinking and algorithmic thinking, on the formation and development of skills for modelling, creating algorithms and programming of algorithms for conducting with cybernetic systems which include mechanical, electromechanical, electronic, optical, computer components.

In the design of the teaching unit the basic curriculum for both Biology and ICT is taken into account for the sake of interdisciplinary activities within a STEM project.

2. CURRICULUM ELEMENTS

2.1 AREA OBJECTIVES

Within the lower secondary education the aim is to reach the following objectives:

1. Integrating knowledge in biology, physics and computer science in order to build robots and using them.
2. Using simulated working environments for working with the robot models.
3. Manual and automatic control of the robot models.
4. Elaborating of driving programs for robot models.
5. Obeying safety, ergonomic and ethical rules in the construction of robot models, in their management and programming.

2.2 THE FORMATIVE VALUE OF ROBOTICS

It consists in:

- developing of fine motor skills and abilities, attention, precision, spatial imagination;
- developing creativity and technical thinking;
- developing skills for building, programming and efficient use of cyber systems;
- developing practical skills for the use of program products intended for driving with robots;
- achieving efficient interaction between humans and cybernetic systems;
- increasing the motivation for studying real life fields;
- orienting students towards performance in achieving the desired goals;
- developing teamwork skills.

2.3 OVERAL LINGUISTIC OBJECTIVES

1. To be able to understand general and specific information in oral messages in various communicative situations, adopting a respectful and cooperative attitude.

2. To be able to speak and interact effectively and adequately in common communicative situations and with some level of autonomy within and outside the classroom.

3. To be able to read and understand texts of an appropriate level taking into account the abilities and interests of the students

4. To be able to extract general and specific information from a written text and use reading seeing it as pleasurable and useful.

4. To be able to write simple texts for different purposes about different issues using appropriate language.

5. To be able to appropriately use the basic structural and functional components of the foreign language in different communicative contexts.

6. To be able to develop autonomy in learning, reflect on the own learning processes and on the functioning of the language and transfer knowledge acquired in other languages to the foreign language.
7. To be able to use learning strategies and all the teaching resources at their disposal, including ICT, to obtain, select and present information both orally and in writing.
8. To be able to see the foreign language as a way to access information and a tool for learning various contents.
9. To be able to value the foreign language and languages in general, as a means of communication and understanding between people of different backgrounds, languages and cultures to avoid any type of discrimination
10. To be able to gain confidence and self-confidence in learning ability and foreign language use.

2.4 VALUES AND ATTITUDES

In the process of studying the Robotics in school, the following values and attitudes will be formed and developed:

1. Expressing a creative way of thinking in structuring and solving work tasks;
2. Awareness of the social, economic and moral impact of using robots;
3. Having a favorable attitude towards science and knowledge;
4. Doing objective evaluation of one's own activities and learning outcomes.

3. CONTENT BLOCKS

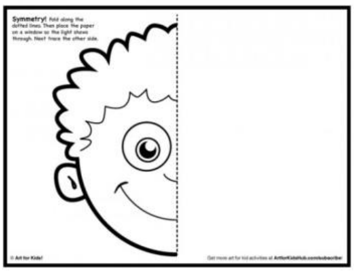
3.1 CURRICULAR CONTENTS

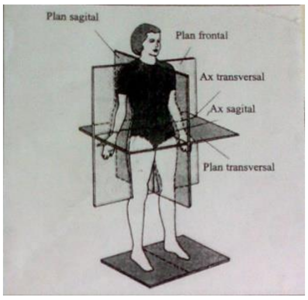
Used in everyday life, the word symmetry denotes ambiguous notions of beauty, harmony and balance. In mathematics and science, symmetry has a different and special meaning. Technically speaking, symmetry is a property of an object.

Almost any object can have symmetry, from palpable things like butterflies, to abstract notions, like geometric figures. Symmetry is the transformation that leaves the body unchanged.

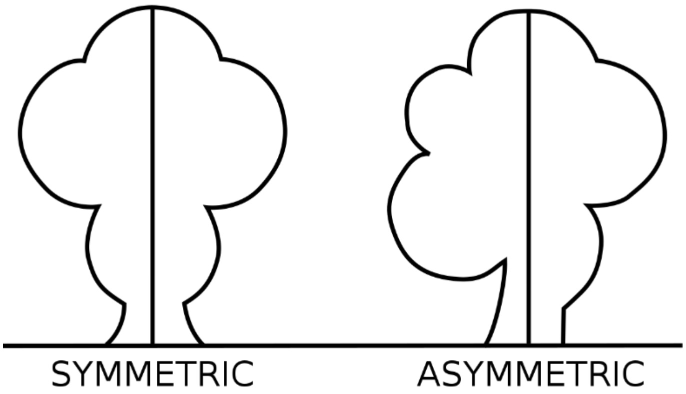
Symmetry in biology

There is a familiar kind of symmetry: the symmetry of the right and left parts of the human body.





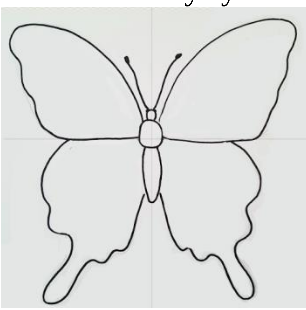
The transformation that gives this symmetry is the reflection towards an imaginary mirror that passes through the middle of the body. Biologists call it bilateral symmetry. As in all symmetries of life, it is only approximate, but it is still an amazing feature of the human body. Many other animals: foxes, sharks, beetle, butterflies have this type of symmetry, and in fact some plants, such as orchids, have it.

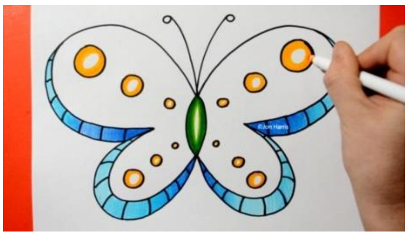


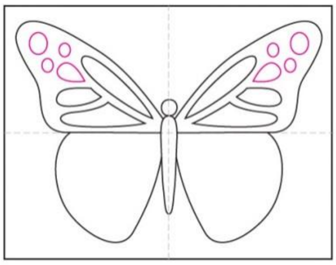
Hedgehogs and starfish have pentaradial or 5-point symmetry, i.e. symmetry with respect to 72° rotations around the centre.

This symmetry is found in plants if we cut an apple horizontally. Some corals have no symmetry, they are completely asymmetrical.

Bilaterally symmetrical animals: foxes, sharks, butterflies and of course humans.

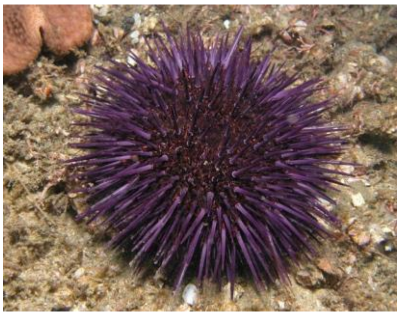






What unites bilaterally symmetrical animals is their body designed for movement. If we wanted to go in one direction, it would help us to have a front end where we can group the sensory organs, eyes, ears and nose. It would help us have our mouths there as long as we run after food or enemies in this way. The head leads to the development of bilateral symmetry.

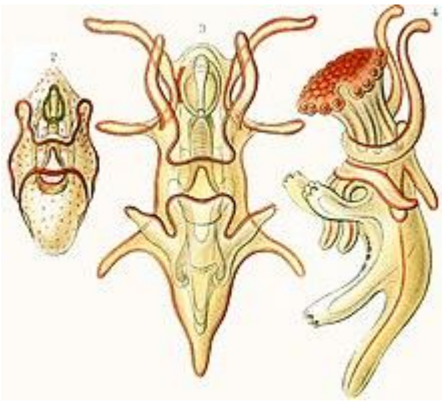
Biologists can use various types of symmetry to figure out what connections there are between animals. For example, the hedgehog and the starfish have 5-point symmetry.



Sea urchins

Starfish

It is worth mentioning the age: the star (adult) and the sea urchin. In the larval stage, they are bilateral, like humans.



Three kinds of bilaterally symmetric starfish larvae (from left to right) scaphularia larva, bipinnaria larva, brachiolaria larva, all of Asterias sp.

For biologists, this proves that we are closer to stars than, say, corals or other animals that do not have bilateral symmetry at any stage of evolution.

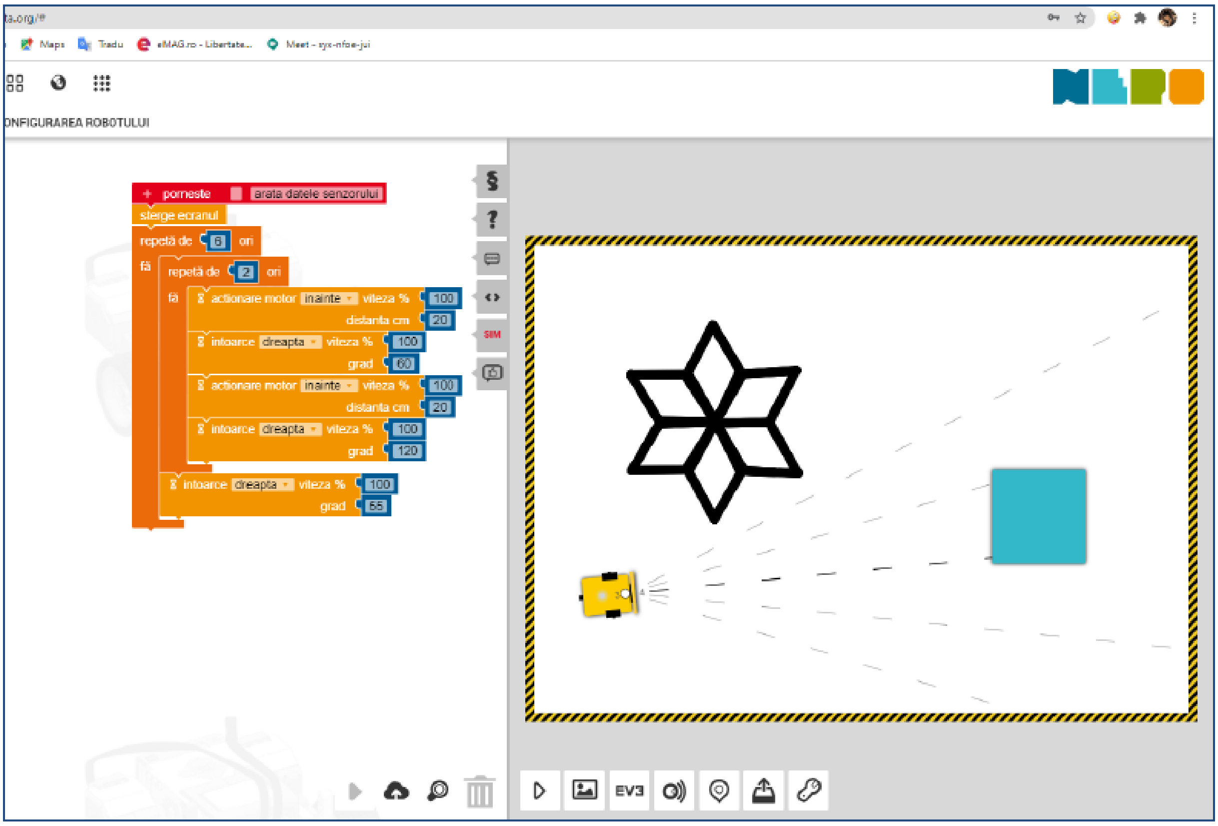
One of the most fascinating and important problems in biology is the reconstruction of the family tree and discovering when and how the branches separated.

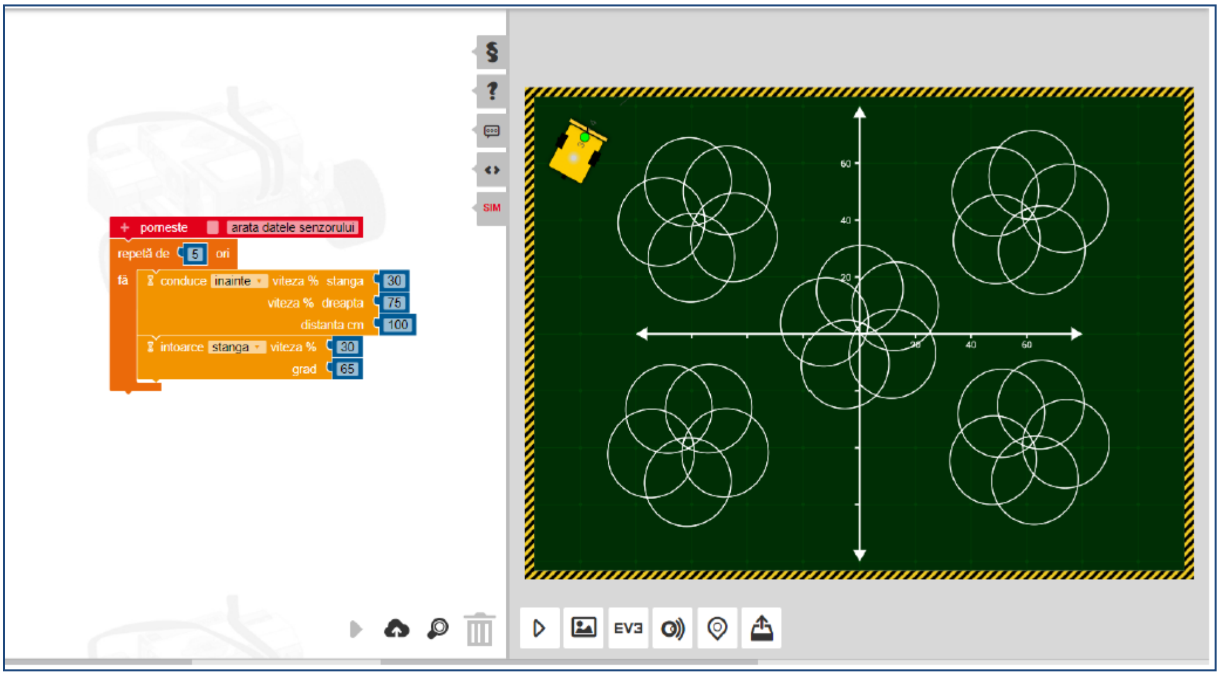
Looking at something as simple as the symmetry of the body can help us dig deeper into the past of evolution and understand where we come from as a species.

3.2 ICT CONTENT

- Using a virtual environment for programming robots with the purpose of teaching, visualization and the use of the values read by the robot's sensors virtual (an ultrasonic sensor for obstacle detection, a color sensor, a pressure sensor, a microphone, an infrared sensor, a gyroscopic sensor, a compass, etc.)
- Use of Open Roberta platform to program Lego robot EV3 to reflect symmetry from nature.
- Searching, selecting and analyzing information.
- Solving interactive exercises inspired from real life activities.
- Basic operations in coding.
- Basic process operations with Lego robot EV3 within the Open Roberta platform.
- Elaborating of the source code for the control of the virtual didactic robot by using and interpretation of data received from its sensors: avoidance of obstacles, maintaining balance, specific reactions to light detection or identifying a marked route etc.

Using NEPO language we are illustrating symmetry in biology by programming the EV 3 to move to a series of symmetrical trajectories:





4. EVALUATION CRITERIA

4.1 CURRICULUM EVALUATION CRITERIA

- Explain the notion of symmetry
- Giving examples of symmetry in the field of biology
- Recognizing symmetry and asymmetry in the creatures around us

The formative evaluation will be done in various ways: observing the student's behaviour, analyzing the results of the student's activity, discussions. Through the current / formative assessment, the teachers inform the student about the level of performance; motivate them to get involved in the training and development of skills.

4.2 ICT EVALUATION CRITERIA

- Being able to program the EV 3 using the NEPO language
- Knowing and using the interface of Open Roberta platform.
- Development of repetitive control algorithms with robot models;
- Graphic programming of repetitive driving algorithms with robot models;
- Introducing code and programmed basic operations (advance, stop, turn) with the Lego robot processor;
- Using information and communication technologies to produce texts and collect and transmit information;

The current / formative evaluation will be done in various ways: observing the student's behaviour, analyzing the results of the student's activity, discussions / conversations, presentations of individual activity projects. Through the current / formative assessment, the teachers inform the student about the level of performance; motivate them to get involved in the training and development of skills.

The summative evaluation is performed at the end of each topic based on the simulation in the Robotics labs of a problem situation from various simulated contexts, which requires the student to demonstrate the competence formed. Teachers will develop tasks that will guide student behaviour to demonstrate the system of knowledge and skills. For this purpose, the performance indicators and descriptors of the process and the product made by the student will be clearly established.

4.3 METHODOLOGIC SUGESTIONS

Starting from the multidisciplinary and applicative characteristics of Robotics, the active-participatory methods are recommended to be used as much as possible in the teaching-learning process. The training and development of the expected competencies is done through activities of design, assembly and elaboration of algorithms and programming of robot models. The most appropriate form of performing such activities is teamwork, with explicit tasks assigned to each member of the team. The time allotted for the presentation of theoretical subjects must be as short as possible.

The theoretical part should be taught and learned while solving practical problems, using the simulator. It is in such contexts that the teacher will facilitate the integration by students of the fundamental knowledge that they have acquired in the process of studying mathematics, physics and computer science. The activities proposed to the students by the teacher will aim to encourage students to think creatively, to analyze situations and to use critical thinking to solve problems in the real world. Teamwork and cooperation will be the basis of any robotics project proposed by the teacher. Students will be taught that it is acceptable to make mistakes, especially if this leads to better solutions. Robotics will be presented as a captivating and fun way to intuitively and thoroughly acquire more knowledge in mathematics, physics, computer science, natural sciences. Recommended teaching-learning activities for the school subject Robotics include: identifying and analyzing problems.

5. ACTIVITIES

5.1 MAKING THE PROGRAM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF AN SYMMETRICAL TREE

1. Listen & Speak: Warm-up, the types of trees

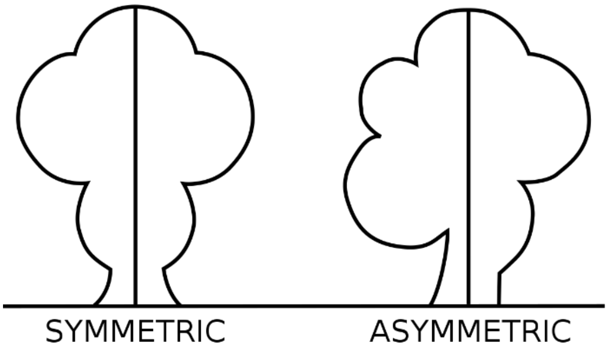
   Work in pairs to find the types of trees. You have 5 minutes to deliver your list of them to the teacher and you can search the Internet.
2. Speaking: Differentiate between symmetrical and asymmetrical trees

   a) Reflect individually for 2 minutes on different types of trees. What do you understand by each of these concepts? Write your answer on the back of paper.

   b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of symmetrical trees. Write previously in the paper these questions you are going to ask them. Then write down examples requested.
3. Challenge

   - Create a tree form trajectory for the EV-3 using Open Roberta

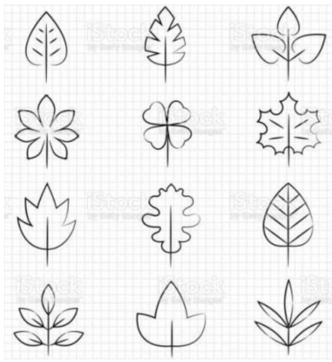
   Groups should complete the challenge by the end of the lesson.



5.2 MAKING AN ALGORITHM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF A LEAVE

1. Listen & Speak: Warm-up, symmetrical leaves

Work in pairs to find symmetrical leaves. You have 5 minutes to deliver your list of symmetrical leaves to the teacher.



2. Speaking: Tell the difference between different types of leaves.

a) Reflect individually for 2 minutes on symmetrical leaves. What do you understand by the concept? Write your answer on the back of paper.

b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of symmetrical leaves. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

3. Challenges

- Create a symmetrical leave trajectory for the EV-3

Groups should finish the challenge by the end of the lesson.

6. ASSESSMENT

Through the activities of the unit a student (he) can get:

	Outstanding	Very good	Pass	Failure
Curricular	He knows the symmetrical and asymmetrical living things. He is able to recognize them without any problems. He identifies the importance of symmetry in everyday life.	He knows the symmetrical and asymmetrical living things. He is able to draw most of them as well as recognize them. He identifies the importance of symmetry in everyday life.	He knows some of the symmetrical and asymmetrical living things. He is able to recognize and draw some of them but finds it difficult to express them in an orderly way. He can complete his tasks with help.	He doesn't recognize the symmetric living things. He does not know the use of symmetry in everyday life.
TIC	He can find information easily on the web. He has a high command of computer coding of Lego robot EV3.	He can find information easily on the web. He has command of ICT tools that allows him to make complex process operations with Lego robot EV3.	He can browse the web without difficulty but in certain cases he does not know how to use it correctly. He has command of ICT tools that allows him to make basic process operations with Lego robot EV3	He has a hard time surfing on the web and he does not know how to use it. He does not have sufficient command of the blocks needed to program a robot.

7. BIBLIOGRAPHY

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8. http://mindstorms.lego.com/en-us/News/ReadMore/Default.aspx?id=351333;

9. https://www.ted.com/talks/colm_kelleher_the_science_of_symmetry/transcript?language=ro#t-293395

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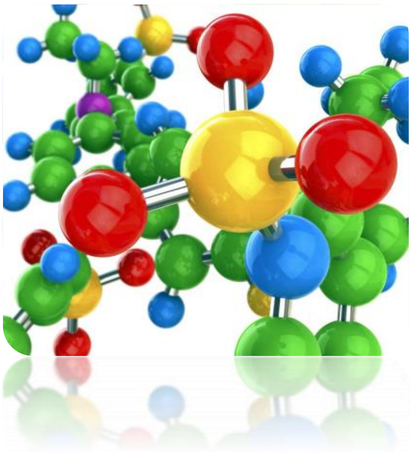
11. https://en.wikipedia.org/wiki/Starfish

12.https://www.google.com/search?q=+phylogenetic+tree+construction&tbm=isch&ved=2ahUKEwiBlcWyiL3wAhUn2uAKHWBZCBYQ2-

Didactic Unit "CHEMICAL BONDS"

Authors: teachers Sorina Cojocaru, Luiza Stroe and Ana-Iulia Chiva



1. PRESENTATION AND NORMATIVE FRAMEWORK

Robotics can provide a captivating and fun way to teach Maths, Chemistry, Computer Science or Technology. Using robots, children become creative and train their critical thinking to solve real-world problems.

As a practical field, Robotics has as object of study the methods of design, construction and management of robots. As a school subject, Robotics aims at developing skills for multidisciplinary use of knowledge in Physics, Mathematics and Computer Science, to develop elementary skills and technical creativity. The achievement of this goal is reached by designing, assembling robot models, developing algorithms, and controlling programs with them in simulated work environments. Overall, Robotics as a school subject contributes to the shaping and developing students' personality, the emphasis of training being on the development of technical creativity, logical and algorithmic thinking, on the formation and development of skills for modelling, creating algorithms and programming of algorithms for conducting with cybernetic systems which include mechanical, electromechanical, electronic, optical, computer components.

In the design of this teaching unit, the basic curriculum for both Chemistry and ICT is taken into account for the sake of interdisciplinary activities within a STEM project.

2. CURRICULUM ELEMENTS

2.1 OBJECTIVES

Within the lower secondary education, the aim is to reach the following objectives:

1. Integrating knowledge of Chemistry, Physics and Computer Science when building robots and using them;
2. Using simulated working environments for working with the robot models;
3. Manual and automatic control of the robot models;
4. Elaborating driving programs for robot models;
5. Obeying safety, ergonomic and ethical rules in the construction of robot models, in their management and programming.

2.2 THE FORMATIVE VALUE OF ROBOTICS

It consists in:

- developing of fine motor skills and abilities, attention, precision, spatial imagination;
- developing creativity and technical thinking;
- developing skills for building, programming and efficient use of cyber systems;
- developing practical skills for the use of program products intended for driving with robots;
- achieving efficient interaction between humans and cybernetic systems;
- increasing the motivation for studying real life fields;
- orienting students towards performance in achieving the desired goals;
- developing teamwork skills.

2.3 OVERAL LINGUISTIC OBJECTIVES

1. To be able to understand general and specific information in oral messages in various communicative situations, adopting a respectful and cooperative attitude;

2. To be able to speak and interact effectively and adequately in common communicative situations and with some level of autonomy within and outside the classroom;

3. To be able to read and understand texts of an appropriate level taking into account the abilities and interests of the students;

4. To be able to extract general and specific information from a written text and use reading seeing it as pleasurable and useful;

4. To be able to write simple texts for different purposes about different issues using appropriate language;

5. To be able to appropriately use the basic structural and functional components of the foreign language in different communicative contexts;

6. To be able to develop autonomy in learning, reflect on the own learning processes and on the functioning of the language and transfer knowledge acquired in other languages to the foreign language;
7. To be able to use learning strategies and all the teaching resources at their disposal, including ICT, to obtain, select and present information both orally and in writing;
8. To be able to see the foreign language as a way to access information and a tool for learning various contents.
9. To be able to value the foreign language and languages in general, as a means of communication and understanding between people of different backgrounds, languages and cultures to avoid any type of discrimination;
10. To be able to gain confidence and self-confidence in learning ability and foreign language use.

2.4 VALUES AND ATTITUDES

In the process of studying the Robotics in school, the following values and attitudes will be formed and developed:
1. Expressing a creative way of thinking in structuring and solving work tasks;
2. Awareness of the social, economic and moral impact of using robots;
3. Having a favourable attitude towards science and knowledge;
4. Doing objective evaluation of one's own activities and learning outcomes.

3. CONTENT BLOCKS

3.1 CURRICULAR CONTENTS

The atom is electrically neutral because the number of protons (positive charges) is equal to the number of electrons (negative charges).

A chemical element is STABLE if the valence layer (last layer occupied by electrons) has a stable configuration of doublet (2 electrons on layer 1) or byte (8 electrons on starting with layer 2). The stable chemical elements are He (doublet) and group VIII A (byte).

All other chemicals are unstable; they can become stable by forming chemical bonds:

- IONIC BONDING is made between metals (gives up electrons) and non-metals (accepts electrons). https://www.youtube.com/watch?v=ygeC3xHuvmg&t=209s
- The COVALENT BOND is made by sharing electrons between identical or different non-metals. https://www.youtube.com/watch?v=Z8oeO1BUyKE

Let's learn with puppies!
https://www.youtube.com/watch?v=_M9khs87xQ8

3.2 ICT CONTENT

• Programming Lego Mindstorms EV3 robots with the purpose of making moves and turns and illustrate the chemical bonding

• Using **Lego Mindstorms EV3 Classroom** to program the robots

• Searching, selecting and analysing information

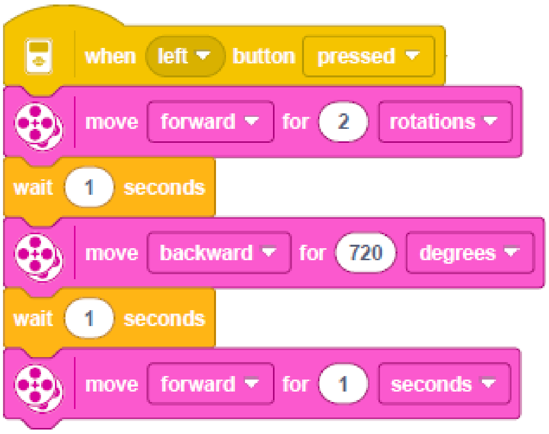
• Solving interactive exercises inspired from real life activities

• Basic operations in coding

• Elaborating the source code for the control of the virtual didactic robot by using and interpreting the data received from its sensors: avoiding obstacles, maintaining balance, specific reactions to light detection or identifying a marked route etc.

By using Lego Mindstorms **EV3 Classroom,** we are illustrating Chemistry bonding by programming the EV 3 to move to a series of trajectories.

- Moving the EV3 straight in three different ways:



- Turns the EV3 in three different ways:

4. EVALUATION CRITERIA

4.1 CURRICULUM EVALUATION CRITERIA

- Explain the notion of chemistry bonding;
- Giving examples of Chemistry bonding;
- Recognizing types of bonding in Chemistry;

The formative evaluation will be done in various ways: observing the student's behaviour, analysing the results of the student's activity, discussions. Through the current / formative assessment, the teachers inform the student about the level of performance; motivate them to get involved in the training and development of skills.

4.2 ICT EVALUATION CRITERIA

- Being able to program the EV 3 using the Lego Mindstorms **EV3 Classroom**;
- Knowing and using the interface of Lego Mindstorms **EV3 Classroom**. ;
- Developing repetitive control algorithms with robot models;
- Graphic programming of repetitive driving algorithms with robot models;
- Introducing code and programmed basic operations (advance, stop, turn) with the Lego robot processor;
- Using information and communication technologies to produce texts and collect and transmit information.

The current / formative evaluation will be done in various ways: observing the student's behaviour, analysing the results of the student's activity, discussions / conversations, presentations of individual activity projects. Through the current / formative assessment, the teachers inform the student about the level of performance; motivate them to get involved in the training and development of skills.

The summative evaluation is performed at the end of each topic based on the solving of a problem situation from various simulated contexts, which requires the student to demonstrate the competence formed. Teachers will develop tasks that will guide student behaviour to demonstrate the system of knowledge and skills. For this purpose, the performance indicators and descriptors of the process and the product made by the student will be clearly established.

4.3 METHODOLOGIC SUGESTIONS

Starting from the multidisciplinary and applicative characteristics of Robotics, the active-participatory methods are recommended to be used as much as possible in the teaching-learning process. The training and development of the expected competencies is done through activities of design, assembly and elaboration of algorithms and programming of robot models. The most appropriate form of performing such activities is teamwork, with explicit tasks assigned to each member of the team. The time allotted for the presentation of theoretical subjects must be as short as possible.

The theoretical part should be taught and learned while solving practical problems. It is in such contexts that the teacher will facilitate the integration by students of the fundamental knowledge that they have acquired in the process of studying Mathematics, Physics, Chemistry and Computer Science. The activities designed for the students by the teacher will aim to encourage students to think creatively, to analyse situations and to use critical thinking to solve problems in the real world. Teamwork and cooperation will be the basis of any robotics project proposed by the teacher. Students learn that it is acceptable to make mistakes, especially if this leads to better solutions. Robotics will be presented as a captivating and fun way to intuitively and thoroughly acquire more knowledge in Mathematics, Physics, Computer Science, Natural Sciences. Recommended teaching-learning activities for the school subject Robotics include: identifying and analysing problems.

5. ACTIVITIES

5.1 MAKING THE PROGRAM FOR MOVING THE LEGO EV3 ROBOT ON THE TRAJECTORY OF CIRCLE

4. Listen & Speak: Warm-up, the types of trees

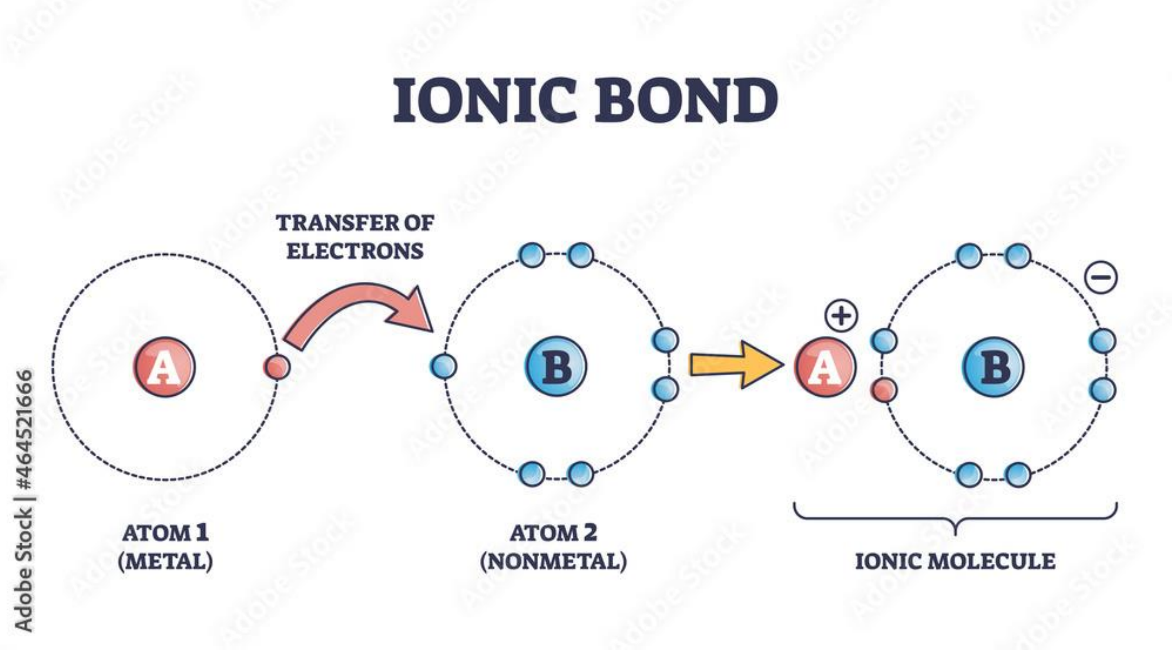
Work in pairs to find the formulas for the area and circumference of a circle; give an informal derivation of the relationship between the circumference and area of a circle. You have 5 minutes to deliver your list of them to the teacher and you can search the Internet.

5. Speaking: Differentiate between circumference and area of a circle
6. Challenge

   - Create a circle form trajectory for the EV-3

   Groups should complete the challenge by the end of the lesson.

5.2 MAKING AN ALGORITHM FOR MOVING THE LEGO EV3 ROBOTs ON THE TRAJECTORY OF Ionic Bonding



1. Listen & Speak: Warm-up, Ionic Bonding

Work in pairs to find ionic bonding. You have 5 minutes to deliver your list.

2. Speaking: Tell the difference between different types of bonding.

a) Reflect individually for 2 minutes on covalent bonding. What do you understand by the concept? Write your answer on the back of paper.

b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of covalent bonding. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

3. Challenges

- Create a trajectory for the EV-3 robots to illustrate de Ionic Bonding.

Groups should finish the challenge by the end of the lesson.

6. ASSESSMENT

Through the activities of the unit a student (he) can get:

	Outstanding	Very good	Pass	Failure
Curricular	He knows the chemical bonds. He is able to recognize them without any problems. He identifies the importance of chemical bonds in everyday life.	He knows the chemical bonds. He is able to draw most of them as well as recognize them. He identifies the importance of chemical bonds in everyday life.	He knows some of the chemical bonds. He is able to recognize and draw some of them but finds it difficult to express them in an orderly way. He can complete his tasks with help.	He doesn't recognize the chemical bonds. He does not know the use of chemical bonds.
TIC	He can find information easily on the web. He has a high command of computer coding of Lego robot EV3.	He can find information easily on the web. He has command of ICT tools that allows him to make complex process operations with Lego robot EV3.	He can browse the web without difficulty but in certain cases he does not know how to use it correctly. He has command of ICT tools that allows him to make basic process operations with Lego robot EV3	He has a hard time surfing on the web and he does not know how to use it. He does not have sufficient command of the blocks needed to program a robot.

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Didactic Unit **Distances and equivalences in Metric System using LEGO EV3**

Author: teacher Miquel Morell

1. PRESENTATION AND NORMATIVE FRAMEWORK

Distances and equivalences in Metric System using LEGO EV3 is the didactic unit proposed, it is formulated from the discipline of mathematics for low-secondary stage. Since it is presented for a Erasmus+ project it is considered appropriate to enclose an appendix relative to the imperial system that allow students to relate Anglo Saxon cultural aspects and different units of measuring. Moreover encourage motivation, through practical concepts for daily life.

In the design of the teaching unit is taken into account the basic curriculum for both mathematics and ICT for being interdisciplinary and framed within a STEM project.

2. CURRICULUM ELEMENTS

2.1 AREA OBJECTIVES

1. To improve the capacity of reflective thinking and incorporate different forms of mathematical expression and reasoning into the language, in scientific processes.

2. To recognize and pose situations that can be formulated in mathematical terms, using different strategies to address them to analyze the results with the most appropriate resources.

3. Use data collection techniques and measurement procedures to quantify and interpret aspects of reality that require analysis of data using different types of numbers and selecting the appropriate calculations according to each situation.

4. Use different technological tools (robots, iPad, calculators, computers, apps) to perform calculations and search for information that contributes to learning.

5. Facing problems of daily life according to mathematical parameters, such as the exploration of alternatives, precision in language, flexibility to modify points of view or persevere in the search for solutions.

6. Develop personal strategies for the analysis of situations, as well as for the identification and resolution of problems, using different resources and instruments and evaluating the suitability of the strategies used in terms of analyzing expected results.

7. Express a positive attitude towards solving problems and show confidence in their own ability to face them successfully.

8. Integrate mathematical knowledge into the set of knowledge that is acquired from different areas so that they can be used creatively, analytically and critically.

9. Value mathematics as an integral part of scientific culture.

2.2 LINGUISTIC OBJECTIVES

Overall Linguistic Objectives
1. To be able to listen and understand general and specific information of oral texts in different communicative situations adopting a respectful and cooperative attitude.
2. To be able to express themselves orally and interact effectively and adequately in common communicative situations and with some level of autonomy within and outside the classroom.
3. To be able to read and understand various texts of an appropriate level taking into account the capacities and interests of the students in order to extract general and specific information and use reading as a source of pleasure and personal enrichment.
4. To be able to write simple texts for different purposes about different issues using appropriate resources of cohesion and coherence.
5. To be able to use with correction the basic phonetic, lexical, structural and functional components of the foreign language in different communicative contexts.
6. To be able to develop autonomy in learning, reflect on the own learning processes and on the functioning of the language and transfer communicative skills and strategies acquired in other languages to the foreign language.
7. To be able to use learning strategies and all the teaching resources at their disposal, including information and communication technologies, to obtain, select and present information orally and in a written way.
8. To be able to appreciate the foreign language as a means of access to information and a tool for learning diverse contents.
9. To be able to value the foreign language and languages in general, as a means of communication and understanding between people of different backgrounds, languages and cultures to avoid any type of discrimination
10. To be able to gain confidence and self-confidence in learning ability and foreign language use, making improvements that lead to success in achieving the set tasks.

3. CONTENT BLOCKS

3.1 CURRICULAR CONTENTS

• Magnitude

✓ Concept of magnitude.

- ✓ Concept of unit of measures.

• Units of length.

- ✓ Multiples and submultiples.
- ✓ Change and equivalence between units.

• Circumference.

- ✓ Radius, centre and diameter.
- ✓ Length of a circumference.
- ✓ Angle, angle of rotation.
- ✓ Arc of circumference

• Use of the different units of measure in the resolution of problems.

3.2 ICT CONTENT

• Use of IPad to program, search, select and analyze information.

• Virtual environments with interactive exercises.

• Basic operations in coding.

• Basic process operations with Lego robot EV3.

3.3 LINGUISTIC CONTENTS

• Listening and comprehension of brief oral messages related with classroom activities: instructions, questions, comments, and dialogues.

• Obtaining of specific information in oral texts about daily life and predictable issues such as numbers, prices, timetables, names or places, presented in different media.

• Use of basic understanding strategies of oral messages: use of verbal and nonverbal context and of previous knowledge about the topic.

• Production of brief oral texts with a logic structure and with an appropriate pronunciation.

• Participation in brief and simple conversations within the classroom and in simulations related with personal experiences and interests.

• Use of reading comprehension basic strategies: identification of the text of a topic with the help of textual and non-textual elements, use of previous knowledge, inference of meanings from the context, comparing words or sentences similar in the languages they know.

• Composition of short texts with basic cohesive elements, with different communicative intentions, taking as a starting point some models and using the most elemental strategies in the writing composition process (planning, contextualization and revision).

• Interest and initiative in the realization of communicative interchanges with foreign languages speakers or learners, using paper as a medium or digital media.

• Recognition and production of basic patterns of rhythm, intonation and accentuation of words and sentences.

4. EVALUATION CRITERIA

4.1 CURRICULUM EVALUATION CRITERIA

• Know the structure of the decimal metric system.

• Identify the magnitudes and differentiate their units of measure.

• Know the units of length, capacity and weight of the D.M.S., and use their equivalences to make unit changes and to manage quantities in a complex and incomplete way.

• Use the units of the metric system to estimate and make direct and indirect measurements, in activities related to everyday life or problem solving.

• Convert the distance to travel in the rotations of the wheels of a vehicle.

• Convert an angle expressed in degrees to rotations of a wheel.

4.2 ICT EVALUATION CRITERIA

• Introduce, code and programme basic operations (advance, stop, turn) with the Lego robot processor.

• Use information and communication technologies to produce texts and collect and transmit information.

• Use information and communication technologies to access, obtain, discriminate and interpret information and as an instrument to learn and share knowledge.

5. LEARNING STANDARDS

Next, the evaluable learning standards worked on throughout the unit are presented:

• Understands the concepts of length as well as their equivalences and measurements.

• Solve problems related to the metric system and use the appropriate units of measure.

• Work in a group and make decisions in a collaborative way before given problems.

Below, there are derivatives of ICT worked on it:

• Fluidly manages the processor by applying the basic editing options.

• Access and use the basic options of the design programs.

• Use the programs to move robot according to instructions.

• Use fluent tools in the network to share information with peers such as Blog, Google Docs and eTwinning.

6. BASIC COMPETENCIES DEVELOPED

1. Verbalize the problems of daily life orally and transcribe the mathematical symbolic language used in the unit contribute to the competence in linguistic communication.

2. The blocks of contents of this unit are oriented to apply those skills and attitudes that allow to reason scientifically, to understand a science argumentation and to express and communicate in the mathematical language, therefore they will allow the acquisition of mathematical competence.

3. The unit's own approach through specific activities with technology develops in students ICT and processing information competence.

4. Given the resolution of problems contributes to learning to learn and also contributes the approach of the proposed activities from the ICT.

5. The cooperative work formulated in the methodology of the unit allows the development of social skills and civic citizenship competence.

6. The problem-solving processes themselves contribute in a special way to promoting autonomy and personal initiative because they are used to plan strategies, assume challenges and contribute to coexisting with uncertainty while controlling the decision-making processes.

7. The presentation of more than one metric system and its historical evolution allow to implement in the students the competence in cultural and artistic expression to better understand the world that surrounds us.

8. Since to know the imperial system the activities have been planned from real life situations, the students develop a competence in the knowledge and interaction with the physical world.

7. METHODOLOGY

During the development we will work on the units of length, distance and movements. Important aspects about the metric system and the difference of its measurements will be known. The characteristics of the system and the differentiation between the units of measurement will be studied, as well as the equivalences.

It will work in a collaborative and participatory way, this means that the source of knowledge will emerge from the interaction between peers and companions through the realization of the different proposed activities. In order for the work to be optimal, the guidelines and guidelines indicated in each one will be followed, through the consultation of web resources and links provided as sources of information.

Computers will be used, showing the proposed resources on the interactive whiteboard, indicating how to carry out the activities of the resource and clarifying doubts about the content treated.

Different exposures and activities will be worked on in different types of groupings.

8. ACTIVITIES

1. Listen & Speak: Warm-up, measuring instruments or devices
Work in pairs to find the maximum number of instruments that are used to measure. What are they measuring? You have 5 minutes to deliver your list of devices to the teacher and you can search in dictionaries or internet.

Measuring instrument	We use it to measure…
1. 2. 3. …	1. 2. 3. …

✂

2. Speaking: Differentiate between magnitude and unit

a) Reflect individually for 2 minutes on magnitude and unit. What do you understand by each of these concepts? Write your answer on the back of paper.

b) Get up and walk around the classroom by asking in English at least 3 classmates to get 3 examples of magnitudes and 3 other examples of units. Write previously in the paper these questions you are going to ask them. Then write down examples requested.

Magnitude	Unit
1. 2. 3.	1. 2. 3.

✂

3. Listen, write and read: Deepen on magnitude

a) Read the following sentence thoughtfully for a few minutes.

Read this paragraph
The **magnitude** is a property that has all bodies, phenomena and relationships between them, which allow to measure them and this measure, represented in quantity, can be expressed by numbers based on a comparison with another body or phenomenon that is taken as a model. The mass, time, length, volume, speed, temperature, among many others, are magnitudes. The magnitude should not be confused with the quantity. The magnitude is the property, the quantity is the quantification of the magnitude, in some system of **units**. For example, time is a magnitude, but 12 hours is a quantity.

b) Watch this video on units of measurement to complete what you have understood reading https://www.youtube.com/watch?v=oAtDAoqdExw

Then discuss a couple of minutes with a partner about unknown vocabulary and relationship between the meaning of the text and this video.

c) Write a similar definition of magnitude using your words and some reflections on video watched.

Definition of magnitude

d) A document with the information must be sent to the teacher by email, and attach your definition in the Classroom Blog if exists, or within a padlet created by teacher beforehand.

4. Read: Newspapers

a) Working in groups of 4, British, American and Spanish newspapers are distributed. Students must locate the largest number of units of measure that appear there and underline these units found with markers.

Reading Newspapers	
 The Daily Telegraph Lunarnauts' perfect landing ARMSTRONG WALKS ON THE MOON 'One small step for Man,' he says Kennedy may face crash summons	1. 2. 3.

b) At the end, the captain of each team will note on a card that will be placed on the wall of the class the units they have found.

Metric system	US customary	BR Imperial system

5. Read, write and speak: Presentation of different metric systems and its cultural origin

a) Students will read the link in this pdf that talks about the historical origins of the metric system and solve the 12 questions that appear there by groups of 3.

http://www.marshall.k12.il.us/data/webcontent/863/file/realname/files/metric-intro1.pdf

b) Every group will deliver a summary of 100 words in which they will synthesize all relevant information.

c) Randomly a couple of groups will perform a 5 minute presentation next session.

d) Teacher will complete this task with suitable personal contributions on the matter.

6. Math skills: Converting units

Practice converting quantities expressed in determined units into other requested units using this online application: https://www.mathfox.com/mathgames/metric-system-game/

7. Work out conversions: Worksheet

1. Express following measures:

a) 9km 6 hm 7m = ____________________ dam

b) 3km 4dam 8dm 7cm = __________________________ dl

c) 9hm 8m 7cm = _________________________________ m

2. Express in extended form:

a) 0,6075 hm =

b) 368,95 dam =

c) 4782 mg =

d) 479,563dam =

e) 0,0156 km=

3. Work out then express in units requested:

a) 6km 2hm 5dam 2cm : 3 = ___________________________ meters

b) (25hm 10dam 16cm) x 20 = _____________________________ meters

8. Speaking, writing: Word problems

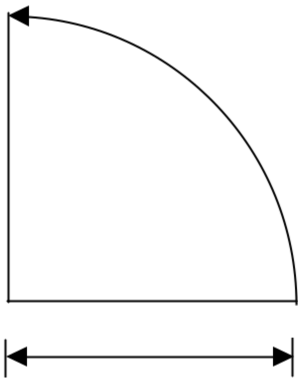
Groups of 4 students are formed and each team prepares in 15 minutes one of the 4 problems. All members analyze and prepare a 5 minute presentation before the whole class.

a) From the measurements of the robot wheel determine the radius, diameter and length of the circumference.

b) Using proportionality, determine the relationship between the distance traveled by the robot and the rotations of the wheel.

9. Speaking, writing: Word problems

Groups of 4 students are formed and each team prepares in 15 minutes one of the 4 problems. All members analyze and prepare a 5 minute presentation before the whole class.



a) From the measurements of the axis distance between the robot wheels determine the arc of circumference that is traveled by turning and keeping one of the wheels locked.

b) Using proportionality, determine the relationship between the distance traveled by the robot (circumference arc) and the rotations of the wheel.

10. Presentation: **making a poster**

Make a poster in digital or artistic format in which the process of converting linear units of length is explained. Prepare a dialogue that includes the purpose of the work, explanation of the procedure and some examples. The presentation will be 5 minutes in front of the whole group.

9. ASSESSMENT

Let's see some examples of proposed rubrics:

Activity 1

Needs improvement-0	**Good-1**
Does not participate in the activity or delivers a list with less than 3 instruments.	Delivers a list with 3 or more measuring instruments.

Activity 2

0- Unsatisfactory	Does not write a reflection or participate interacting with the group

1-Pass	Writes a reflection but do not actively participate with the group as it does not complete the list.
2- Very good	Writes a reflection and actively participate with enthusiasm.

Activity 3

	1-Almost satisfactory	2-Very good	3-Excellent
Delivery & attitude	Little cooperation and passive attitude does not deliver everything	Send the email but do not create an entry in blog or padlet.	Sends email, creates entry in blog and cooperates actively with his/her partner
content	Does not have grasp of information.	Attempts to define purpose and subject. Weak examples	Demonstrates full knowledge with examples

In general, all the activities of the unit can respond to a generic rubric like this:

	Outstanding	**Very good**	**Pass**	**Fair**	**Failure**
Curricular	He learns about the concepts of units of measure and the International metric system. He is able to express them without problems. He identifies the importance of the use of the units of the international metric system, defining the related concepts.	He knows the concepts about the units of measure and the International metric system, and I am able to express the majority as well as recognize them. He identifies the importance of the use of the units of the international metric system, although defining some related concepts.	He knows most of the concepts worked on but I find it difficult to express them in an orderly and comprehensible way, as well as to recognize them. He identifies the importance of using the units of the international metric system, although defining some related concepts with help.	He knows the main concepts worked on but I express them in a disorderly way, although clearly. Identify the importance of using the units of the international metric system and define some concepts with help.	He does not master the concepts nor express them with clarity or order. He does not identify the importance of the use of the units of the international metric system, nor do I define the related concepts.

TIC	Browse without difficulty on the web. He has a very high command of ICT tools and the processes necessary to carry out the activity.	Surf without difficulty on the web but in certain cases he find it difficult to navigate properly. He has a high command of ICT tools and the processes that allow me to carry out the activity.	Browse the web without difficulty but in certain cases he does not know how to use it correctly. His mastery of ICT tools and the processes associated with this activity is medium but sufficient for its realization.	Sailing with some difficulty and ways of use are not very adequate. He has difficulties to correctly use ICT tools and their processes to carry out the activity.	He has a hard time surfing the web and he does not know how to use it. He does not have sufficient command to use ICT tools, nor does he know processes that allows him to work on the activity.

Lesson Plan: Three STEM perspective to introduce programming: Scratch, Lego EV3 & GeoGebra.

1. CONTEXT

Topic: Drawing geometric shapes with Scratch 5 sessions. Carry out directed movements with the Lego EV3 robot for another 5 sessions and specify the mathematical learning required for understanding programming practices in 3 introductory units with GeoGebra.

Number of students: 12

Description: Didactic guide for students aged 12-15. The students are already able to explain the meaning of a problem and an algorithm and they can also explain what a program is. This learning activity will be your first contact with a programming environment. Some students may have already learned the rudiments of programming in elementary school.

2. OBJETIVES

- Solve a mathematical problem with code.
- Introduce students to programming environments.
- Sequence orders logically to solve the activity.
- Solve a problem by using a mobile robot.
- Work as a team, valuing and respecting the ideas and decisions of others and assuming responsibility for individual tasks.
- Know the basic mathematical foundations that allow a more significant learning of the technical knowledge necessary to program.

3. RESULTS

Application: learn the free programming language Scratch; learn to combine blocks from different command palettes.

Comprehension: design geometric shapes in Scratch with the appropriate blocks to calculate the angle of each of them; knowing how to correct, improve and extend the generated program.

Psychomotricity: collaborate and share knowledge and skills with the team. Knowledge: recognize where they can use the "repeat" block.

4. SPACE & MATERIAL RESOURCES

- Ordinary classroom - Tablet to program - Mobile robot. - Programming guides - Circuits with geometric figures on paper

5. ORGANIZATION

Cooperative work groups of 4 students maximum.

6. DIDACTIC ACTIVITIES

SESSION 1: BASIC GEOMETRY

Read Watch Listen // 10 minutes

Presentation of basic elements of geometry and the main polygons.

Read Watch Listen // 20 minutes

Elements: Sides, angles, base, diagonal, height, apothem.

Properties: Sum of interior angles of a polygon.

Types of polygons: regular, non-regular, concave and convex, central angle, radius and diameter.

Investigate // 20 minutes

Polygons: rectangle, triangle, square, parallelogram, pentagon, hexagon.

Geometric shapes: circle.

SESSION 2: WORK ENVIRONMENT & INITIATION

Scratch demo

Read Watch Listen // 10 minutes

The teacher must teach the Scratch programming environment, which will already be installed on all computers in the computer lab. It will introduce new concepts such as block, script, sprites, event-driven programming, and object-oriented programming. He will also make a presentation of the scratch.mit.edu platform.

Read Watch Listen // 2 minutes

The teacher will distribute the cards with the tasks.

Programming with Scratch

Collaborate // 10 minutes

Students will have to write a program in which the sprite draws a square. To do this, they will start by drawing a line. Later, they will work on the turns and angles to find out how to move the sprite to achieve their goal. The blocks they need are on the worksheet.

Investigate // 10 minutes

Students will have to write a program in which the sprite draws a triangle. In this case, they must take into account the degrees of each angle of the triangle.

Investigate // 5 minutes

This time, they will have to think about the changes they want to make in the program to use fewer blocks when they have to draw the square and the triangle. It is about realizing that there is a part of the code that is repeated.

Discuss // 5 minutes

The teacher should talk to his students about the use of the “repeat” block.

Practice // 5 minutes

Students will have to modify their programs with the "repeat" block to reduce the number of blocks used.

Recap and discussion

Debate // 3 minutes // 12 students // with tutor

At the end of the session, the teacher should review what the students have learned and answer any questions they have.

SESSION 3: GETTING TO KNOW LEGO ROBOT EV3

Read Watch Listen // 10 minutes
The teacher will show the programming language of the EV3 robot indicating the main blocks to program. The way to connect the inputs and outputs of the robot and the basic notions to be able to download the program from the tablet to the robot

Practice // 10 minutes
The students will practice sending the robot a program that the teacher shows on the blackboard, and they will execute it to check the correct operation of the robot.

Schedule // 30 minutes // Groups of 3 students // Tutor
The class is distributed in cooperative work groups, then the didactic material is presented (cards with programming instructions to achieve the basic movements of the robot)
1. Advance in a straight line for a certain time
2. Go back in a straight line for a certain amount of time

Students will test the proposed programs and analyse the movement of the robot

Recap and discussion

Debate // 5 minutes // 12 students // with tutor
At the end of the session, the teacher should review what the students have learned and answer any questions they have.

SESSION 4: LEGO ROBOT EV3 LEARN TO TURN

Investigate // 10 minutes

Students will analyse the seconds it takes for the robot to turn 90º and 60º.

They will analyse how the Gyro Sensor works

Schedule // 30 minutes // Groups of 3 students // Tutor

The class is distributed in cooperative work groups, then the didactic material is presented (cards with programming instructions to achieve the basic movements of the robot)

1. Turn a certain angle and stop

2. Use the gyro sensor to turn a certain angle

The robot will have a marker (with ink that can be erased) on its front part and the route will be drawn.

Do you follow the route correctly? If the robot does not complete the activity correctly, the students will make the necessary adjustments to correct the direction and try the task again until they successfully complete the course.

Recap and discussion

Debate // 5 minutes // 12 students // with tutor

At the end of the session, the teacher should review what the students have learned and answer any questions they have.

SESSION 5: GEOMETRY OF THE TRIANGLE WITH GEOGEBRA.

Read Watch Listen // 10 minutes

Analyse the characteristics of triangles: bases, heights, angles.

Practice // 10 minutes

Classification of triangles based on their sides.

Classification of triangles based on their sides.

Investigate // 10 minutes

Presentation of commands and basic sentences in GeoGebra.

Carrying out activities on the construction of different triangles.

Schedule // 30 minutes // Groups of 3 students // Tutor

Recognition of different triangles.

Presentation of work with GeoGebra on classification of triangles.

SESSION 6: LEGO ROBOT EV3 LEARN TO DRAW

Investigate // 5 minutes

Students will analyze the angles in an equilateral triangle.

Create // 10 minutes

On a 1m x 1m piece of paper (with a marker that can be erased) they will draw two equilateral triangles with different side measurements. One with a side of 50 cm and the other with a side of 80 cm

Schedule // 20 minutes

The students will carry out the programs so that the robot follows the path marked by the triangles.

Try // 10 minutes

The robot will have a marker (with ink that can be erased) on its front part and the route will be drawn.

Do you follow the route correctly? If the robot does not complete the activity correctly, the students will make the necessary adjustments to correct the direction and try the task again until they successfully complete the course.

SESSION 7: DESIGNING BASIC SHAPES

SCRATCH DEMO

Read Watch Listen // 5 minutes

The teacher will explain in class the objectives of the activity.

Read Watch Listen // 2 minutes

The teacher will distribute the sheet with the tasks.

PROGRAMMING WITH SCRATCH

Collaborate // 10 minutes

The students will have to draw a house and a boat with squares and triangles. They will use the structures explained in session 1.

Investigate // 5 minutes

The students will have to think about how they can draw the two figures they need to form the objects and in what order they should do it.

Create // 10 minutes

The students will have to program the requested drawing, they will have to take into account how many degrees they have to rotate the sprite when drawing those objects. The least use of blocks to achieve the objective will be valued.

Practice // 8 minutes

Students will review the program to see if there is any way to make the program with fewer instructions.

Discuss // 7 minutes

Students will share the various solutions they have found to the problem posed. The teacher will emphasize that there is no single valid solution. Introduction of the concepts of efficiency and effectiveness.

Recap and discussion

Debate // 3 minutes // 12 students // with tutor

At the end of the session, the teacher should review what the students have learned and answer any questions they have.

SESSION 8: CONSTRUCTION OF POLYGONS WITH GEOGEBRA.

Read Watch Listen // 10 minutes

Analyze the characteristics of input commands: distances, angles.

Practice // 10 minutes

Construct polygons from a given side.

Construct regular polygons inscribed in a circle.

Construct regular polygons of a given number of sides.

Investigate // 40 minutes

Present an original construction from the combination of different commands and more elaborate sentences in GeoGebra.

Carrying out activities on the construction of different polygons.

SESSION 9: LEGO ROBOT EV3 DRAW A FLAT SHAPE WITH A LOOP BLOCK

Read Watch Listen // 5 minutes

The teacher will show the control block (loops) of the EV3 robot programming language whose function is to repeat several instructions to simplify the programs.

Create // 10 minutes

On a 1m x 1m piece of paper (with a marker that can be erased) they will draw the circuit with all the straight and curved lines. If a pattern repeats, the loop block will be applied to simplify and reduce the instructions.

Investigate // 5 minutes

The students will analyze the angles and the time that the robot will use to describe each part of the circuit. The advance and turning time must be calculated in each case.

Schedule // 20 minutes

The students will carry out the programs so that the robot follows the path marked by the circuit.

Try // 10 minutes

The robot will have a marker (which can be erased) on its front part and the route will be drawn.

Do you follow the route correctly? If the robot does not complete the activity correctly, the students will make the necessary adjustments to correct the direction and try the task again until they successfully complete the course.

SESSION 10: CREATING COMPLEX SHAPES FROM BASIC ONES.

Scratch demo

Read Watch Listen // 5 minutes

The teacher will explain in class the objectives of the activity, emphasizing the theme of angles.

Read Watch Listen // 2 minutes

The teacher will distribute the sheet with the tasks.

Programming with Scratch

Collaborate // 8 minutes

The students will have to draw a 10-pointed star formed by the repetition of squares, using the instructions learned in the previous sessions.

Investigate // 5 minutes

The students will have to study how to draw the squares and the degrees that must be rotated before making each one of the drawings so that the final result is similar to a star.

Discuss // 5 minutes

Students should study how to use nested repeat blocks to get a valid solution.

Create // 12 minutes

The students will have to program the star so that it fulfills the requested conditions.

Practice // 5 minutes

Students will review the program to verify that it works correctly.

Discuss // 5 minutes

Students will share the various solutions they have found to the problem posed.

Recap and discussion

Debate // 3 minutes // 12 students // with tutor

At the end of the session, the teacher should review what the students have learned and answer any questions they may have.

SESSION 11: CREATING SHAPES WITH CURVED LINES.

Scratch demo

Read Watch Listen // 5 minutes

The teacher will explain in class the objectives of the activity, emphasizing the concept of circumference and its properties.

Read Watch Listen // 2 minutes

The teacher will distribute the sheet with the tasks.

Programming with Scratch

Collaborate // 10 minutes

Students should draw a circle using the structures studied.

Discuss // 5 minutes

Students will need to study how a circle can be formed using Scratch instructions.

Investigate // 10 minutes

After the students try to figure out how to get the circle, the teacher will help the students to understand how small straight lines and turns can get the requested drawing.

Create // 10 minutes

Students must schedule the circle following the teacher's instructions.

Practice // 5 minutes

Students will review the program to verify that it works correctly and that the desired product is obtained.

Recap and discussion

Debate // 3 minutes // 12 students // with tutor

At the end of the session, the teacher should review what the students have learned and answer any questions they may have.

SESSION 12: CREATING A COMPOUND SHAPE BASED ON BASIC SHAPES STUDIED

Explanation of the final activity

Read Watch Listen // 8 minutes

The teacher will explain to the students what the final activity of the didactic unit consists of. He will show the students different figures that they can try to reproduce as an activity, although he will value the creativity of the students more positively.

Read Watch Listen // 2 minutes

The teacher will distribute the sheet with the tasks.

Programming with Scratch

Collaborate // 5 minutes

Students must make a drawing using the superposition of the figures studied.

Discuss // 5 minutes

Students must decide which figure they want to create.

Investigate // 5 minutes

The students will decide which basic figures are necessary to achieve the final object and the necessary instructions to carry it out.

Create // 10 minutes

Students must program their object according to the study they have done previously.

Practice // 5 minutes

Students will review the program to verify that it works correctly and that the desired product is obtained.

Expose // 7 minutes

Students will show their creations to classmates and explain how they have achieved their goal.

Recap and discussion

Debate // 3 minutes // 12 students // with tutor

At the end of the session, the teacher should review what the students have learned and answer any questions they may have.

SESSION 13: LEGO ROBOT EV3 FOLLOWS LINE USING COLOR SENSOR

Read Watch Listen // 5 minutes

The teacher will show the sensor block of the EV3 robot programming language whose function is to detect objects, color or ultrasound.

It will mainly explain how to program the color sensor

She will also show the control block that allows two different tasks to be carried out depending on the result provided by the sensor.

Create // 10 minutes

On a 1m x 1m paper (erasable marker) they will draw the circuit as complicated as they want with a 3 cm thick black line.

Investigate // 5 minutes

Students will need to calibrate the light sensor so that it can differentiate between the black line and the white line.

Schedule // 20 minutes

The students will carry out the programs so that the robot follows the path marked by the circuit until it reaches the goal.

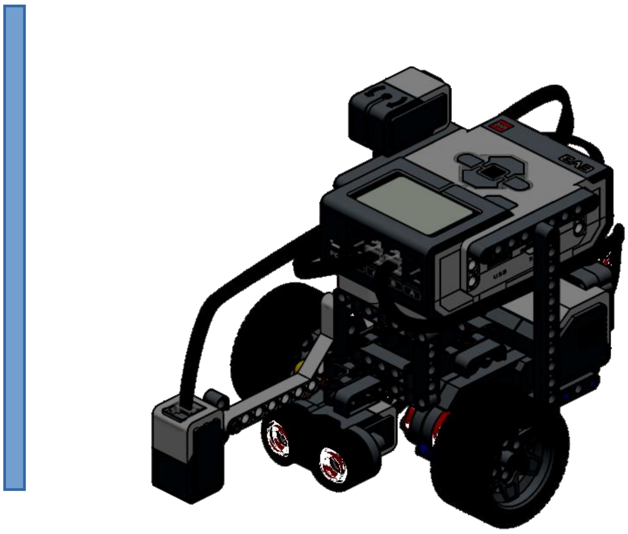
Try // 10 minutes

The program will be executed so that the robot performs the route

Do you follow the route correctly? If the robot does not complete the activity correctly, the students will make the necessary adjustments to correct the direction and try the task again until they successfully complete the course.

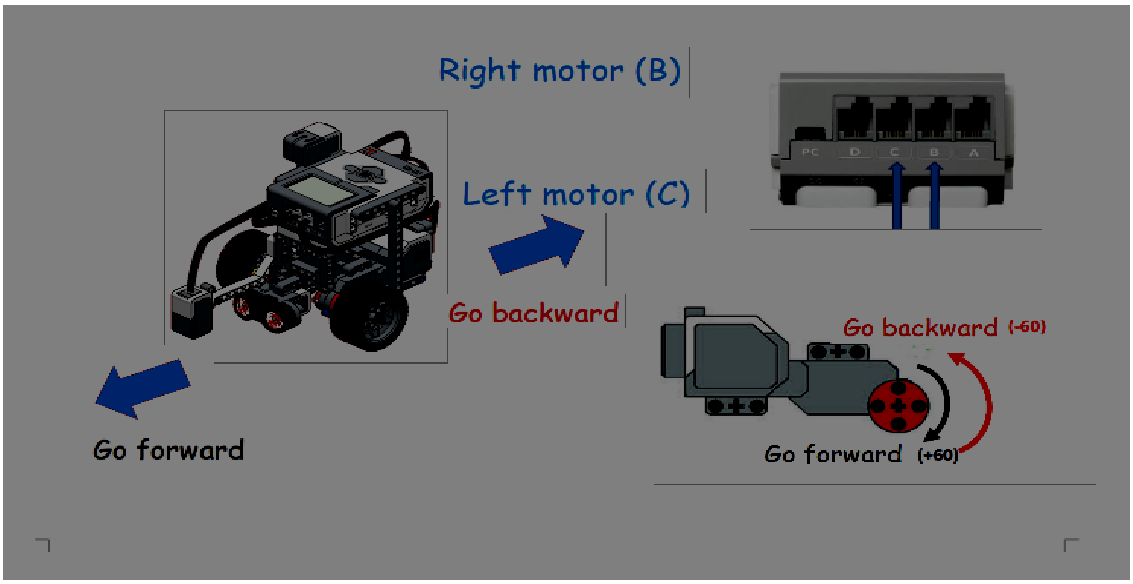
Didactic Unit

Robot workshop EV3 Classroom

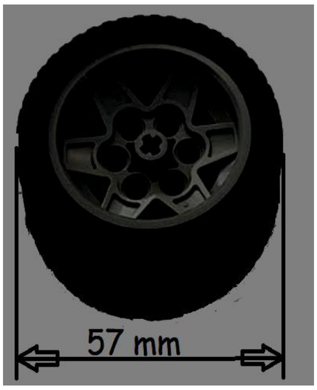


Author: teacher Maria Consuelo Hoyuelos Gayoso

How to Move the Robot

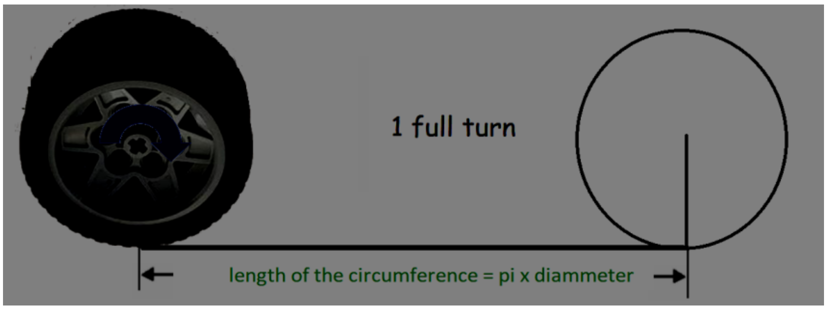


How to calculate rotations



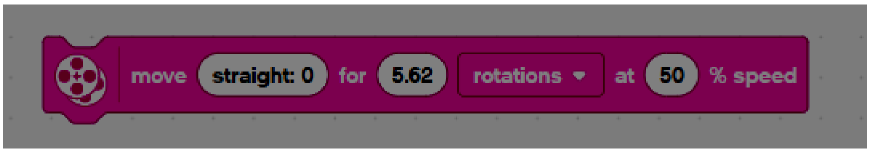
Measure the diameter of the wheel, calculate the length of the circumference and define the number of rotations to advance one meter.

Wheel diameter (circumference), D = 56.64 millimetres (approx. 57 mm)



Radius of the circumference, r = 28.32 millimetres
Circumference longitude, L = $2 \cdot \pi \cdot r = 2 \cdot 3.14 \cdot 28.32$ mm
Circumference longitude (wheel), L = 177.94 millimetres in one rotation.
Distance to move one meter = 1.000 millimetres

To move 1.000 millimetres, the wheel needs to rotate 5.62 times

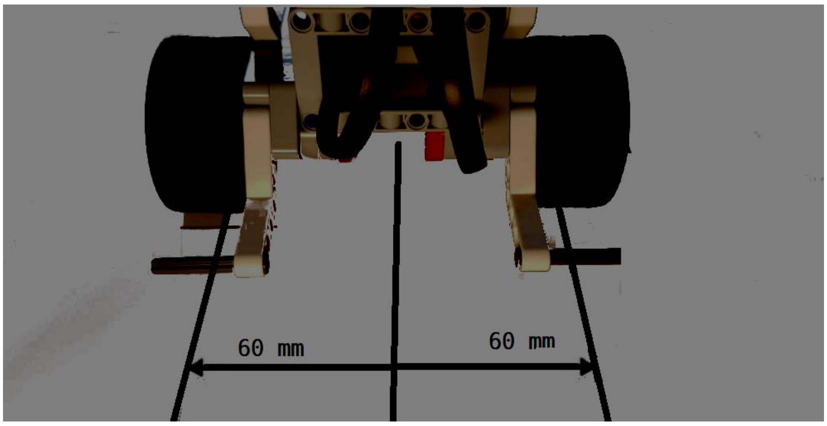


(5.62 times 177.94 millimetres as to travel 1000 millimetres →1 metre)

How to Move the Base

Left wheel movement:

Half of 2 · π · r = (2 · 3.1416 · 60 mm) divided by 2 is the same as 188.50 millimeters, that is the distance to travel



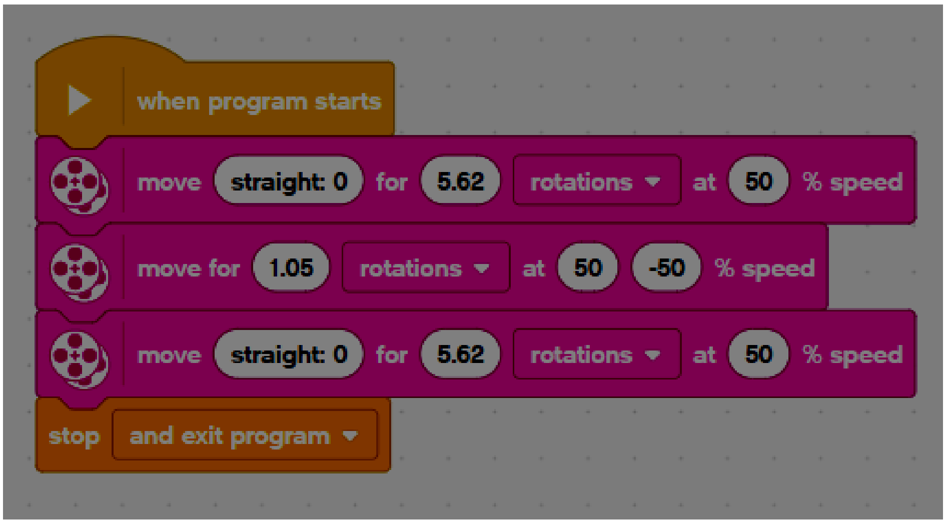
Left wheel rotation:

The longitude of the distance travelled divided by the longitude of the wheel 188.50 mm divided by 177.94 is equal to 1.05 rotations

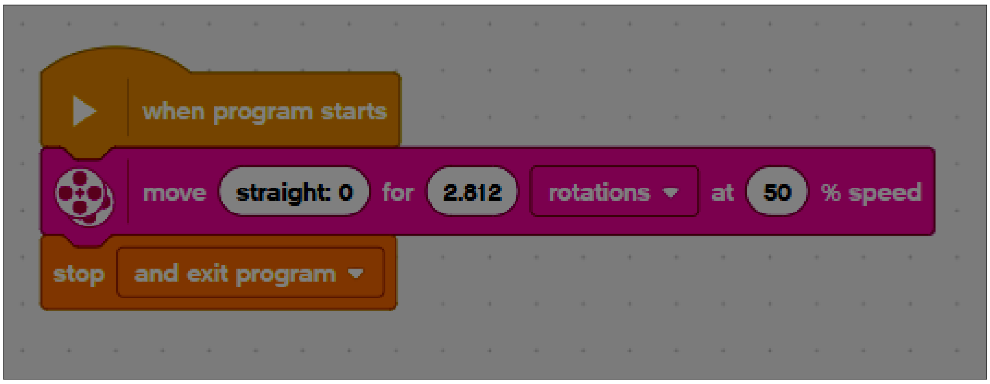
The same calculations for the right wheel, given that the same power is being applied to both wheels, but the opposite sign.

Challenge Turn Around

Move the vehicle forward and then back to the starting point.



Go forward 50 cm



This number must be adjusted. There are variations due to friction and mechanical adjustments of the robot.

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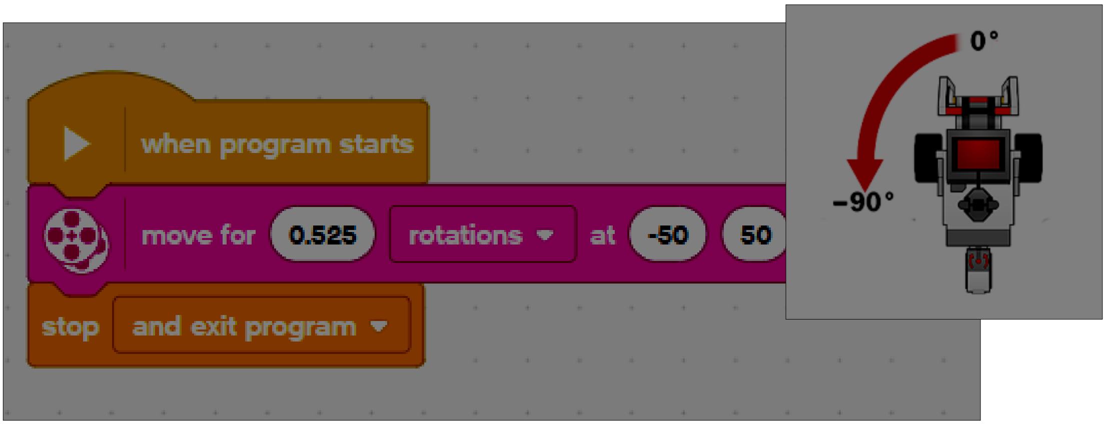
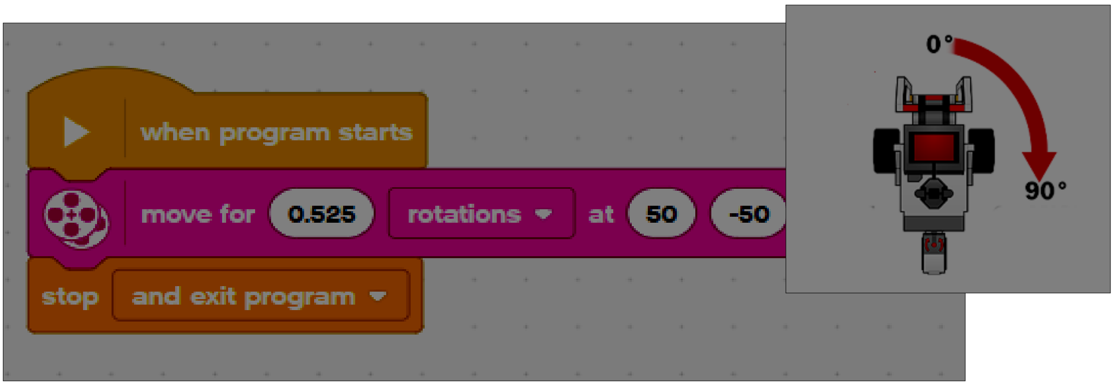
Turn 90 degrees to the left



This number must be adjusted. There are variations due to friction and mechanical adjustments of the robot.

Turn 90 degrees to the right



This number must be adjusted. There are variations due to friction and mechanical adjustments of the robot.

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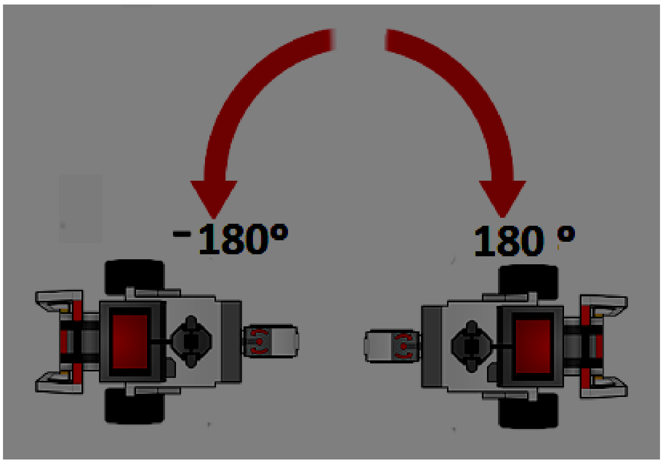
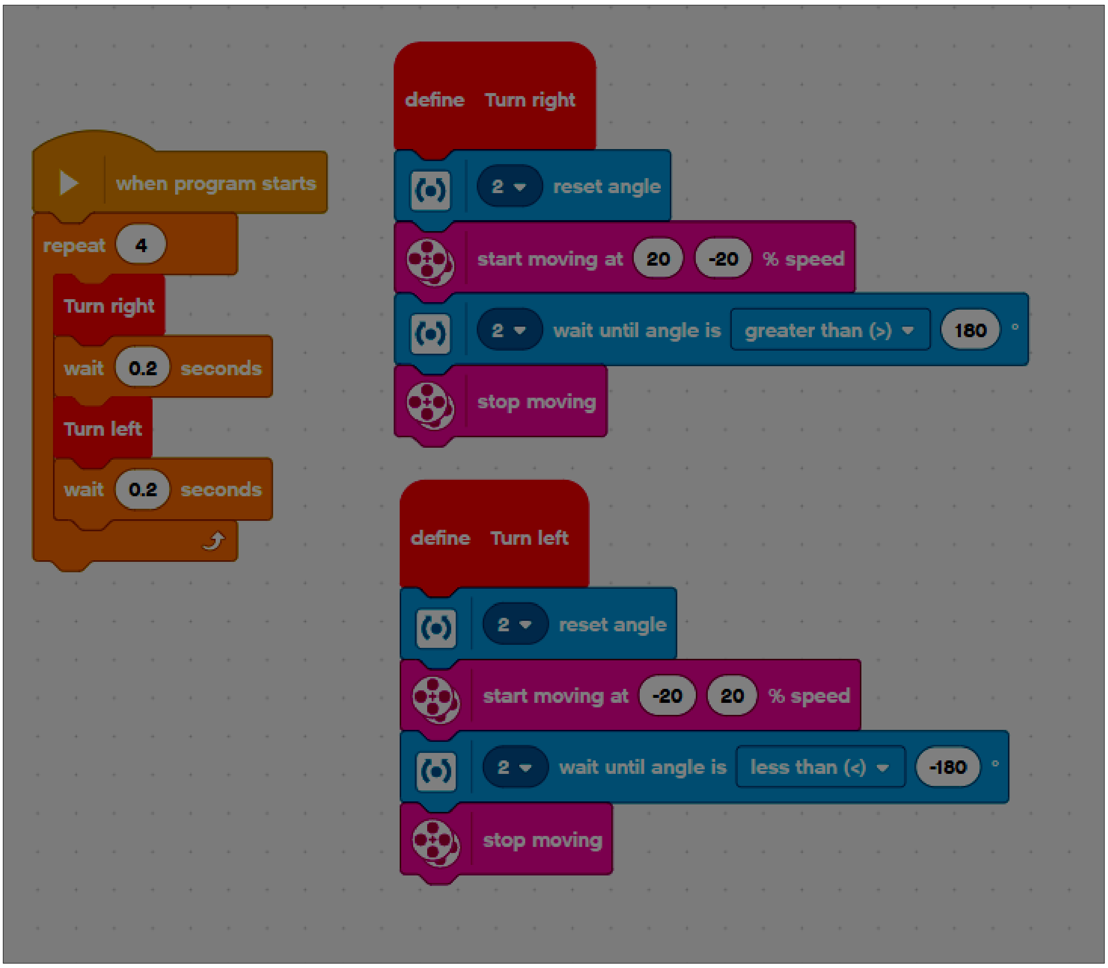
Turn 180 degrees and -180





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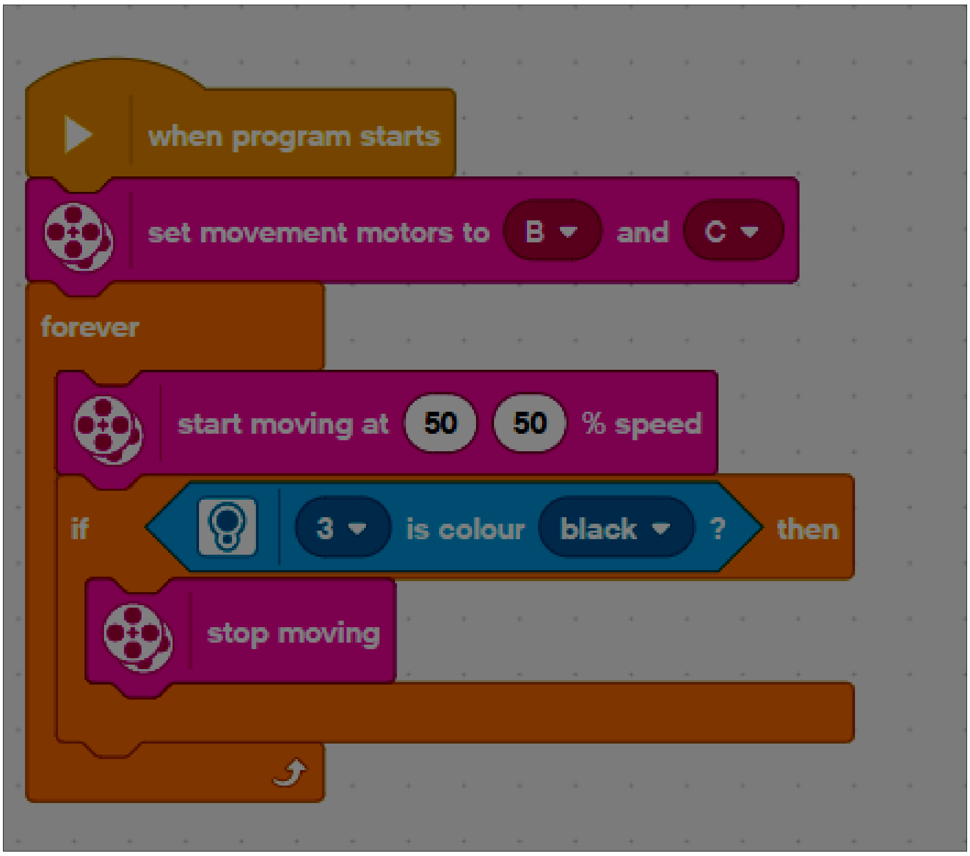
Black line detector



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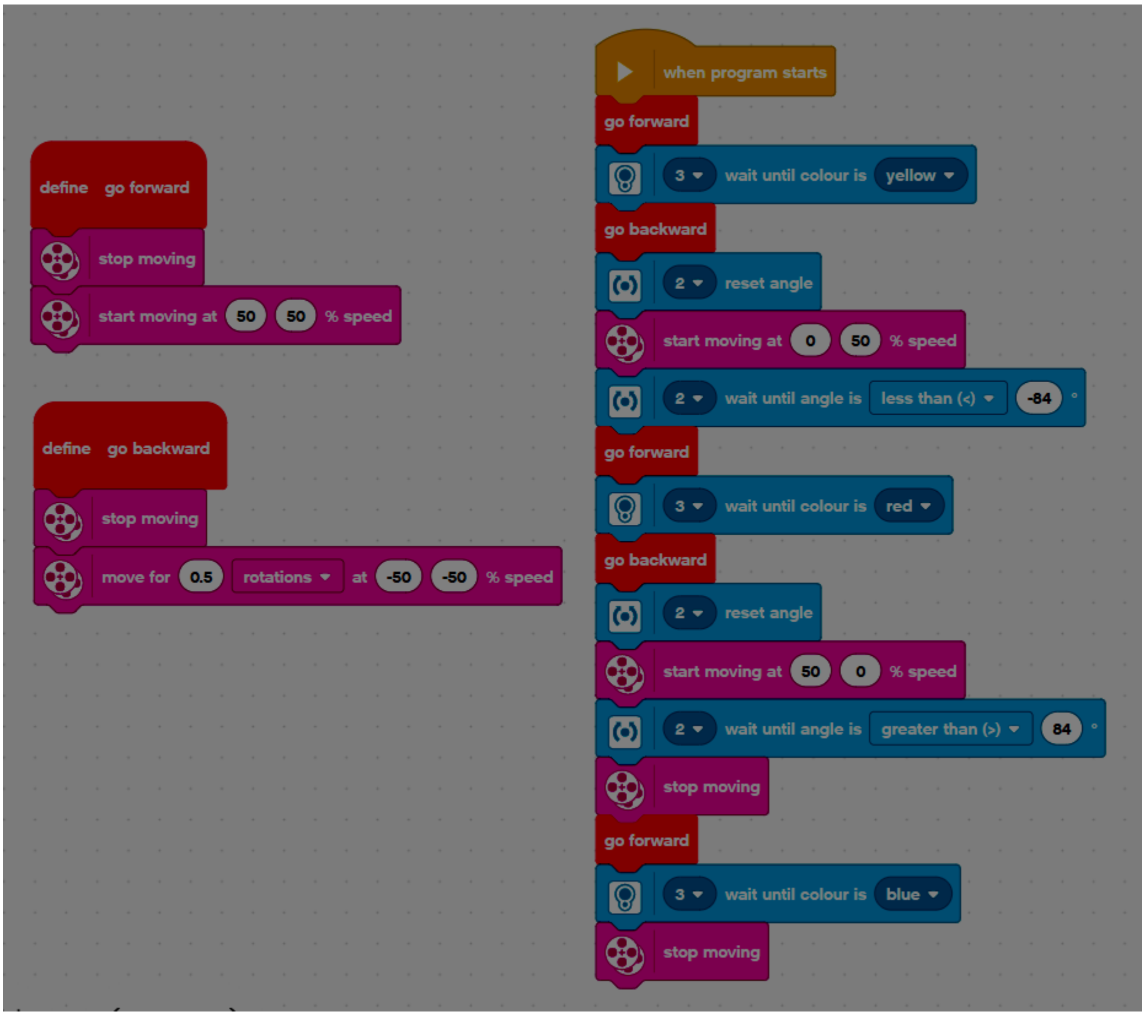
Colour Maze



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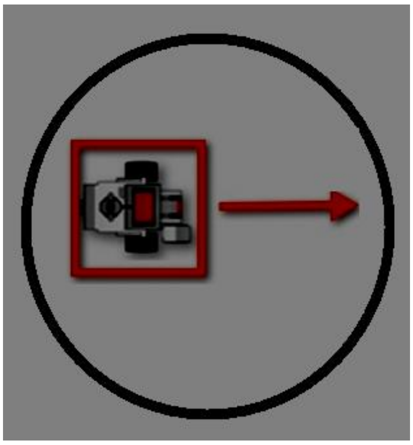
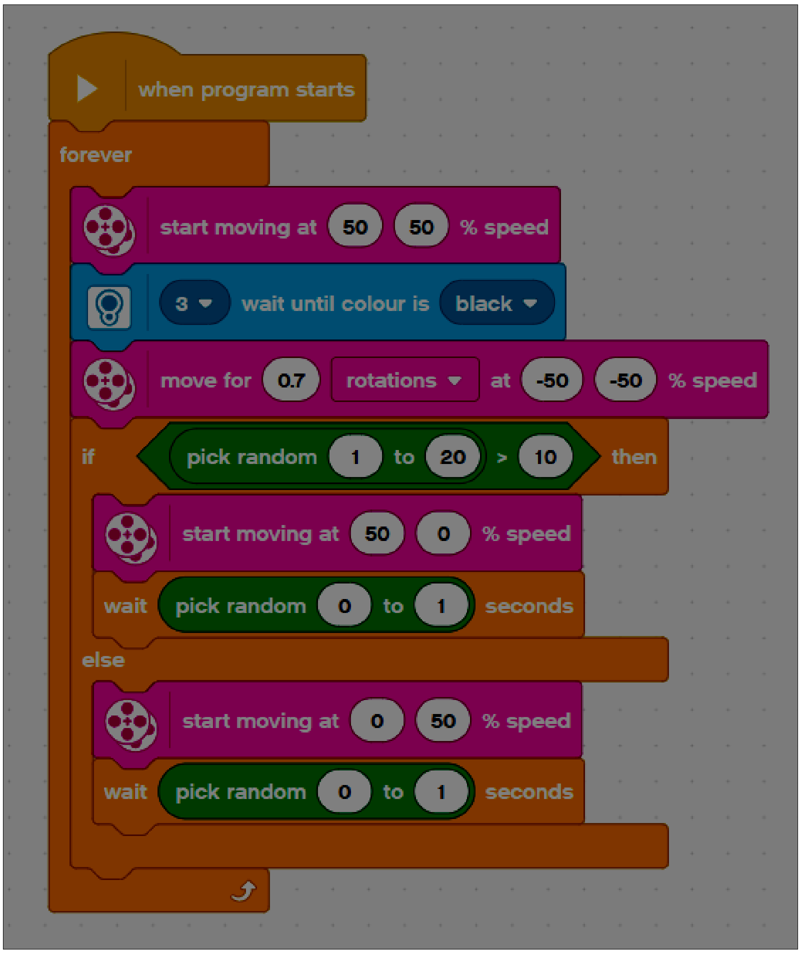
Don’t Leave the Circle





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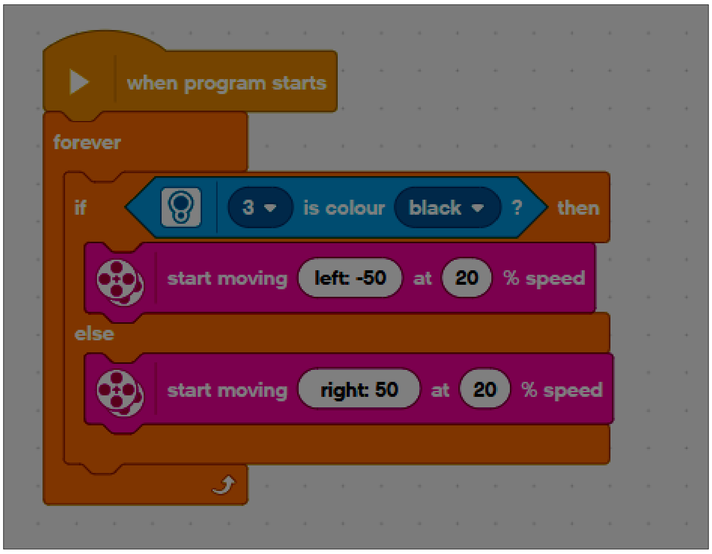
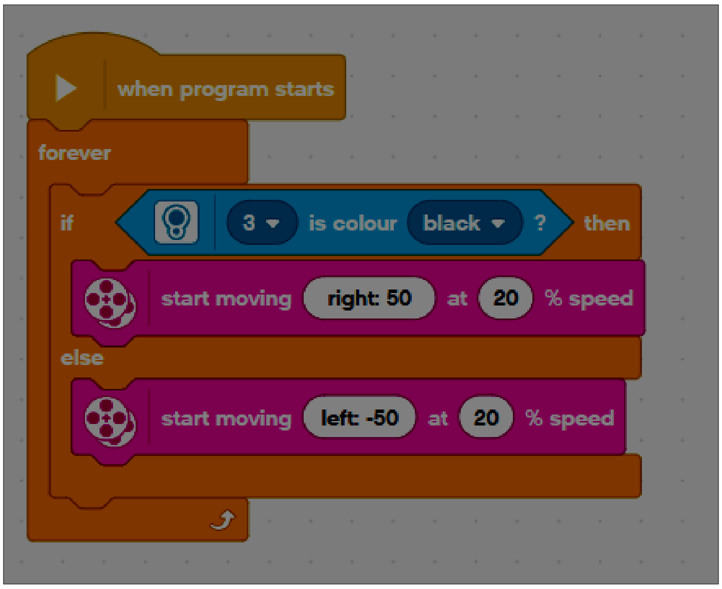
Line follower left edge



Robot follows the left edge.

Line follower right edge



Robot follows the right edge.

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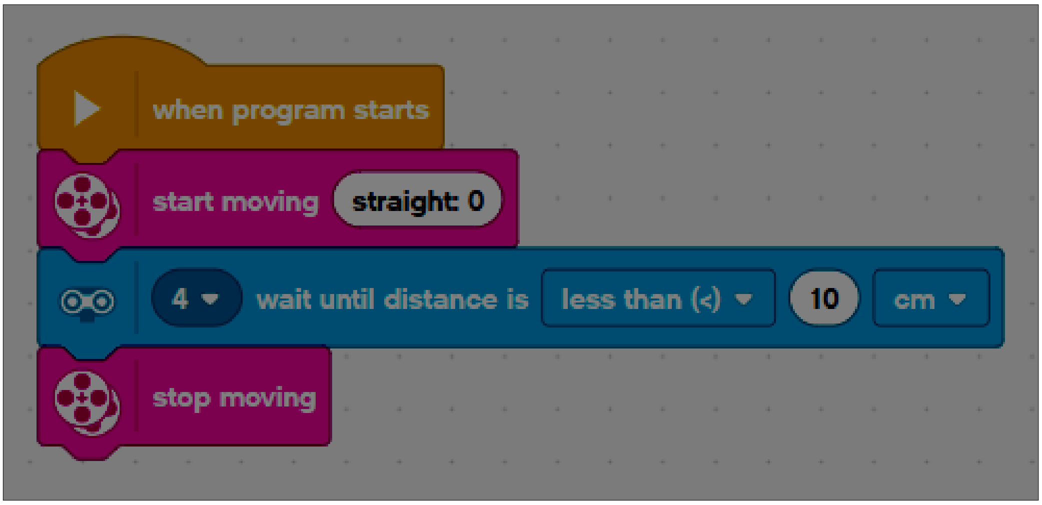
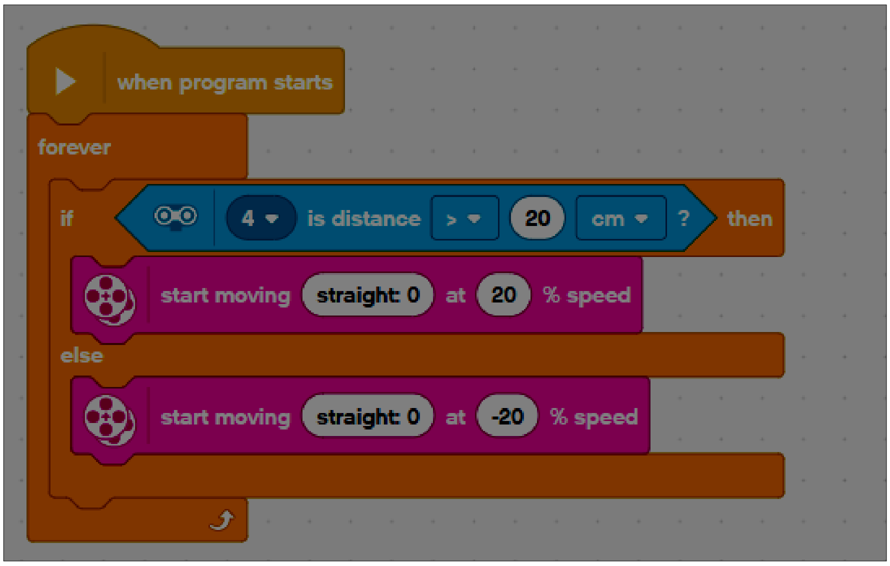
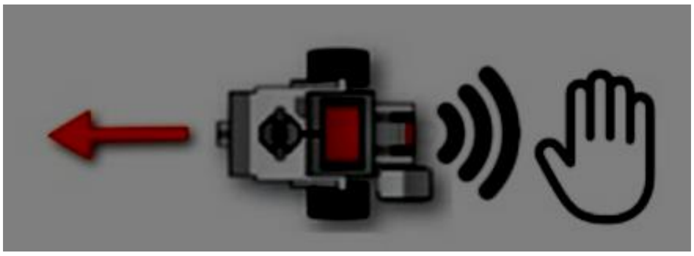
Obstacle detector at 10 cm



Run-Away Car





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Credits

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Sources:
https://agora.xtec.cat/zermoianesllevant/steam/
canaltic,com
www.lego.com

Created by María Consuelo Hoyuelos Gayoso

Didactic Unit: Measurement Error of a turn in EV3 Lego robot.

This lesson plan is intended to use the Lego EV3 robot as an instrument in which to calculate the absolute and relative errors that occur when turning through a certain angle by fixing one of the two wheels. In this way, both concepts are going to be introduced from an empirical point of view in which students experiment with these ideas by taking samples of real data. To carry out this lesson, the interdisciplinary work of technology teachers and physics or mathematics teachers within the STEM field is considered appropriate.

OBJECTIVES

Students will be able
- know the magnitudes involved in the rotation of the robot
- define the accepted value of a measurement,
- relate the angle of rotation to the length of the wheel,
- take multiple measurements accurately,
- know the resulting theoretical value,
- define the absolute measurement error,
- define the relative measurement error,
- calculate relative measurement error values.

PREREQUISITES

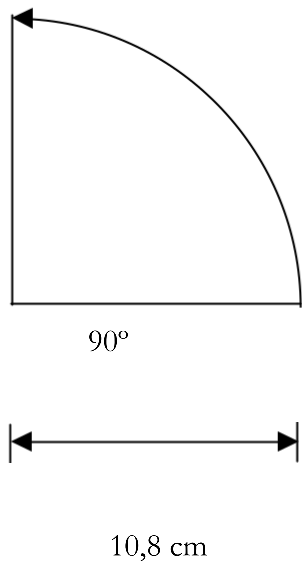
Students should already be familiar with meanings of the terms quantity, unit, and value.

DIDACTIC GUIDELINES

Absolute Error
For absolute error, measuring tools, rulers, tape measures, protractor and smartphone app for measuring angles are needed. Please note that absolute and relative errors account for that degree of imprecision to provide the most accurate measurement possible. We consider the absolute error of a measurement to be the difference between a measured value and a true value of a quantity.
Relative error
Note that relative error is an amount of error that depends on the absolute error of a measurement tool and the measured value. Also, as the absolute error increases, the relative error also increases. If, for example, two different measurement tools are used to measure the same object, the absolute error would be different for each tool, since each tool has a different degree of precision. All these checks will be carried out based on the work of the different groups and the 4 robots that are used for the development of the activity.

PROCEDURE

First, students see how to convert an angle expressed in degrees to rotations of a wheel. Starting from the idea that the length of a circumference is $2 \cdot \pi \cdot r$ or what is the same $\pi \cdot D$.
Keep in mind that when the robot turns, for example to the left, it keeps the wheel on that part fixed and only turns to the right and vice versa when it turns to the right, it keeps the one on the right fixed and turns the one on the right. on the left. left. So, if we assume that it is going to turn 90º to the left, the following drawing on the next page shows the angle that the robot would make:



In the supposed case in which the robot made a complete turn, that is, 360º, it would travel $\pi \cdot D$, which is the entire length of the circumference. As in our case it has a diameter of 21.6 cm, that is, 10.8 * 2, therefore the result will be 67.85856 cm. A proportionality criterion is applied to calculate the length of the arc that the robot would have to travel, expressed in cm, turning the desired degrees. We call degrees_to_turn the degrees we want to turn on each occasion and X_arc the distance we are going to obtain, thus:

360º =======> 67,85856 cm

degrees_to_turn =======> x_arc cm

Therefore: **X_Arc = (67,85856 * Degrees_to_turn) / 360**

Once we have the centimetres that we must travel with a wheel, we only have to translate those centimetres into rotations, for which we apply the previous formula:

17,59226 cm =======> 1 rotation

x_arc cm =======> x_rotations_turn rotations

Thus, x_rotations_turn rotations = x_arc / 17,59226

In the Lego software to be able to rotate both clockwise (to the right) and counterclockwise (to the left), we have to use the Motor block, not the Move block, and select the suitable Motor. As the robot is currently configured, if we want to turn left, we will only have to move the motor of the right wheel, so we will select Motor A and indicate the corresponding number of turns. While if we want to turn to the right we will have to move the wheel on the left and therefore we will select Motor C.

LESSON TIMING

Two sessions are recommended for data collection and an expository session to explain the theoretical concepts. Finally, you can do a test or test for a total of 4 sessions.

Photon™

Primary school | Grade: 8

Author: teacher Tomasz Suleja

9. Tornados and tropical cyclones in North America

Geography

Time: Robots: Interfaces:

Reference to the core curriculum

Primary school

Geography core curriculum credits: XVI.3

Session goals

Pupil:

- explains the meaning of the terms: tornado, tropical cyclone
- discusses the mechanism of tornado formation and shows the effects of tornadoes
- discusses the causes of tropical cyclones, their structure, lists the main areas where cyclones occur and describes the effects of cyclones.
- co-operates in a group

Materials

- tablets (1 for each group)
- interactive board

- a mat showing a schematic drawing of a tropical cyclone
- envelopes with information on the structure of a cyclone (attachment no. 1)
- a multimedia presentation prepared by the teacher

Attachments

Zalacznik_1_Zawartosc_kopert.pdf

Working methods	Forms of work
	- group
- brainstorming	
- discussion	
- chat	

Course of classes

Introductory part:

- The teacher displays to the students a presentation he/she has prepared with the topic and objectives of the lesson. He/she explains what will be covered in today's lesson and divides the class into groups. He/she explains the working principles.

Main part:

- The teacher, on the basis of a presentation (or textbook), explains what a tornado is, how it forms and what its effects are. In groups, the pupils search the textbook for information on where in North America the most tornadoes occur. They answer the teacher's questions.

- The teacher explains what a tropical cyclone is based on a presentation (or textbook).

- Pupils programme the robot to move around the board with a drawing of a tropical cyclone from envelope number 1 to envelope number 4. To do this, they use a ruler to measure the distance between each envelope.

- Moving around the board, the robot discovers the conditions under which a tropical cyclone is formed and its structure, which are contained in individual envelopes.

- The pupils travel deep into the tropical cyclone with the robot and have the opportunity to find out what weather conditions are like in the different parts of the tropical cyclone. Each envelope contains a message (Attachment 1) which the pupil programming the robot should read aloud. Pupils have a discussion with the teacher on the information they have discovered, discussing the structure of a tropical cyclone.

- Based on the textbook/presentation, the teacher explains what tropical cyclones are called in different parts of the world and discusses the effects of their occurrence.

Concluding part:

- As a conclusion to the lesson, in their groups the pupils take a test on tablets, available at the link

- The group which wins first place can be rewarded with a mark, a plus or verbal praise (according to the rules introduced by the teacher).

Interesting facts / Opening questions

Have you heard the names of the tropical cyclones that have occurred around the world?

Primary school | Grade: 7

Author: teacher Tomasz Suleja

10. Big city development and changes in suburban zones.

Geography

Time: Robots: Interfaces:

Reference to the core curriculum

Primary school 5-8

Geography core curriculum credits: XI.3

Session goals

Pupil:

- lists the reasons for migration from cities to the suburban area
- explains what suburbanisation is
- cooperates in a group
- identifies relationships between the development of large cities and changes in population and demographic structure of the population on the example of the metropolitan areas of Warsaw and Kraków
- identifies the relationship between the development of large cities and changes in suburban areas

Materials

- tablets (1 for each group)

- interactive board
- interactive monitor
- a mat showing a layout of a city and a suburban area (in my case with very clearly marked boundaries ofthe city centre, suburban area and countryside)
- questions for the envelopes (Annex 1)
- multimedia presentation prepared by the teacher
- physical map of Poland (wall)

Attachments

Zalacznik_1_Pytania_do_kopert.pdf

Working methods	**Forms of work**
	- group
- chat	
- discussion	

Course of classes

Preparation for classes:

There should be a space in the middle of the classroom to lay out a mat depicting a city, a suburban zone and a village. I madesuch a mat myself from coloured sheets of paper. In the middle (yellow zone) is the city, around it the suburban zone (closer) – pink and the farthest one is the countryside, which in time may also become a suburban zone (green). The two arrows should also be highlighted:

- one – leading from the vcountryside to the city,
- the other – leading from the city to the closer suburban area. (the photo shows my mat with the envelopes spread out)

Introductory part:

2. The teacher displays to the students a presentation he/she has prepared with the topic and objectives of the lesson. He/she explains what will

be covered in today's lesson and divides the class into groups. He/she explains the working principles.

2. The teacher asks the pupils what a city is and what a suburban zone is and displays the key (opening) question Is a suburban zone being created or developing in my municipality/district? Pupils write down a question in order to

to be able to answer this question after the lesson. The teacher can also write or hang the question on the board so that it remains visible to the pupils throughout the lesson.

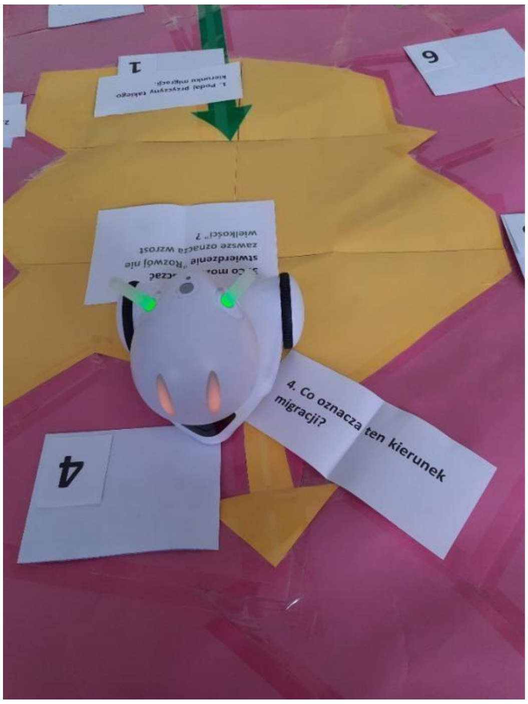
Main part:

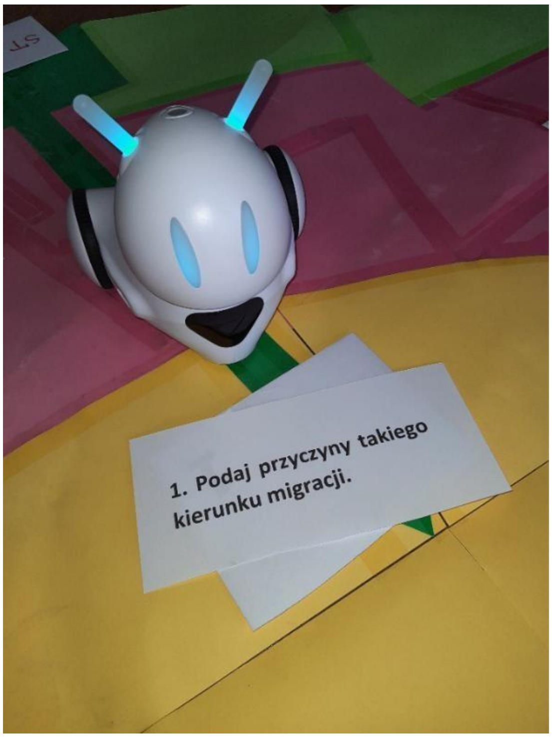
2. The teacher, on the basis of the presentation, explains oncemore whata city is and asks a selected pupil to indicate on the map the 5 largest cities in Poland.

2. The teacher explains what changes have taken place in the metropolitan areas of Warsaw and Krakow. In groups, the pupils analyse the maps displayed on the presentation and draw their own conclusions.

3. The teacher asks a volunteer pupil to go up to the board and program the robot to drivefrom the place marked with the word START to envelope 1 along the arrow. The pupil then opens the envelope and reads the question. Together, the groups think about the reasons behind the direction of migration (i.e. rural-urban). After brainstorming, the teacher displays the answer on the presentation. The next pupil-volunteer further programs the robot to reach the envelope with question number 2. The principle is the same untilthe Photon robot has covered the route from envelope1 to envelope 9. In each envelope there is a question to be answered by the pupils (you can guide the pupils to the answer in case of more difficult questions). Pupils can use a ruler to measure the distance between envelopes. The teacher rewards each correct answer with a point, writing this on the board with the group and task numbers.

The game consists of the robot’s moves throughout the suburban zone and the city. Together with the robot, pupils explore the changes that have taken place in migration patterns, population changes and land use changes. Note in particular that when the robot moves from the green zone to the pink zone and then to the yellow zone (i.e. from the countryside to the city) – it shows us the former direction of migration, while at the end the robot „escapes” from the yellow zone to the pink zone – which means a now noticeable change in the direction of migration (from the city to the countryside, i.e. to the suburban zone). It is important at this point to explain the causes.





4. At the end of the robot's journey (stop 9), pupils solve a rebus (found in question 9 in Attachment 1) and explain the password. They can use tablets and look up the answers on the internet or in a textbook.

Concluding part:

2. Pupils answer the concluding questions (only examples are given below): What have I enjoyedthe most about the lesson?

What have I learnt today?

What had I already known and what was new? What would I like to review again?

2. The teacher summarises the groups' work and evaluates them. The group,, which scores the most points can be rewarded with a mark, a plus or verbal praise (according to the rules introduced by the teacher).

Interesting facts / opening questions

Is a suburban zone being created or developed in my municipality/ district?

Designing a hockey game

Author: teacher Renata Wotalska

Primary School: grade VI

Students learn about the advanced features of the Scratch application. They will create their own game in which ‘ghosts’ will play hockey. The ability to create relationships between the ghosts in the game will be introduced.

GENERAL OBJECTIVES

- formulating instructions in the form of an algorithm for solving problems in different subjects (I.2a, I.3),
- building a script according to the given assumptions and checking its correctness (II.1a, II.2).

SPECIFIC OBJECTIVES

The student:

- uses the Scratch program,
- creates his own ghosts and builds scripts specifying their behavior on stage,
- changes the appearance and name of the character,
- changes the background of the scene,
- builds scripts specifying the movement of the character,
- uses a block that causes repetition of actions,
- duplicates a ghost – modifies the script copied with the ghost,
- specifies launch of the commands in the scripts when the specified event occurs.

TEACHING METHODS

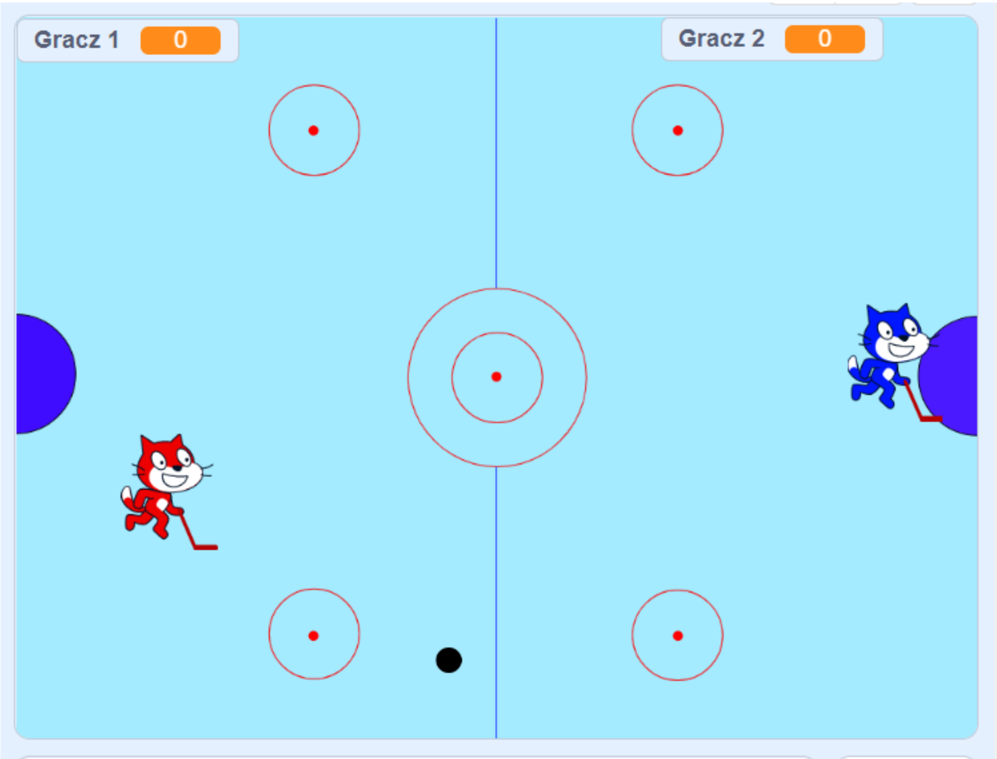
- multimedia presentation,
- working with a work sheet,
- working on a computer,
- discussion.

MATERIALS

- computer set with Internet access or Scratch software installed,
- interactive whiteboard,
- instructional videos,
- worksheets.

Activities during the classes

Stating the subject and making students aware of the purpose of the lesson. The teacher discusses what the project is that the students will do in class. He/she explains how to work in class. Students start the Scratch program. The teacher outlines the effect to be achieved by the students when the subject is completed. (Presentation of the finished game)



Links to use:

https://scratch.mit.edu/educators/

http://scratch.psp26.opole.pl/pdf/podrecznik.pdf

Procedure

1. Creating a pitch and starting programming.

The student designs a hockey pitch. He/she selects a programme (e.g. Paint) in which he/she uses the basic figures and functions of the programme to produce the effect as in the picture:

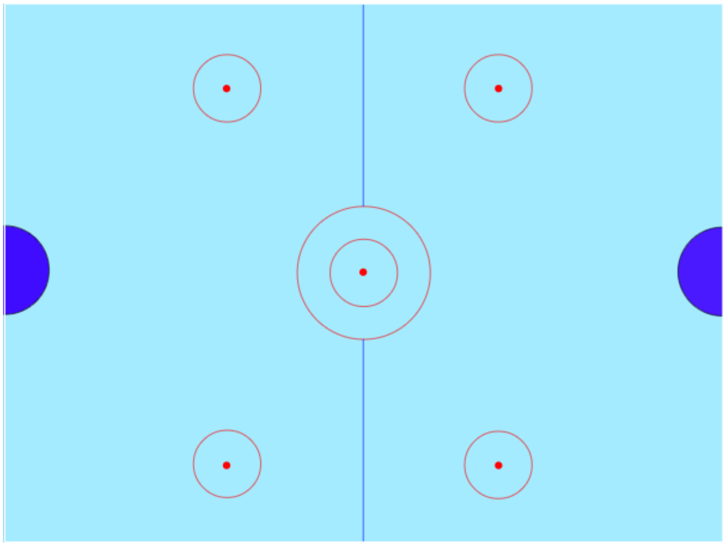


Fig.1. *Example of a hockey pitch design*

Once the image is saved and loaded in Scratch, the student begins to write the program code.

We start the script with the green flag block. In the script, the student incorporates the background change that they have previously designed.

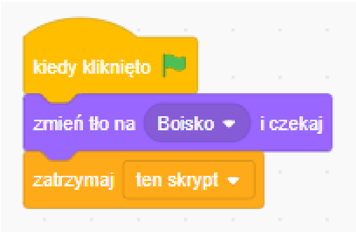


Fig.2. *Script displaying the correct board*

2. Programming the ghosts.

This chapter is dedicated to programming the characters we will play hockey with. To do this, we go to the costume selection and choose a character (e.g. Cat-b) from the suggested ones. Every hockey player has a stick to play with, so try drawing it in Scratch so the cat is fully ready to play! An important aspect is to duplicate our cat and reflect it symmetrically to render realistic movement of the character. Use any colour to fill in and name your player to distinguish them in the programme. Done! Now we move on to programming.

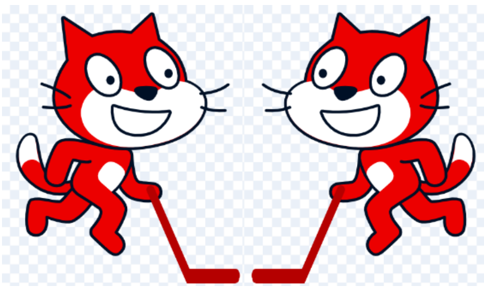


Fig.3*. Example design of two ghosts*

By default we start with a green flag and in this case the student must determine the original position of the ghost. This position will differ depending on the board he/she designed . The ghost should start the game from its own goal. To do this, the student must choose the coordinates correctly. Once the coordinates have been chosen, it is time to program the keys you will use to move the ghost. The ghost should not go outside the pitch area, use the correct function that prevents it from doing so. The student should note that when moving left (button „a”) and right (button „d”) the cat should change its vertical orientation.

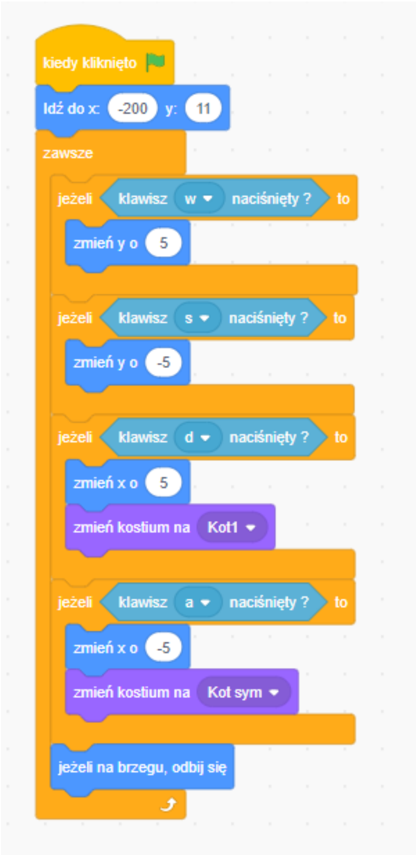


Fig.4. *A script that defines the starting coordinate of a ghost, along with the ability to move and a function that does not allow it to leave the pitch area. Additionally, a costume change is used to change the orientation of the ghost*

In the same way, the student programs a second soul so that they can compete against each other in a game on the pitch. The student should note that the same keys cannot be used to move the other player. To do this, he/she should change the keys to (e.g. arrows).

3. Designing a hockey puck

The student can draw the hockey puck as a black large point. Once this is done he/she should move on to programming. The student creates two variables for player 1 and player 2 that will be used to show the result of the match. The next step is to place the puck in the centre of the pitch and set the direction of the puck to a random number from -180 to 180 degrees.

Fig.5. *A script with variables, specifying the initial position of the puck*

In the loop, we will set the puck movement by a specific number of steps. The student should also make such settings so that the puck does not go outside the pitch. An important point is to program the orientation of the puck in the loop when it is touched by player 1 or player 2.

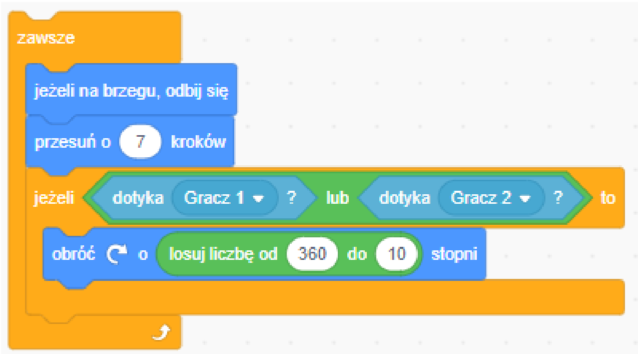


Fig.6. *A script with a function that does not to allow the puck to leave the pitch, including the position of the puck after being touched by player 1 or player 2*

The student sets up goal colours and assigns them to variables so that when the puck touches the goal, points are scored for a particular player.

Attention! The colours of the goals must differ by at least 5 points of brightness so that no points are awarded to both characters.

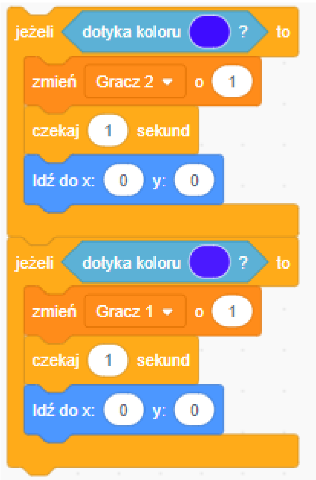


Fig.7. *A script to calculate points for scoring a goal.*

The student sets up a message as to which player has won the match. The player who scores the first 5 goals is the winner. It is important to use the function to stop the script so that when the game restarts, the program resets itself.

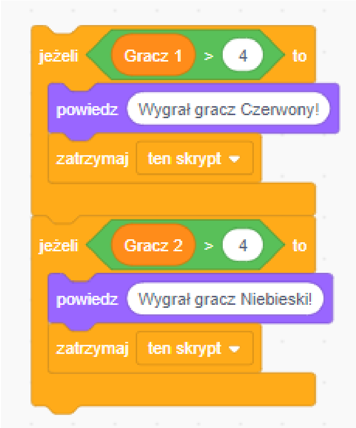
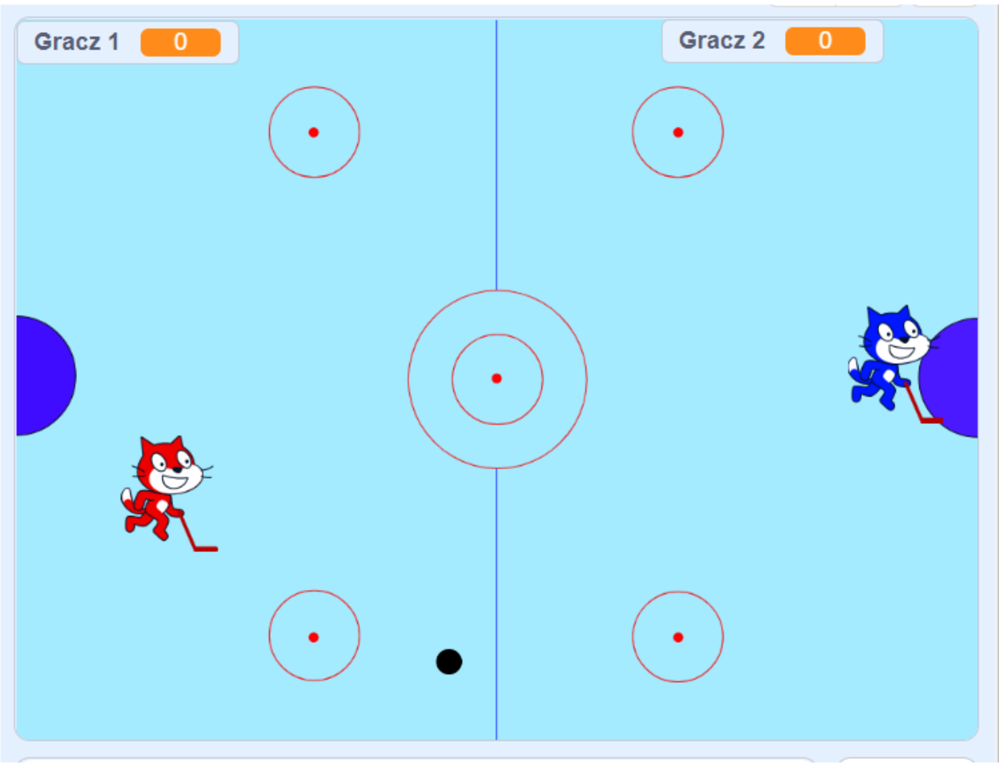


Fig.8. *The script determining which player wins the match*

after a specific result has been obtained.



Didactic Unit: “In town” – revision

Author: teacher Urszula Kaniewska

Primary School: grade IV
Subject: ICT, English

Students use Lego Mindstorms EV3 robot called "Arm H25" in ICT lessons (90 min) and English lesson (45 min.). Firstly, they build the robot according to the instruction and program it (ICT lessons). During the English lesson, they use the robot to grab the chosen question (a 3 point question or a 5 point question) – the 3 point question is on the left side of the robot and the 5 point question is on the right side of the robot. The questions are put into Kinder Surprise Capsules. The students will answer the questions connected with the topic of town (Unit 8 “In town: “Link”, grade 4, Oxford University Press). The questions may be based on any other topics.

Footage from the English class in the link below:
https://youtube.com/shorts/O61jCRuK2dw

COURSE OBJECTIVES

The student:

- understands the technical language and builds the "Arm H25 Robot" according to the language given in the instruction,
- programs a robot that collects an object from a designated position and moves that object to another designated location,
- is able to answer questions related to the material recently covered in the lessons of English.

TEACHING METHODS

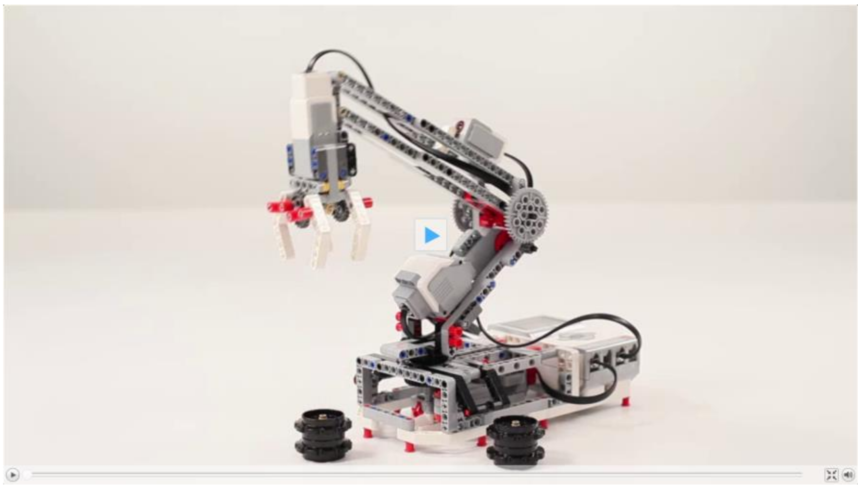
- multimedia presentation,
- working with a worksheet,
- working on a computer,
- discussion,
- working in groups.

MATERIALS

- computer set with Internet access or The EV3 Classroom App software installed,
- Lego Mindstorms Education EV3 Core Set,
- interactive whiteboard,
- instructional videos,
- worksheets,
- “Link” book published by Oxford University Press – student’s book for 4 graders
- Kinder Surprise Capsules .

ACTIVITIES DURING THE ICT CLASSES

Stating the subject and making students aware of the purpose of the lesson. The teacher discusses what the project is that the students will do in class. He/she explains how to work in class. Students start the EV3 Classroom App. The teacher outlines the effect to be achieved by the students when the subject is completed. (Presentation of the finished task)



Links to use:

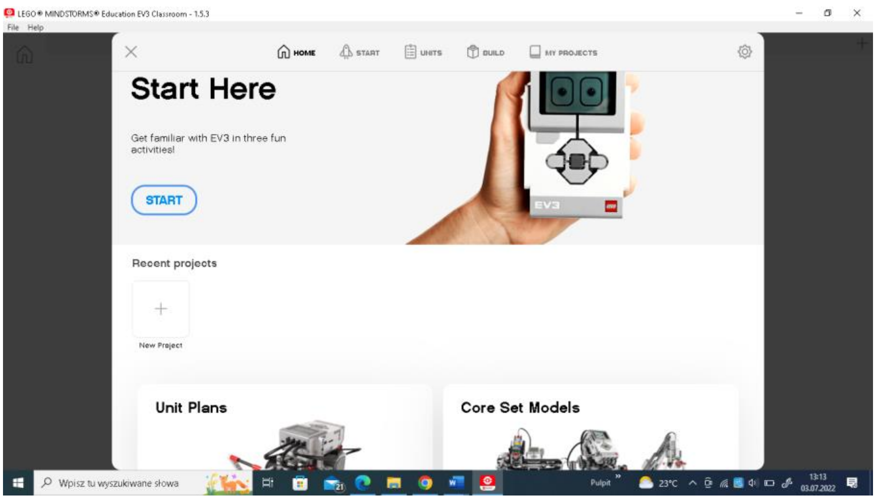
https://education.lego.com/pl-pl/downloads/mindstorms-ev3/software

https://www.youtube.com/watch?v=9cTo20lmyKY

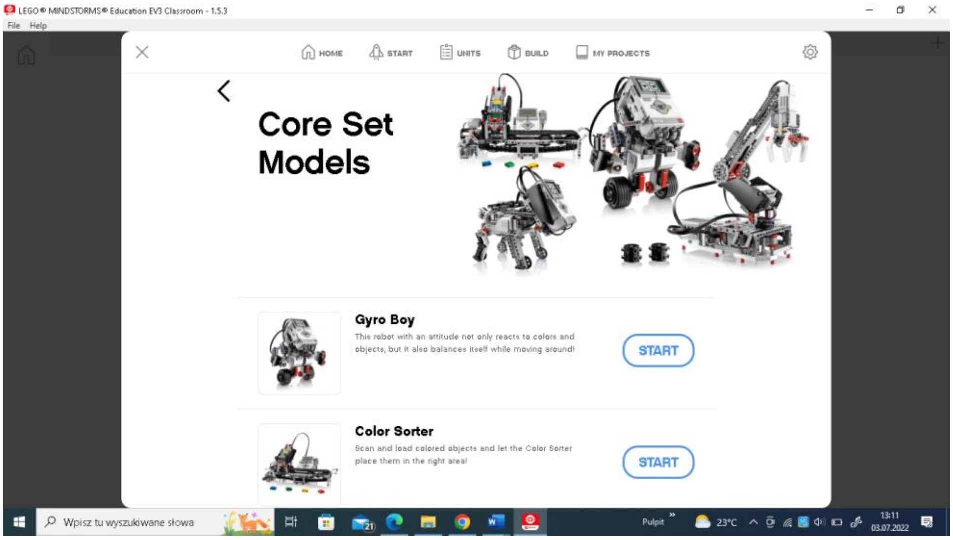
Procedure

4. Building the "Arm H25 Robot" and starting programming.

The students have The EV3 Classroom App opened. Then they click “Core Set Models” icon.

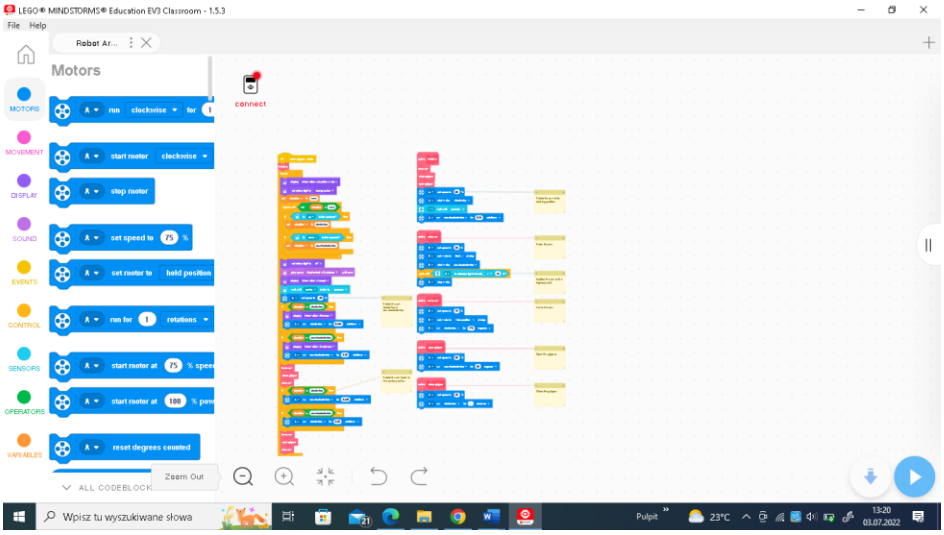


Then, they choose “Core Set Models” icon and finally they find “Robot Arm H25” on the list and click it.



After that, they start the "Robot Arm H25" icon and follow the instruction to build the robot.

When it is finished, the students start programming the robot using Scratch language.



ACTIVITIES DURING THE ENGLISH CLASSES

Preparation for classes

1. The Kinder Surprise Capsules needs to be collected.
2. The questions for 3 points and for 5 points needs to be created. The questions are based on the material from Unit 8 "In town" in English book titled "Link". Cut ou the question and each question needs to be put into one Kinder Surprise Capsule. The questions are here and here

3. Two containers are needed. The questions need to be separated into two containers. In one container, there are easier questions - each for 3 points. The second container contains questions for 5 points
4. The Robot Arm H25. On one side of the robot I put a 3 point question, on the other side of the robot I put a 5 point question.

Introductory part

The teacher displays to the students a presentation he has prepared with the topic and objectives of the lesson. He explains what will be covered in today's lesson and divides the class into groups.

Main part

One student from each group comes up in turn, decides which question they choose for themselves (a 3 point question or a 5 point question) and gives a command to the robot according to their choice. The students then opens the Kinder Surprise Capsule and reads the question. Together with the group, they think about the answer. After brainstorming, the student gives the answer and the teacher displays the answer on the presentation, too. If the student's answers is correct his/her team receives a point. The team that collects the most points wins.

Concluding part

1. Pupils answer the concluding questions (only examples are given below):

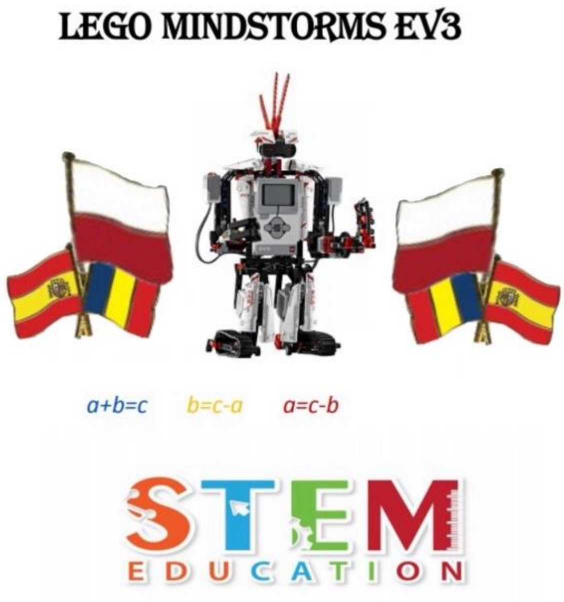
What have I enjoyed the most about the lesson?

What have I learnt today?

What had I already known and what was new?

What would I like to review again?

2. The teacher summarises the groups' work and evaluates them. The group,, which scores the most points can be rewarded with a mark, a plus or verbal praise (according to the rules introduced by the teacher).



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