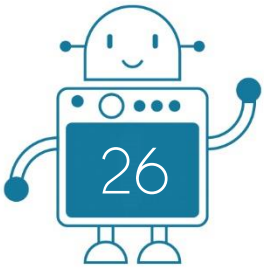


SAILBOAT RELAY REGATTA

STEMJAM Teaching Guide

Developing make spaces to promote creativity around STEM in schools
Acronym: STEMJAM
Project no. 2016-1-ES01-KA201-025470

www.stemjam.eu

Co-funded by the Erasmus+ Programme of the European Union

SAILBOAT RELAY REGATTA

ABSTRACT

The activity consists in running a "relay race" in the sea, with sailboats, based on the ability of the students to answer science questions.

The race will be between two teams, which will sail at the same time. Each team of students have three sailboats: MB01, MB02, MB03 (three mBots). As the race advances, the program prompts the students for STEM questions on the computer screen: if the team answers correctly, their next boat is allowed to start sailing and continue the race. The team who first arrive at the finish line, will win.

DIDACTIC OBJECTIVES

GENERAL:

- Learning to develop the algorithm of an activity.
- Acquiring skills in problem solving.
- Acquiring motivation for the study and understanding of the contents of the different STEM areas.
- To learn the operation of different sensors and components.
- To develop computational thinking.
- Learning to work and cooperate in a group.

TECHNOLOGY:

- Learning to program communication between robots, using infrared messages.
- Learning to program the Arduino board.
- Having the first contacts with the Arduino programming language.
- To make a program that combines the operation of a robot linked to a computer program, with other autonomous robots, all working as a team.
- Learning how to use a 7-segment display, led lights, fan component and chronometer function.
- Calculating the current flowing through a lightbulb, when it is connected to a battery.
- Solving lever problems.

MATHEMATICS:

- Solving percentages and proportions.

SCIENCE:

- Calculating velocity as a function of space and time.
- Calculating density as a function of mass and volume.

STEM Subject: Science☒ Technology ☒ Engineering☐ Mathematics☒

Education Level: 12-14 years☒ 14-16 years☐

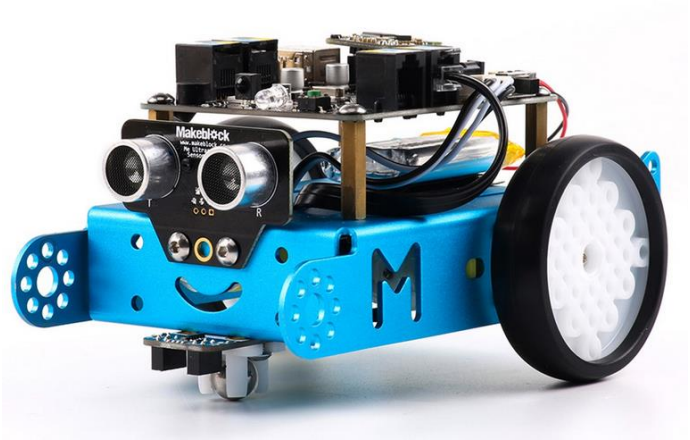
PROBLEM STATEMENT

We will combine different programs and routines in one. Therefore, the flow chart is very important for the success of the activity:

- Random approach to questions from different subjects.
- Actions conditioned on events.
- Movement, lighting effects, chronometer, fan ...
- Autonomous robots with their program recorded on the Arduino board working as a team with robots linked to a PC program.
- Communication between robots by sending infrared messages.

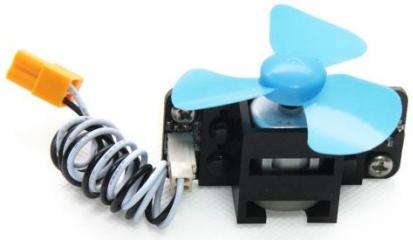
BOM (Bill of Materials Needed)

- (x6) mBots => Ref. 90054

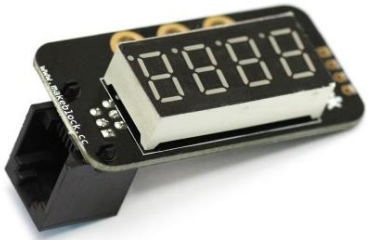


- Different beams and structures:

❖ 6 Me **130 DC Motor Pack**:



❖ 2 Me **7-Segment Serial Display - Red**:



❖ Rest of Attrezzo: buoys to signal the start and end of the stage. Flags for boats.

ELEMENT	ID	CABLE	AMOUNT	PORT 1			PORT 2			PORT 3				PORT 4				P.MOT1	P.MOT2
				Am	Az	Bl	Am	Az	Bl	Am	Az	Bl	Ng	Am	Az	Bl	Ng	Bl*	Bl*
Mbot Robot 2´4G			6																
Motor 1	Bl*																	Bl*	
Motor 2	Bl*																		Bl*
ME 130 motor pack 5V/10000rpm (FAN)	Az	6	6		Az														
ME 7-Segment serial display	Az	2	2												Az				
RJ25 cables			8																
Structures																			
Beam 0808-040			6																
Cuttable Linkage 080			6																
Bracket P1			8																
Laptops			2																
Atrezzo (not essential)																			

ACTIVITY DESCRIPTION

In this activity, each team must answer correctly two STEM questions. If they do so, the first sailboat (MB1) will start to navigate. If they do not give the proper answer, the program will ask them another question. This proceeding will continue until two questions are being answered correctly.

Time will start to count since the beginning of the program. Time will be reflected in a display located on the third mBot (MB3). This third robot is the one which will cross the finish line.

The process is repeated two more times:

- After guessing another 2 questions, the MB2 will advance towards the MB3.
- Finally, by answering the last 2 questions, the MB3 will advance towards the finish line. When it arrives, the chronometer will stop.

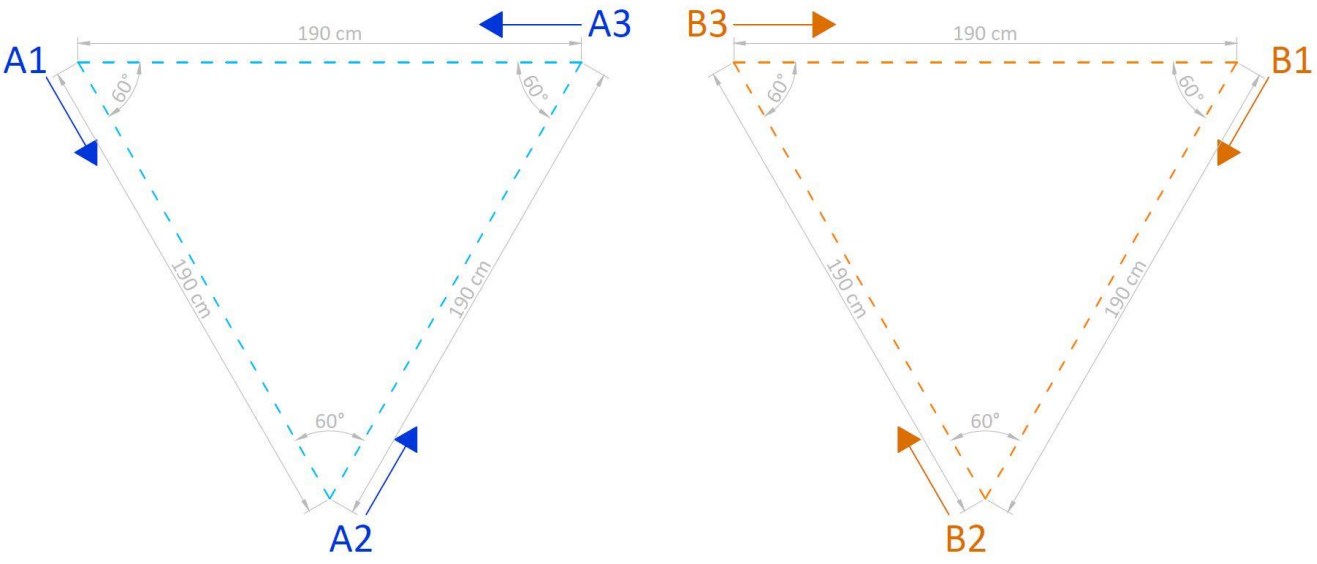
The main program will run from a PC and will be connected to the MB1 through the Wi-Fi or Bluetooth connection.

The MB2 and MB3 robots will work autonomously. Their own codes have to be recorded on their Arduino boards.

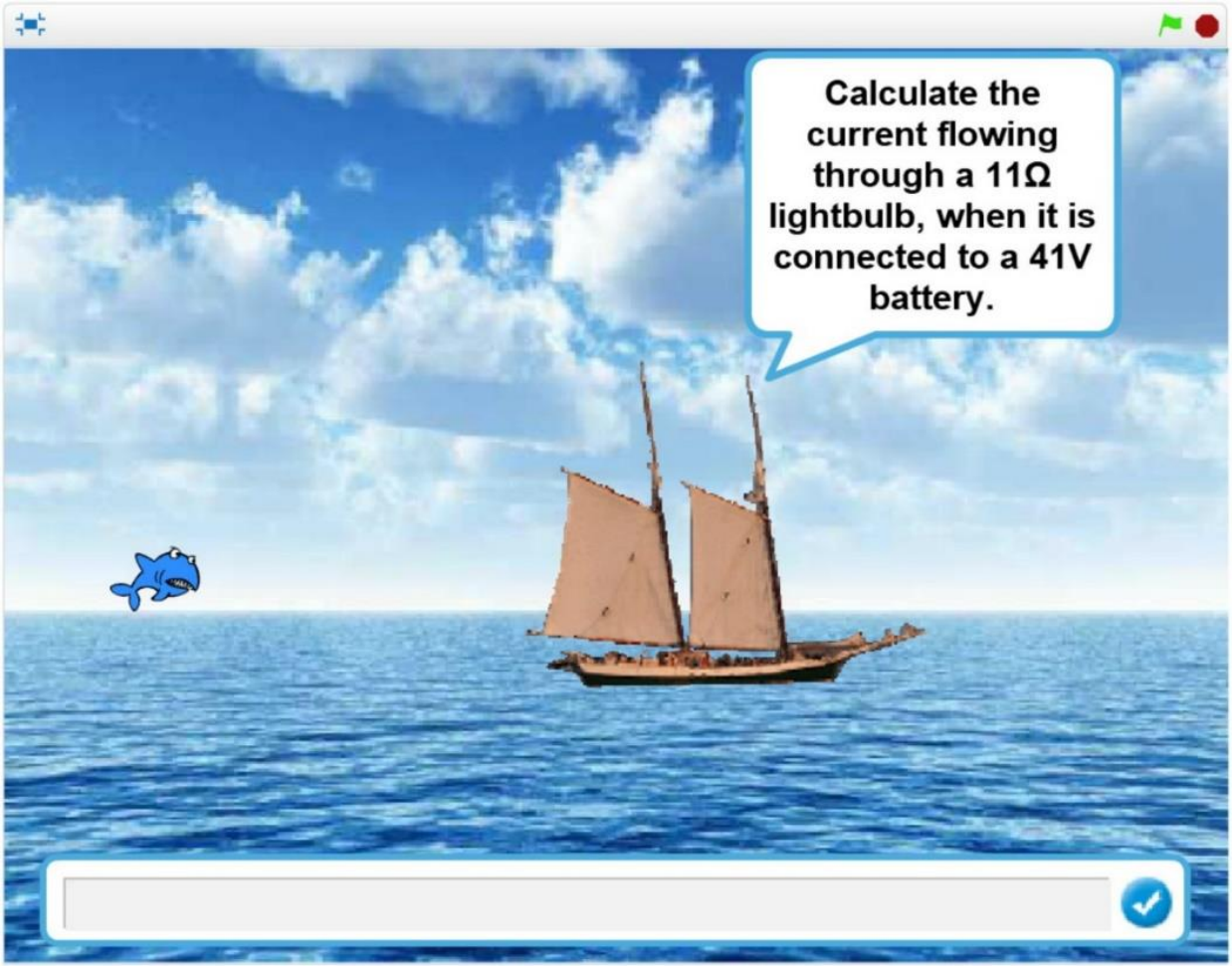
The MB1 will make a connection between the PC program and the autonomous robots (MB2 and MB3) by sending messages to them to execute their routines at the right time.

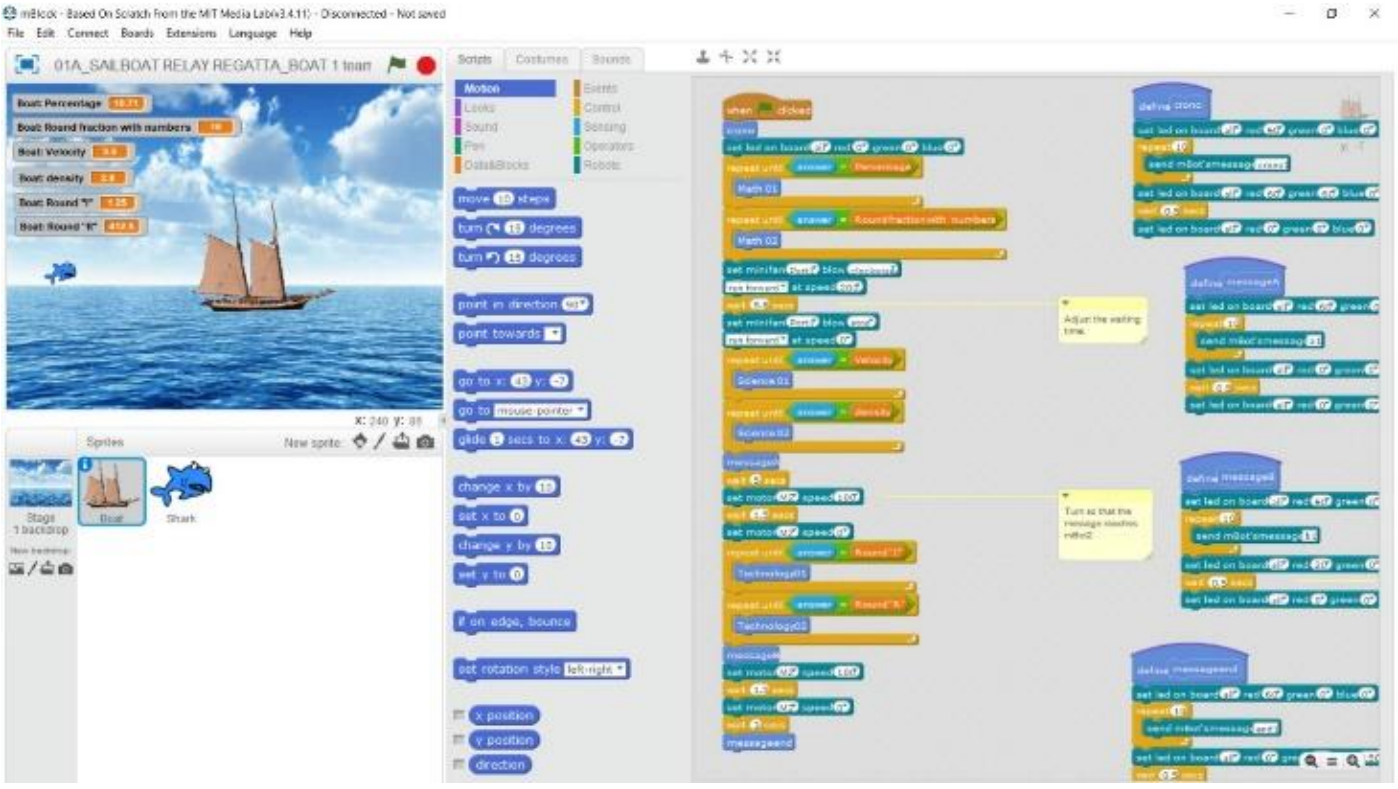
The configuration of movements and waiting times has been done according to the route for the regatta, which we can see in the sketch below.

Any change in the separation distance between mBots means that we must adjust these parameters in the affected code routines.



MAIN SCREEN – PC PROGRAM:





The complexity of the code recides in how to join the different routines without affecting the performance of the program.

There are **3 base programs for each team** (one for each of the three robots of a team). The programs of each team must be different, so that there is no interference between the messages of the two teams.

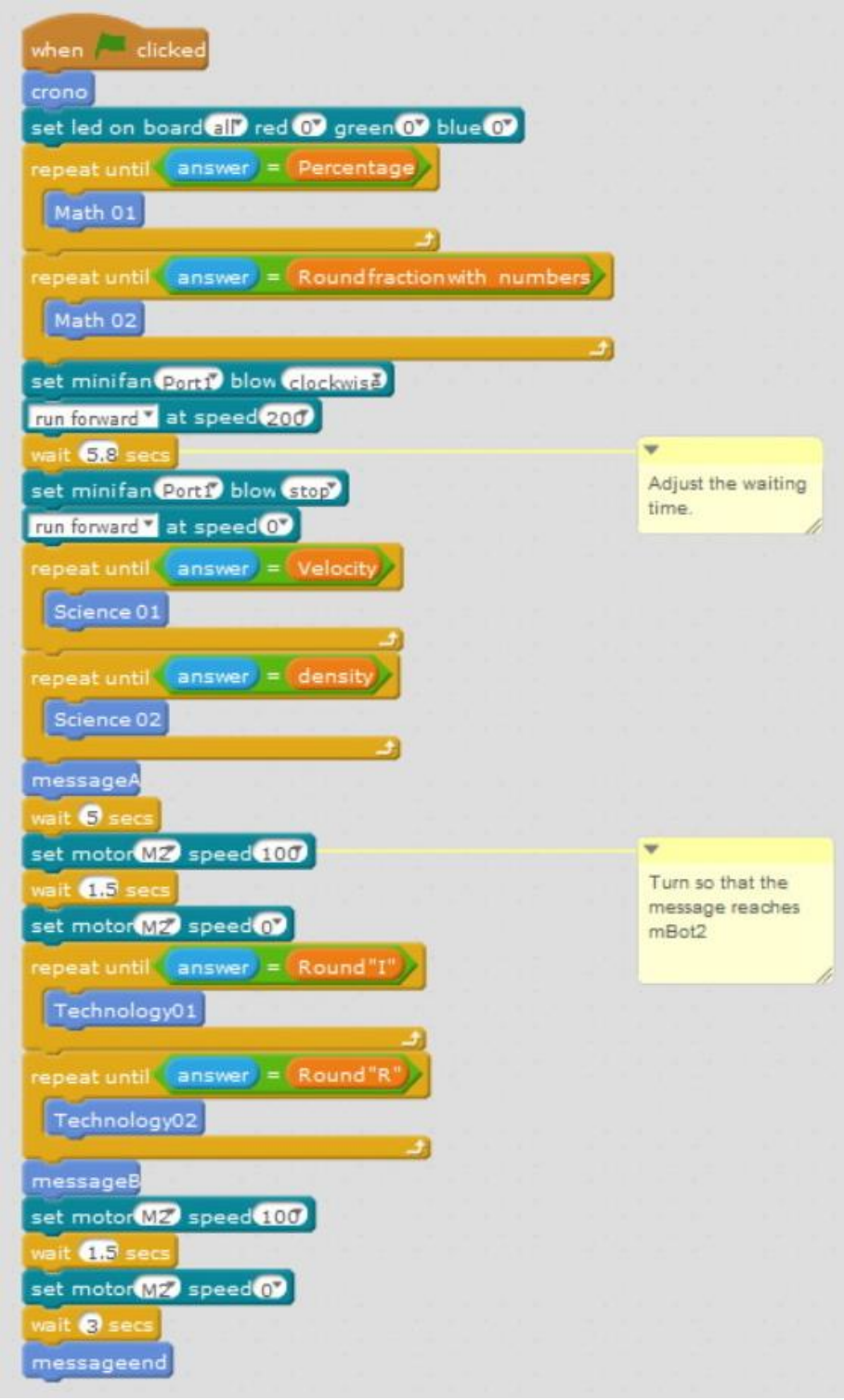
The only difference between the programs of the two teams are the messages that are sent. All the messages sent by the robot MB1 of team1 end in 1 ("chrono1", "a1", "b1", "end1"). The same for team 2, ("chrono2", "a2", "b2 "," end2 ").

Program 1, called "starter", is the main program that the PC will run. This program manages the contest questions and the reactions of the MB1.

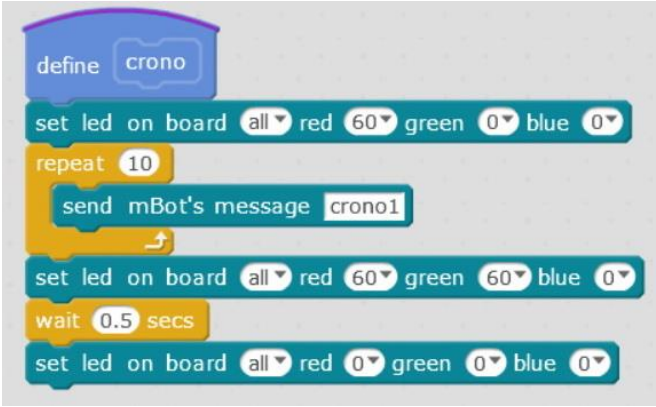
Programs 2 and 3 will be recorded on the Arduino boards of MB2 and MB3. The execution of the routines of these two programs, depend on the messages sent by the MB1, (it will communicate with them through the infrared port). Next, the different routines will be shown in the running order.

The codes shown are those of team 1. The codes of team 2 are identical and the only difference is that the messages end in "2" instead of in "1" and the orientation of the turn of Mb1.

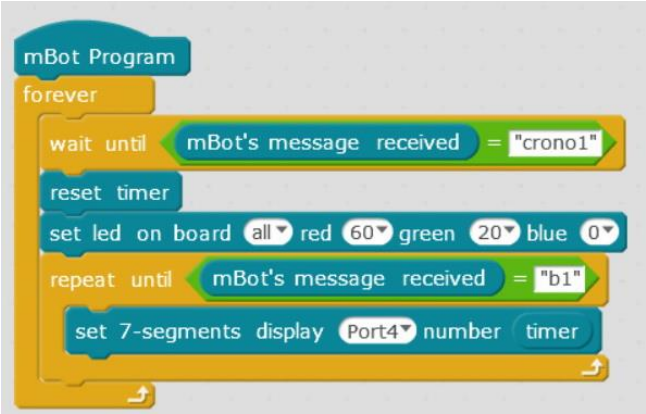
ROUTINE 1: MAIN CODE (PC PROGRAM)



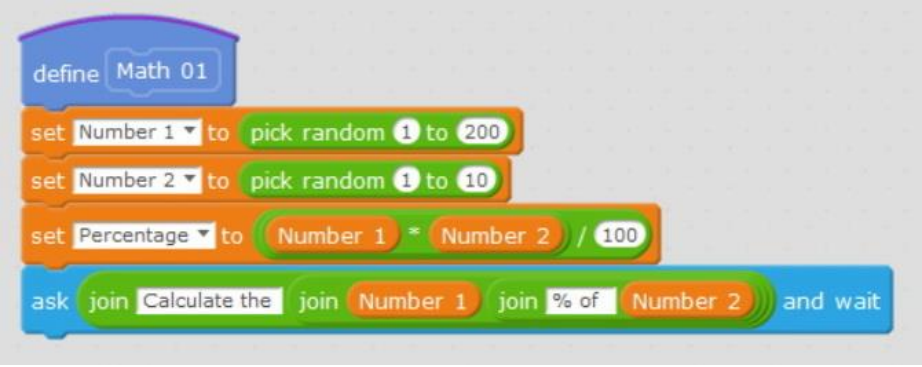
ROUTINE 2: MESSAGE “crono” SEND FROM MBOT1 TO MBOT3



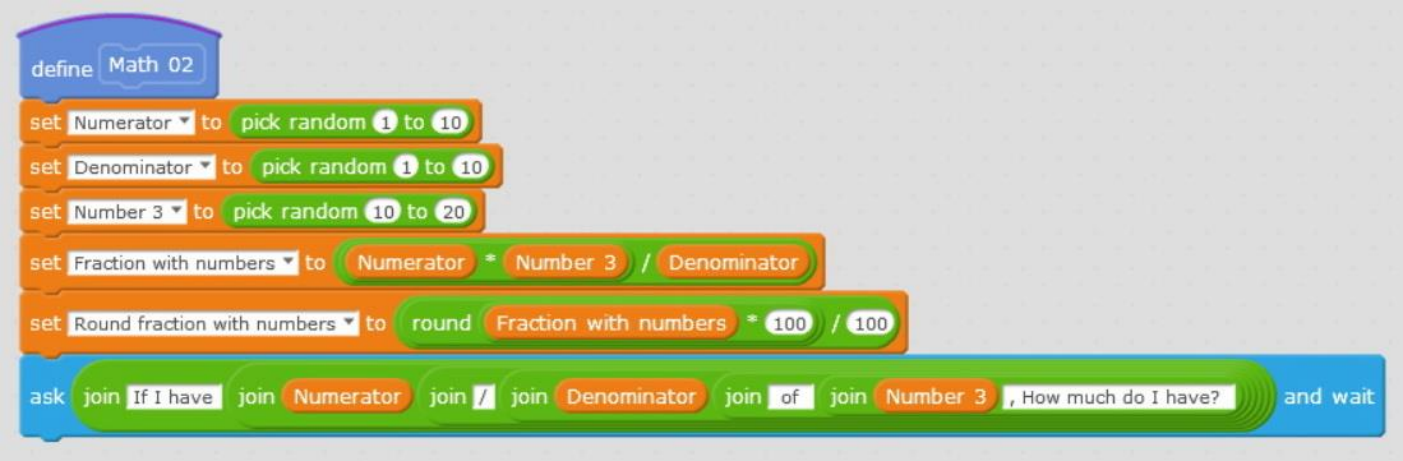
ROUTINE 3: MBOT3 ARDUINO PROGRAM – PART ONE – MESSAGE “crono” RECEIVED



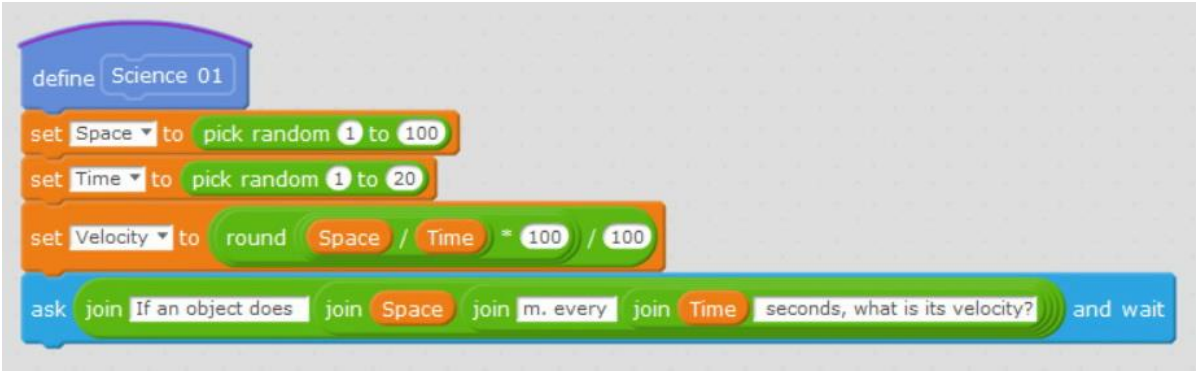
ROUTINE 4: MATH1 QUESTION



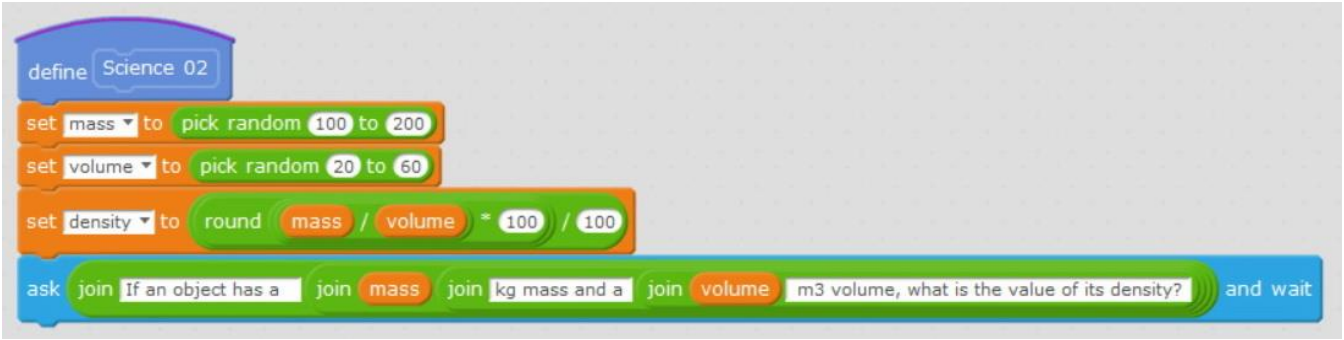
ROUTINE 5: MATH2 QUESTION



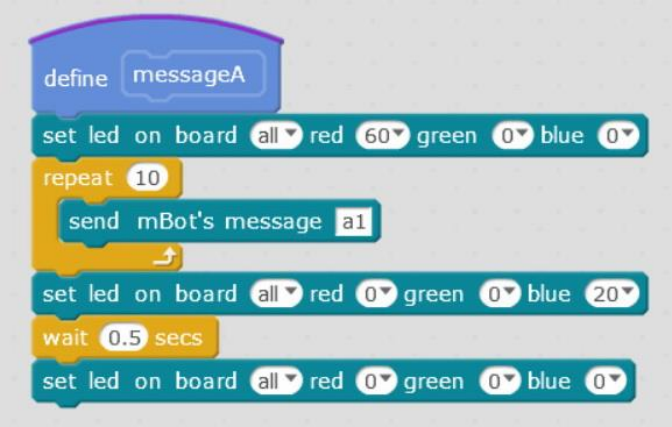
ROUTINE 6: SCIENCE1 QUESTION



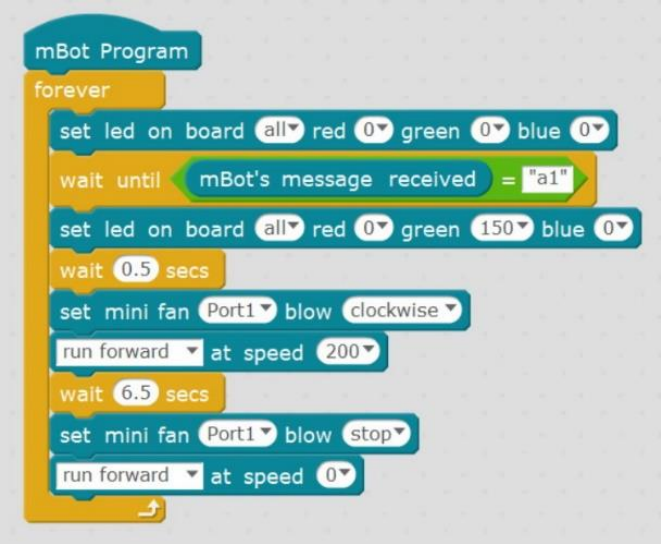
ROUTINE 7: SCIENCE2 QUESTION



ROUTINE 8: MESSAGE “a” SEND FROM MBOT1 TO MBOT2



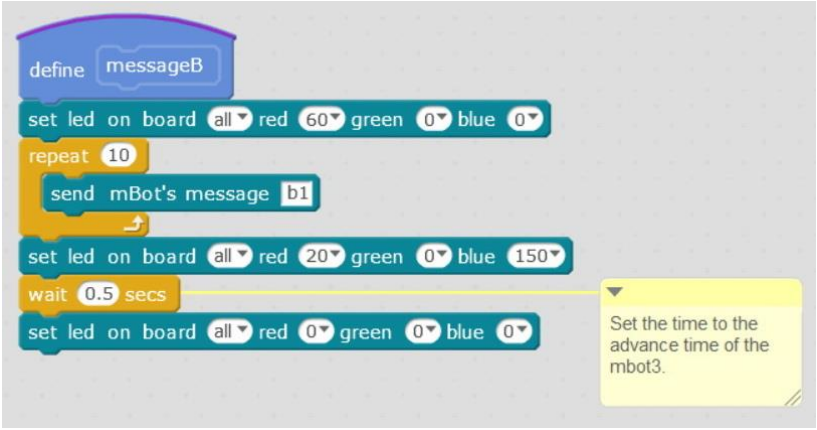
ROUTINE 9: MBOT2 ARDUINO PROGRAM – MESSAGE “a” RECEIVED



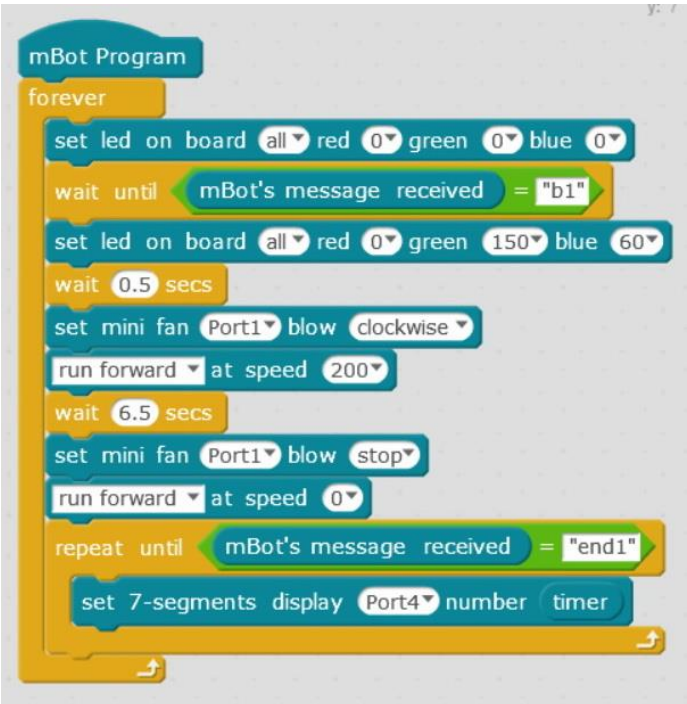
ROUTINE 10: TECHNOLOGY1 QUESTION

ROUTINE 11: TECHNOLOGY2 QUESTION

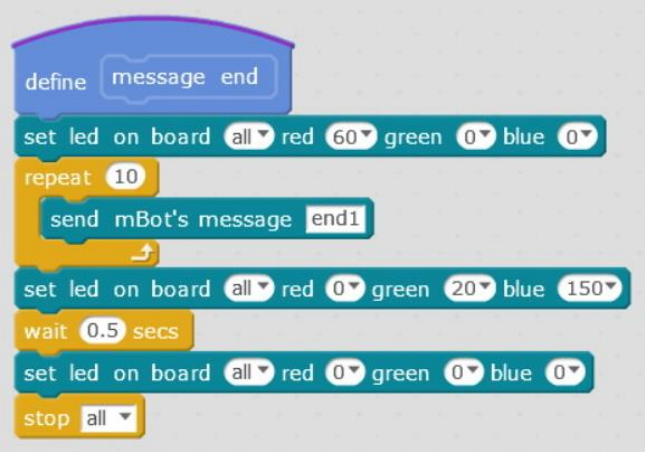
ROUTINE 12: MESSAGE “b” SEND FROM MBOT1 TO MBOT3



ROUTINE 13: MBOT3 ARDUINO PROGRAM – PART TWO – MESSAGES “b” OR “end” RECEIVED



ROUTINE 14: MESSAGE “end” SEND FROM MBOT1 TO MBOT3



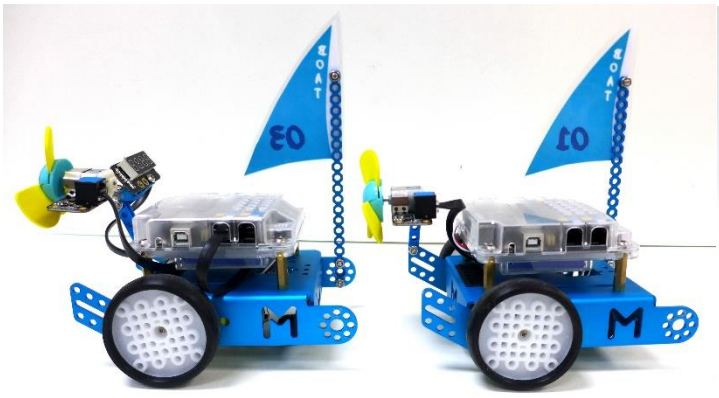
We will record the code from mbot2 and mbot3 in their Arduino boards. In this way, the mBots will work independently of the computer and there only will be need it two laptops to control six robots.

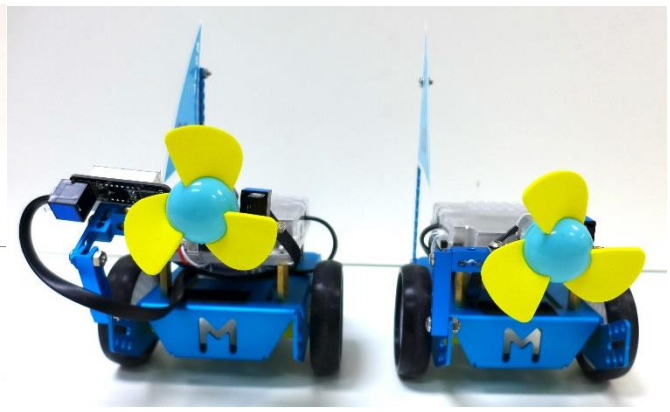
How to load a program on the arduino mBot board using mBlock:

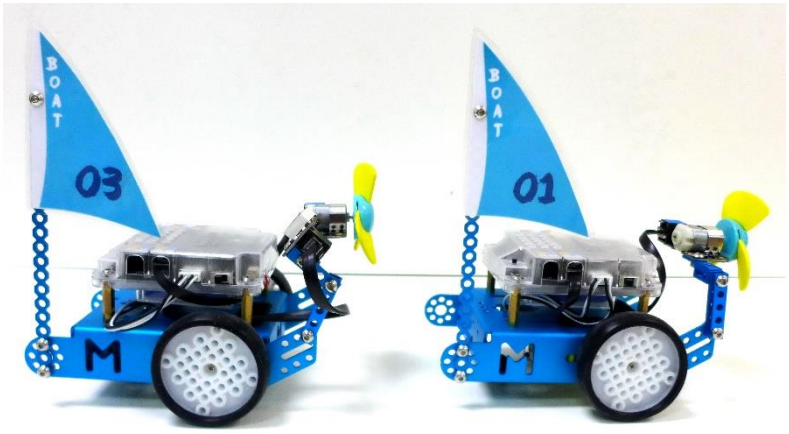
In order to load a program on the board using mBlock:

1. Choose mBot in the Board tab of the mBlock menu.
2. Connect the USB and choose "Serial Port" in the connect tab.
3. In the tab edit, choose "Arduino Mode" (In the program that we are going to load, instead of the green flag, we will put the blue command "mBot program")
4. A window with the code will open to record it on the Arduino board of mBot. You can, if you want, modify your program. Finally, click on Upload to Arduino.
5. If there have been no errors, a message will be sent informing that the program has been recorded correctly. At this moment, you will be able to start enjoying the program introduced in the robot, without the computer turned on. For doing this, you must disconnect the USB cable and connect the batteries (or lithium battery) of the robot. You will see that your mBot works independently.

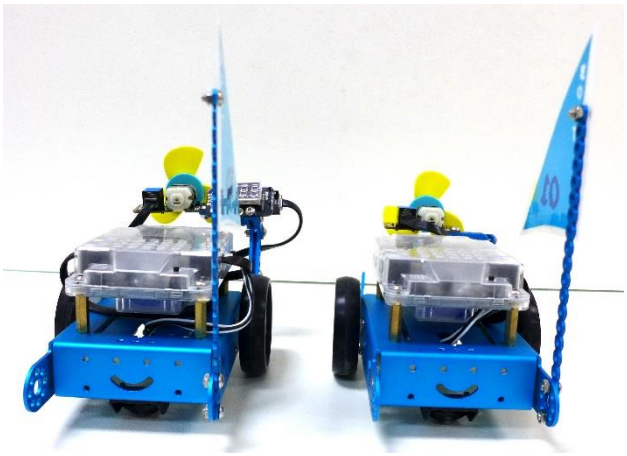
Once, the programming is finished, we start building up THE STRUCTURE, where all the mechanical elements will be set. Also the electronic elements.

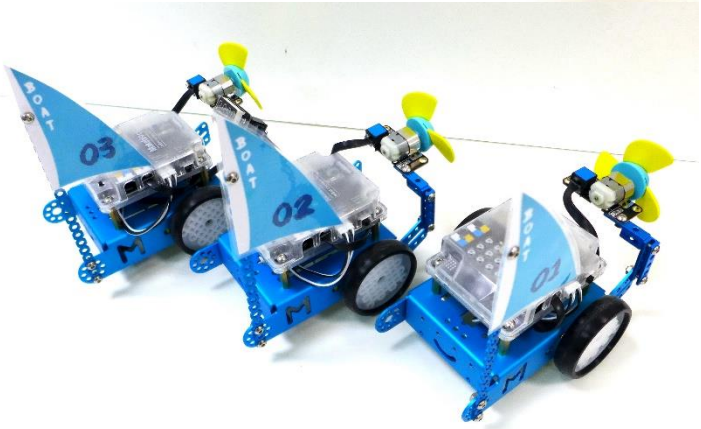





BOAT
03
BOAT
01
M
M


MakeBlock


BOAT
01


BOAT
03
BOAT
02
BOAT
01
M
M
M

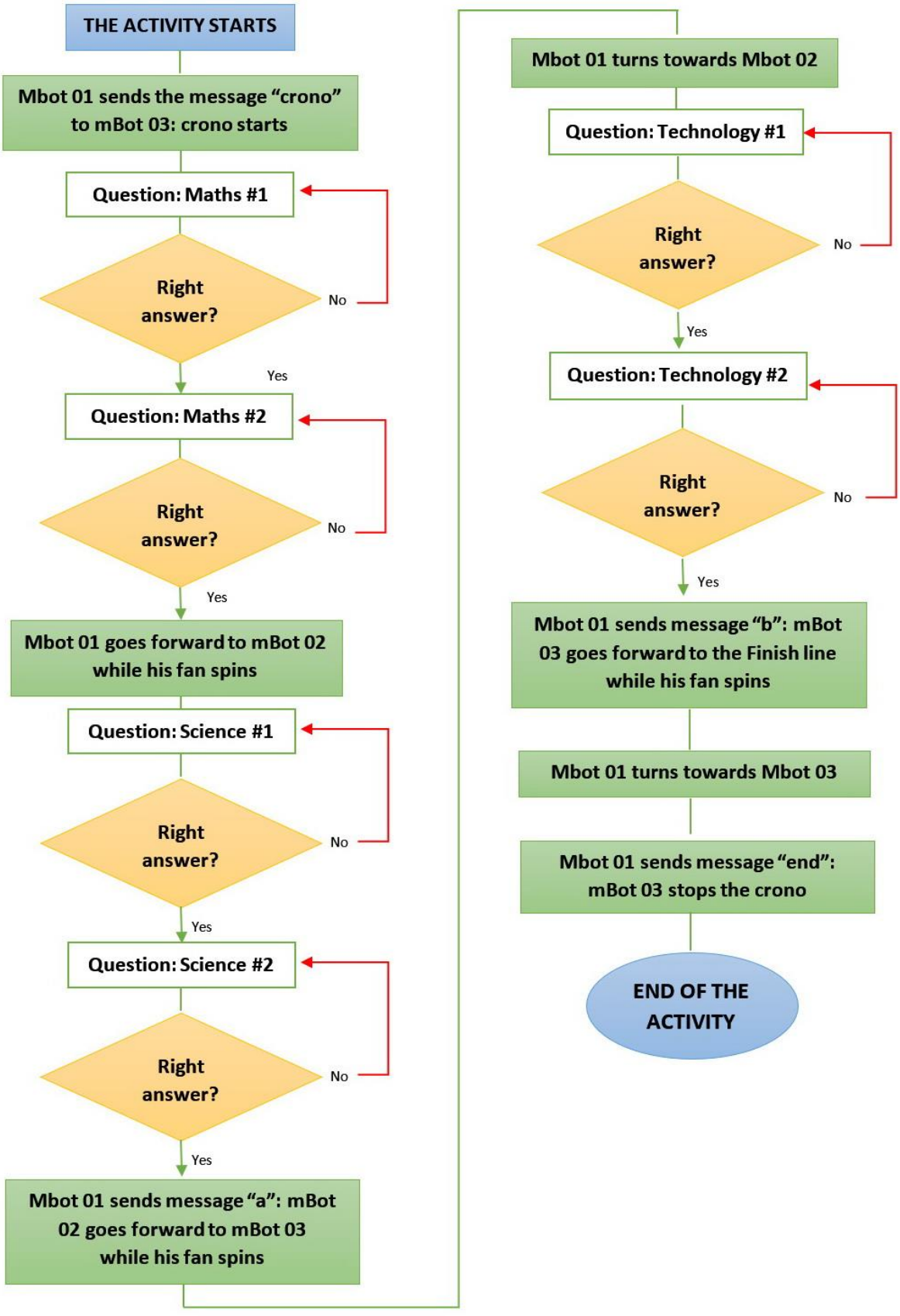

BOAT
03
BOAT
02
BOAT
01
M
M
M


BOAT
03
BOAT
02
BOAT
01
M
M
M


BOAT
01
BOAT
02
M
M

FLOW CHART

SAILBOAT RELAY REGATTA



STUDENT'S EVALUATION

For the evaluation of the students in this activity, use the Evaluation Rubric designed for this project.

MORE INFORMATION

DIFFICULTIES:

1. Finding the way to combine the different routines without affecting the performance of the program.
2. To transform the initial idea into a flowchart and the flowchart into code that works well.
3. To get 3 robots to work as a team using only one pc.
4. Combining six random questions from different subjects in a single code.
5. On many occasions some mBots do not move in a straight line.
6. The speed of the mBot depends on the charge level of their batteries.
7. In order for infrared messages to be received, they must be sent repeatedly for a period of time (see the code). If an infrared message is sent in a timely manner it is normal that it is not received by the receiver.
8. The infrared signal is very sensitive to intense light. To enable the reception of infrared messages the mBot activity has to be carried out in a place without direct sunlight and with a moderate light intensity.
9. The infrared transmitter/ receiver is located on the front of the Mbot. To enable the reception of the messages, the robots must be placed in a position as close as possible (see the sketch). According to our tests, an angle of 60º and a distance of 1'90 meters are parameters that work.
10. During the activity, the transmitter mBot has to change its position to always comply with the previous conditions.