Title: Exploiting an arduino controlled vehicle to investigate proportional relationships

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## 1st Teaching Period

### Activity 1

Time: 10' min

Type of activity: Warm-up and discussion on the project content and familiarisation with the equipment.

Class organisation: In whole class.

**Actions/Tasks:** The teacher explains to the students the content of the project, which is to program an arduino microprocessor to control the movement of a small car and investigate its motion, through measurement of the distance that it covers in a certain period of time. The teacher shows the vehicle, explains to students its components and the way that it moves. The students write the name of each component on a worksheet provided by the teacher.

### Activity 2

Time: 15' min

Type of activity: Discussion/Familiarisation of the arduino code .

Class organisation: In whole class and in pairs.

**Actions/Tasks:** The teacher explains the necessary arduino code for controlling the vehicle to the whole class and demonstrates the way that the code is uploaded to the arduino uno board.

### Activity 3

### Time: 20' min

Type of activity: Division of the class into groups and assign roles to each student.

Class organisation: In whole class

**Actions/Tasks:** The teacher assigns roles to each student in two group levels: In whole class level and in small group level (the suggested number of students per group is 3).

When the scenario takes place in an ordinary classroom, and not in a laboratory dedicated for this kind of projects, it is important to bring the necessary materials in the classroom and arrange the desks and chairs in order to leave free room to put the vehicles to move and do the measurements. To do so it is important to distribute responsibilities to the students to bring the necessary material in the classroom if it is kept outside of it, and to arrange the space. Of course, at the end of each teaching period the same students are responsible to restore everything. The following roles in class can be adapted to meet the needs of the class.

Roles in whole class level :

Before the beginning of the teaching period:

1. Students responsible for carrying all the necessary material in the classroom

* The **vehicle operators** of each small group (see small group roles) bring the vehicles to the classroom.
* Two or three students bring to the classroom the measure tapes and the cable cover rail needed for the measurements.
* Three or four students bring to the classroom the laptops and the usb cables for writing and uploading the code on the Arduino UNO board .

1. Students responsible to arrange the classroom in order to have free space

* The rest of the students place chairs and desks of the classroom close to the wall making space for moving the vehicles and performing the measurements.

After the end of the teaching period:

1. Students responsible for carrying all the necessary material in the classroom

Make sure all the necessary material is carried back to the place they are being stored.

1. Students responsible to arrange the classroom in order to have free space

Put the chairs and desks back to their normal place in the classroom.

Roles in small groups:

Students will be divided into small groups of three with a specific role for each member. The roles will be

* **Vehicle operator**
* **Measurements’ responsible**
* **Note taking responsible**

The **vehicle operator** is responsible for uploading the code, decided by the team, from the computer to the arduino uno board and for placing the vehicle in the appropriate position and turning the vehicle on and off. The vehicles must be numbered so that each team works with the same vehicle because each one moves at a different speed.

The **measurements’ responsible** controls the correct placement of the measure tape before performing the measurements and announces the readings to the whole group.

The note **taking responsible** fulfils the worksheet with the readings decided by the group.

The teacher can use the following tablate in [xls google doc](https://docs.google.com/spreadsheets/d/1DfAgO_OnLhNNMW4WTNkg05dOyMWXCTuntDQ8xY0rw1k/edit#gid=0) or a hardcopy of it to record the duties of each of the students. It is important for all students to have a role in the project.

### 2nd Teaching Period

Activity 1

Time: 5' min

Type of activity: Setting up the classroom to conduct the measurements, taking responsibility.

Class organisation: Whole class.

**Actions/Tasks:**  The students setting up the classroom according to the role that was assigned to them at the 1st Teaching period for the face “At the whole class level - Before the beginning of the teaching period”.

Activity 2

Time: 35' min

Type of activity: Programming and taking measurements, keeping notes ,making decisions .

Class organisation: In small groups of three.

**Actions/Tasks:**  The students work in small groups of three according to the role that was assigned to them at the 1st Teaching Period for the face “Roles in small groups”. Their assignment is to set the time that the vehicle will move by putting the appropriate value in the Arduino UNO code and measure the distance that the vehicle will travel. In order to deal with measurement errors, students are asked to conduct the same measurement a number of times and decide the one that they think is the best. They may choose to use as the most appropriate of the following values: the average value, the mean value or the median of their measurements. The values and their calculations will be noted on a Worksheet given by the teacher.

Activity 3

Time: 5' min

Type of activity: Restoring the classroom and equipment, taking responsibility.

Class organisation: Whole class

**Actions/Tasks:**  The students restore the classroom for the next lesson according to the role that was assigned to them at the 1st Teaching period for the face “At the whole class level - After the end of the teaching period”.

**Note: It may take more than 35 minutes for Activity 2. Therefore, the sequence of Period 2 Activities should be repeated.**

### Homework

For Homework students are asked to place in a Cartesian time-distance coordinate system the points with coordinates the time the car moved and the value they decided as the distance the car travelled. The Cartesian coordinate system will be given by the teacher. The students have to answer certain questions (see worksheet) posed by the teacher regarding the interpretation of the graph. They must answer the question as a team so they will use a cooperative worksheet to answer. The answers of each team will be used for the discussion that will take place at the 1ct Activity at the 3rd Teaching Period .

### 3rd Teaching Period

Activity 1

Time: 15' min

Type of activity: Interpretation of the graph, making assumptions , reasoning, .

Class organisation: In small groups (of three) , in whole class level, Flipped classroom.

**Actions/Tasks:**  The students are asked to interpret the graph that they prepared for homework after the previous teaching period. They are asked whether or not it is sensible to connect the points of the graph and what is the information that they can get from it. They are asked to predict the distance the vehicle will travel in a certain period of time and justify their reasoning. The goal of the activity is for students to observe that when the time is multiplied by a number then the distance is multiplied by the same number and that the points at the graphs are all on the same straight line. Therefore the quantities time of travel and distance are proportional.

Activity 2

Time: 20' min

Type of activity: Contest: Which team can predict with the maximum accuracy the required movement time to cover a given distance?

Class organisation: In small groups of three

**Actions/Tasks:**  For the closure of the project a small contest is organized in order to add a gamification note to the project. A fixed distance is marked on the floor and the groups are asked to program their vehicles to cover this distance with the maximum accuracy they can achieve. The group that will program the vehicle to move achieving the smallest deviation from the requested distance will win the contest. The next four best performances will be noted to the board as well, forming a five place leaderboard.

The group members have a short meeting to decide for how long they should make their vehicle move in order to cover the given distance. In order to take this decision they use the graph created during the previous activity.

During the testing phase of the contest the students have the following responsibilities according to their role in the group:

The **vehicle operators** are responsible for uploading the code, placing the vehicle in the starting position and turning the vehicle on.

The **measurements’ responsibles** work in pairs or in groups of three: while one responsible performs the measurement of deviation for his/her team, at least one responsible from another team is watching to control the accuracy of the measurement. If there are no objections, the responsible announces the deviation between the spot the vehicle actually arrived and the finishing line.

The note **taking responsibles** write down to the worksheet the measurements for all vehicles. Then they short the values in increasing order and announce the winner and the 5 place leaderboard.

Activity 3

Time: 10' min

Type of activity: Reflection: what went right, what went wrong.

Class organisation: Groups of three, Whole class

**Actions/Tasks:**

The group members have a short meeting to exchange their ideas about what went right and what went wrong. Then one student of each group shares with the whole class these conclusions. The teacher summarizes good practices to adopt and common errors to avoid.