Estimating the launching height of a water rocket

Background:

In F2 IS, there is a water rocket design competition in which we need to estimate the rocket's launching height. As part of this STEM project, we want to introduce the use of an accelerometer in the micro:bit as a tool for measuring the launching height of a water rocket.

We designed this STEM project in the middle of the academic year when most of the teaching content was already pre-planned. Therefore, we used a relatively reserved approach to deliver this STEM curriculum. After reviewing the actual implementation and gathering feedback from teachers, we can fine-tune it for next year.

Therefore, this year we will do the following:

- In the CL lesson, we will introduce the use of micro:bit to measure the launching height. Students will learn how to measure the launching height themselves by using an air-pressured rocket, which is more stable during launch and produces data that is easier to interpret.
- In the IS lesson, students will work with their water-rocket designs as usual and measure the launching height using the non-micro:bit approach, as before.

We suggest that next year:

- Students can design their water rockets to integrate with a micro:bit measuring device and conduct height measurements during the competition to verify the measurements taken by the school.

Theoretical Background:

By interpreting the readings of the accelerometer attached to the water rocket, we can estimate the time when the water rocket reaches its highest point and starts to freefall, as well as when it impacts the ground. Then, using the formula $h=gt^2$ in physics (where g is the acceleration due to gravity), we can estimate the launching height.

STEM Knowledge:

- **Science:**
  force (action and reaction forces), acceleration and gravity
- **Technology:**
  Use of micro:controller and sensor
- **Engineering:**
  Mechanical design of the rocket, fixing the micro:bit to the rocket for measurement
- **Mathematics**
  Data handling, graph interpretation, 3D spatial concept

Students' Background:

They all learned basic micro:bit and blocky programming in F1, as well as basic spreadsheet skills in the first term of F2.

Brief overview of the CL lessons:

Lesson 0 – Accelerometer (70 mins)

Objectives:

1. Students should know how to interpret the X/Y/Z readings from the micro:bit accelerometer using the analogy of a ball fixed by springs in the X, Y, and Z axes inside a box.
2. Students should be able to program the micro:bit to obtain accelerometer readings and verify their understanding through experiment.

Lesson 1 – Micro:bit Data logger (70 mins)

1. Students should be able to use the micro:bit data logger to collect data and retrieve it in batches.
2. Students should be able to use Google Sheet to plot a graph form selected data.
3. Advanced students would attempt to design more complex logic for controlling the micro:bit in different measuring situations.

Lesson 2 – Use of micro:bit accelerometer to measure the launching height (70 mins)

1. Students should know and understand the idea of how to measure launching height using readings from the micro:bit accelerometer.
2. Students should understand how to interpret the accelerometer readings attached to the water rocket.
3. Students should be able to verify their understanding through an experiment involving throwing up a ball with a micro:bit attached.

Lesson 3 – Consolidation of learning

1. Students should be able to find a way to attach a micro:bit to their water rocket.
2. Students should be able to conduct an experiment by firing their rocket and obtaining data from the micro:bit.
3. Students should be able to interpret their data and estimate the launching height. (Problem-solving skills)
4. Students should present their findings and discuss any challenges they encountered. (Reflection skills)

Detail Lesson Plan for Lesson 3: (70 mins) (Lesson Observation)

Before the lesson, teachers need to prepare:

- micro:bits
- batteries and battery boxes (for micro:bit)
- micro-usb cables
- back-up air rocket
- air pump
- fully-charged laptop computers (with tables) (playground)

(Teacher has already briefed the logistic of this lesson)

Duration:	**Objective and Activities**	**Learning Materials**
5 mins	Objective: Introduction and Preparation Activities: Greeting, Handling Equipment, Set up rules, Routine (iPad, etc)	
5 mins	Objective: Revision of last lesson Activities: Q&A, Distribution of worksheet, provide instruction on worksheet, Distribution of materials and tools, reminders of launching arrangement	PPT / iPad Worksheet microbit
40 mins (playground)	Objective: Air-rocket launching and height measurement Activities: Moving from classroom to destination, air rocket launching, data retrieving and group discussion, completion of worksheet.	air-rocket air pump programmed micro:bit laptop computers
15 mins (Classroom)	Objective: Ensuring students to be able to understand the measurement result and conclusion Activities: presentation, reflection, follow-up Q&A	iPad worksheet
5 mins	Objective: Tidying up and Buffering Activities: Returning materials, collection of worksheet	micro:bit worksheet