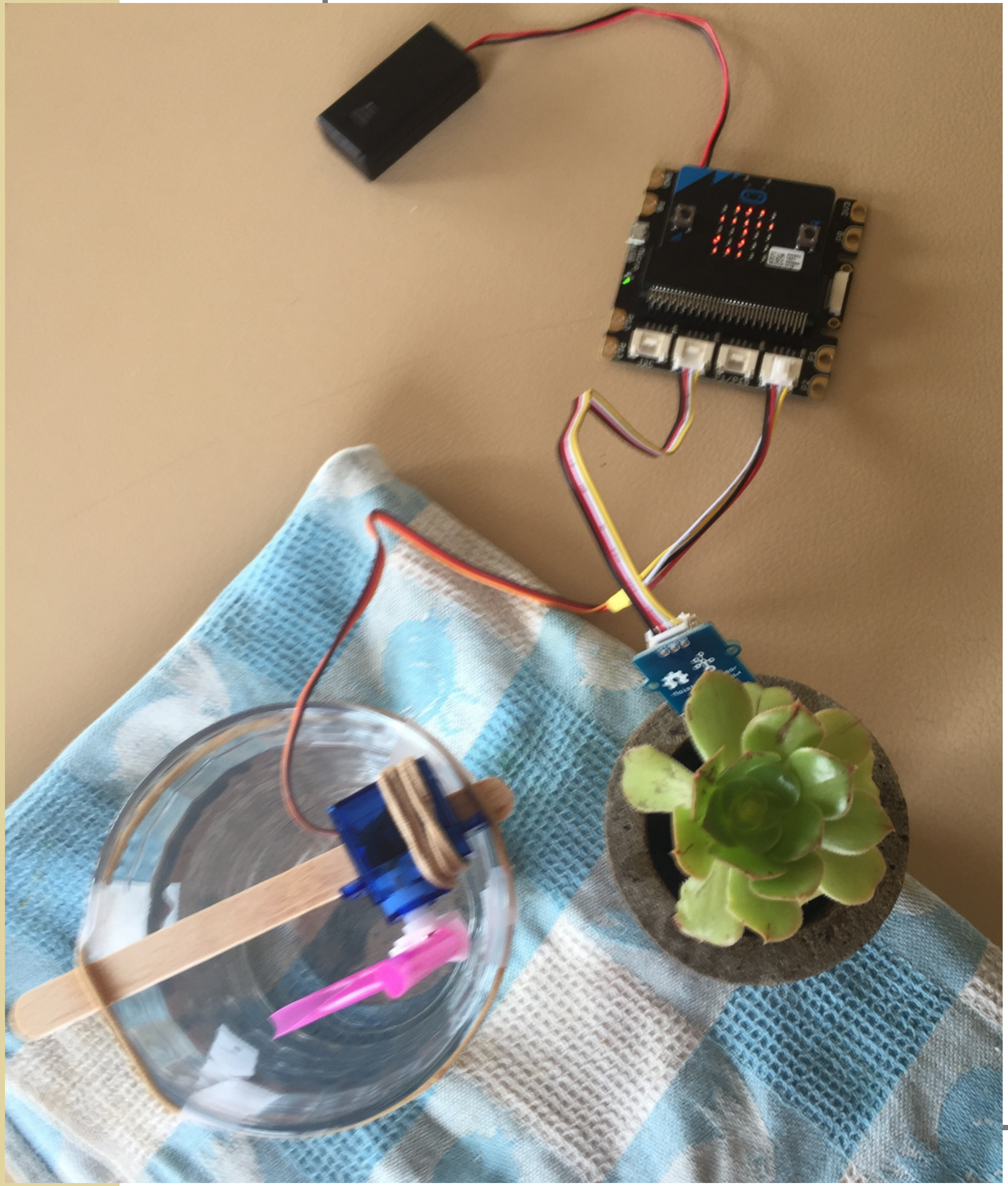
AUTOMATED SOIL MOISTURE SENSOR

Presented by Trudy Ward



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CLASS PEN PORTRAIT

Setting the Scene

The soil moisture sensor project was aimed to be conducted with a group of Year 4/5 students from Clarendon Vale Primary School.

Clarendon Vale Primary School is located within Clarendon Vale on Hobart's Eastern Shore. Identified as one of the most disadvantaged and low socio-economic demographics in Australia. Many students have below average aptitudes and struggle with concentration and behaviour in the classroom for their traditional lessons, however show a keen interest in technology. Two of the students who have chosen to participate in the project have a diagnosed learning difficulty of autism (ASD). This created added layers of complexity, as even though their aptitude and ability to function at school was seemingly high, the need for differentiation and pedagogical practice heightened to ensure that both students felt comfortable whilst completing the project.

Necessary adjustments were made to lighting and room noise levels, as well as an initial meeting with the students to discuss the project and their needs. This allowed necessary social stories and routines for the ASD student to be scaffolded to enable them to participate to the best of their ability. Duncan, Ruble, Thomas & Stark (2017) discuss the importance of creating an environment that includes pedagogical practises of scaffolding and reinforcement as crucial to ASD students remaining engaged in school. Many other students have behavioural issues and hold all too common trauma backgrounds. Their needs were also met through close consultation with their learning plan and calmer classrooms trauma pedagogies to ensure a calm, safe space where they felt valued and respected in the hope of creating a hands-on inquiry environment where a culture of measured risk taking within the task is accepted and encouraged (Geary, 2007).

Some students had some coding experience and interest, using visual block coding with scratch, but neither had used micro:bits or programmed using written code prior to the commencement of the soil moisture project. With only five lessons of 45 min allocated to complete the task, concerns were raised with the staff and students as to how far the project would actually get.

A Reminder

TECHNOLOGY IS AT ITS BEST WHEN IT BRINGS PEOPLE TOGETHER

Matt Mullenweg

LEARNING SNAPSHOTS

Lesson 1 - Identifying the problem

The first lesson included taking the students to the MONA 24 Carrot garden and discussing the purpose of the project and look at the problem first hand.

Since the initial call out of the project the students seemed to be quite interested in micro:bits and one had independently familiarised himself with the makecode software which proved to be a huge advantage in the project design.

LESSON SNAPSHOTS

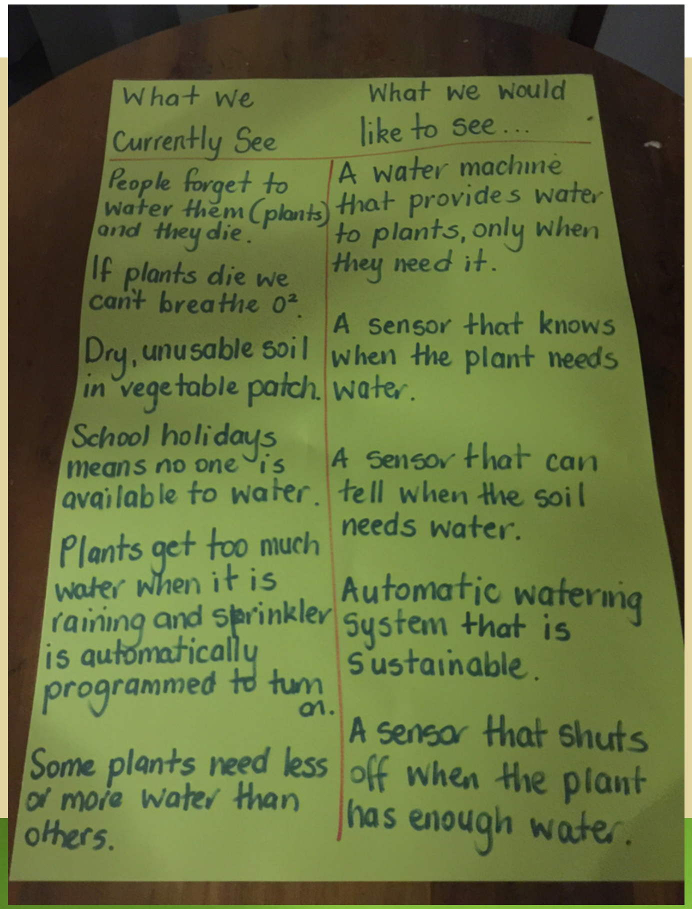
Lesson 2 – Investigating and Defining

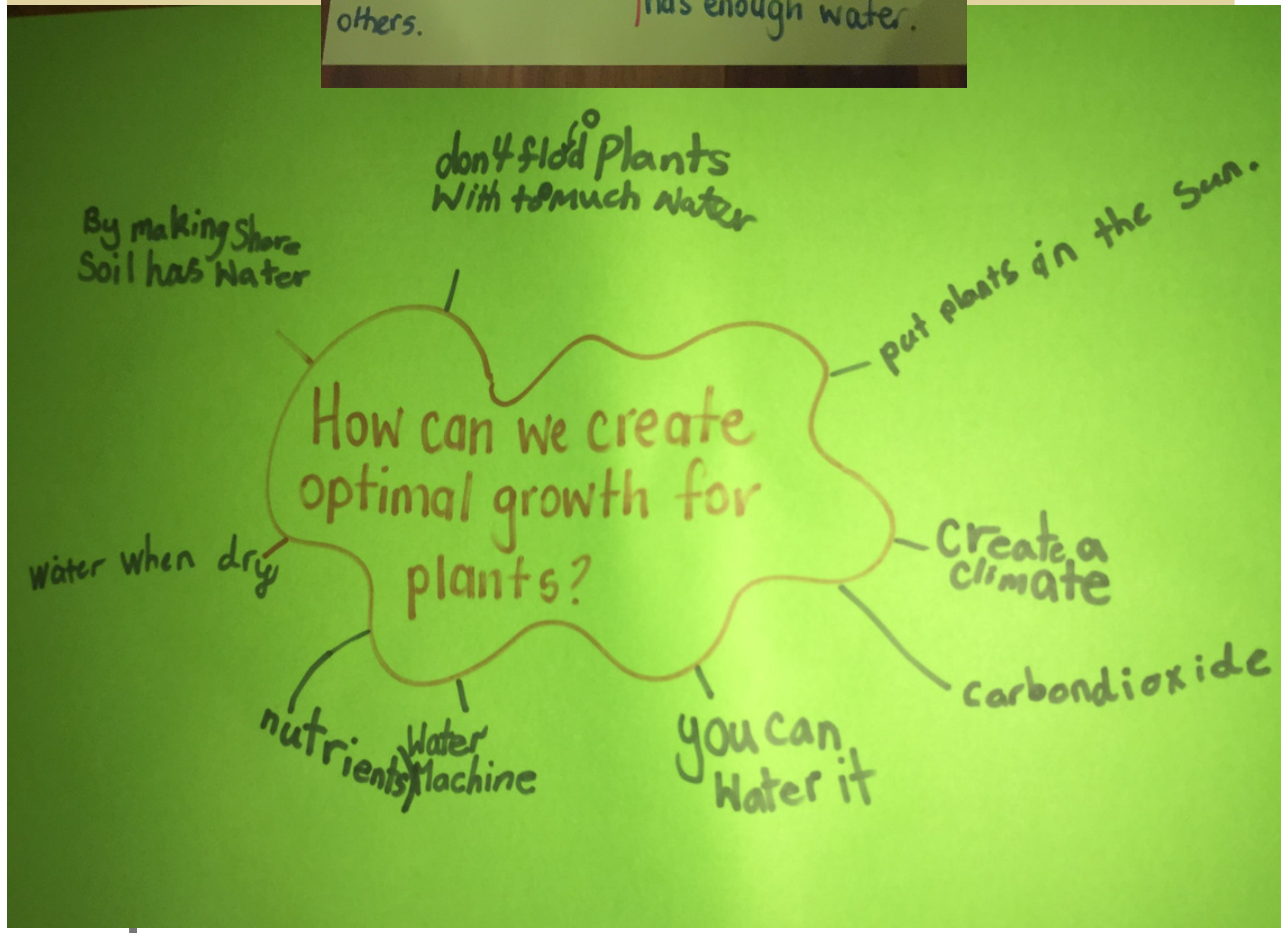
Using a collaborative approach and teacher as facilitator pedagogies, the initial problem was posed to students in the form of the following question and the cyclic design process commenced.

“How can we achieve optimal plant growth using sustainable water practises?”

Students investigated and defined the problem within their world, of the germination of plants and then discussed the issues pertaining to the current state. They then brainstormed and researched potential solutions using the internet, mind maps and T chart to communicate what they currently see, and what they wanted to see, to solve this real world problem. Albion, Campbell & Jobling (2018) support this type of collaborate inquiry, and pedagogical practise, as it provides students with necessary enterprise skills required for real world projects.

Consideration to each other’s ideas, skill sets and preferences also assisted in determining the type of solution they would like to create and how they could realistically achieve the necessary processes required to create a product suitable for the purpose intended.





LESSON SNAPSHOTS

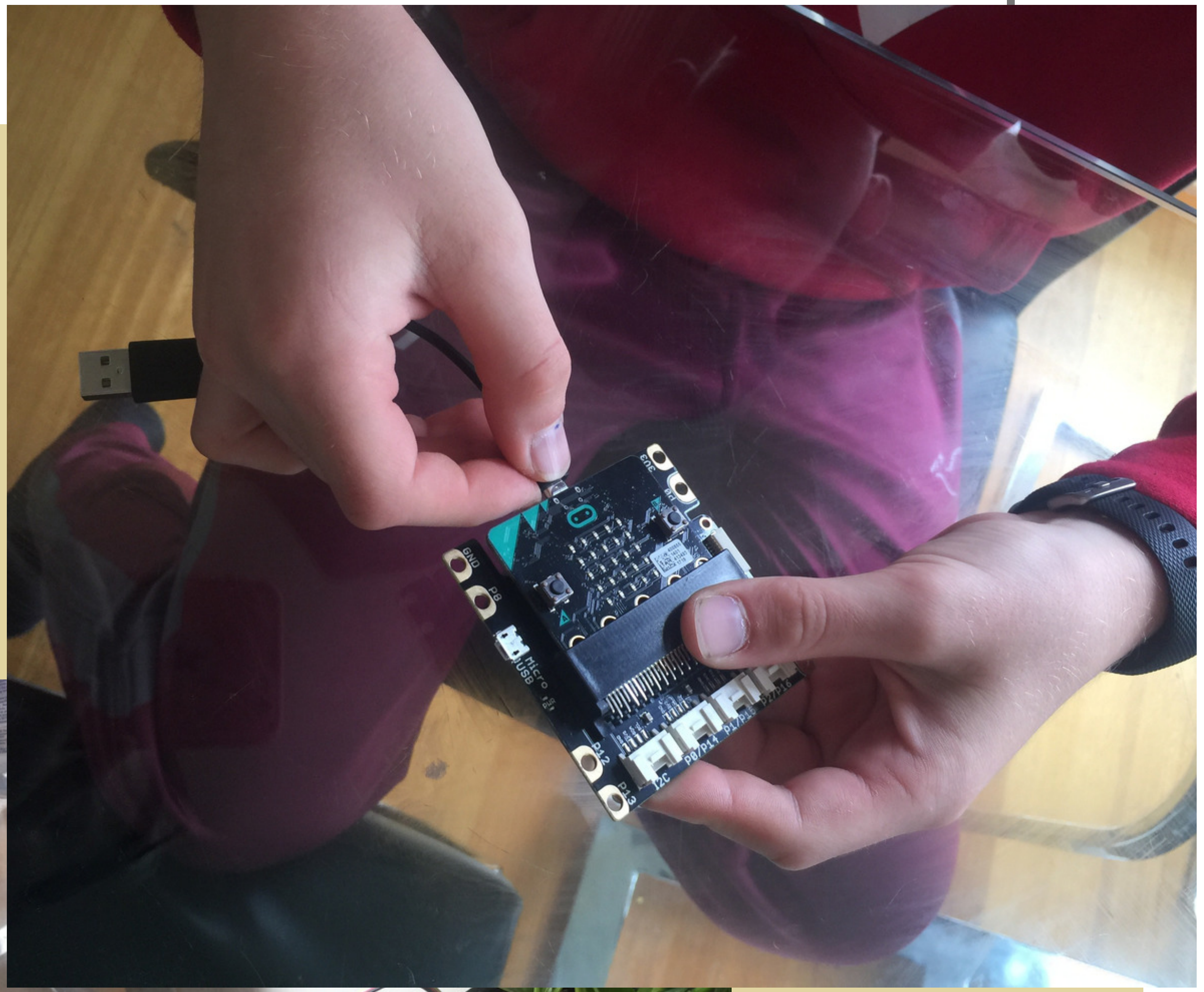
Lesson 3 - Generating and Designing

Evaluation Criteria	E	D	C	B	A
Student can define real world problem and decompose in terms of functional requirements and constraints required to produce a soil moisture sensor.	Student did not attempt the task.	Students made some attempt to define problem. Student identified some usability, functionality and data requirements for soil moisture sensor.	Students can define problem and idealise a possible solution. Student identified usability, functionality and data requirements for soil moisture sensor.	Students can define problem and describe multiple design ideas including functionality and possible constraints. Student can discuss how to use and provide accurate written instructions for sensor.	Student can do all of B level and can also: Evaluate suitability of their own and peers' digital solution, including how effective their own product is for intended use and how they may extend reliability.
Student designed, tested, modified and implemented digital solutions for sensor.	Student did not attempt the task	Student attempted to set up experiment using micro:bits and blockly programming but did not complete the task.	Student designed and programmed micro:bit using blockly visual coding, to test moisture in the soil to collect some data and read voltage.	Student designed, programmed micro:bit and using visual coding blockly, tested and implemented soil moisture sensor experiment to collect accurate data and read voltage.	Student designed, programmed using text based coding (javascript) within blockly, or converted python coding language, tested, modified and implemented soil moisture sensor experiment to collect data and read voltage.
Student analysed data collected to create solutions and reported on soil moisture experiment.	Student did not attempt task.	Student made some attempt to analyse data with minimal success. No recorded data and/or experiment.	Student attempted to analysed data with some success and recorded some written data. Student provided a verbal report on findings.	Student analysed data with success and completed visual graph representation. Student provided a detailed multimodal report on findings.	Student analysed data with success and completed visual graph representation and multi-model sophisticated presentation with extensive explanation on findings and potential extensions.

Through process of elimination and affordability they then researched independently and collaboratively communicated, discussed and justified their potential solutions and chosen programming software. After some lengthy discussion, they both decided on using micro:bit and grove Seeed kit to create a soil moisture sensor to collect, analze and evaluate data for the purpose of keeping the soil moisture at optimal levels for a seedling to germinate and grow. This product was justified as it was accessed within the school already and would lower the cost and time spent sourcing components and resources.

They determined strategies such as peer assessing for the coding to ensure any errors were mitigated and a collaborative approach so as to not place blame on each other for any one part going wrong. A collaborative approach was used so students could leaern from each other, and carefully scaffolded by the teacher, learn each other's strengths and weaknesses whilst building mutual friendship and trust. Through students becoming aware of a problem, identifying a data source and proposing an automated sensor they are using computational thinking; allowing their current thoughts, learnings and outcomes to be transformed through coding which requires a precise form of language to enable a system to operate (Henderson & Romeo, 2015).

They also worked with the teacher through the rubric and assessment criteria for the project. This ensured both students felt included and valued in each step of the design project. It also allowed for greater productivity as they could refer back to the rubric at any stage of the project and stay on track.



PROGRESS SNAPSHOTS

Lesson 4 - Producing and Implementing

This was a lot of fun for the students. Together they commenced playing with the micro:bits and were scaffolded using a website called Makecode that allowed them to create code for their project in both block and javascript (Makecode, 2018).
Firstly they gathered all their resources and began the coding journey. They then completed stage 1 of the soil moisture sensor. Once they evaluated the project as successful and they built confidence, they extended their learning to create an automated product of an automated soil moisture sensor, able to collect, analyse and evaluate soil moisture levels to maintain optimal soil conditions for seedlings. Many ups and downs, including modifying coding, changing the water levels, glass circumference, stick length, tape used all enabled students to complete the project authentically as in the real world.

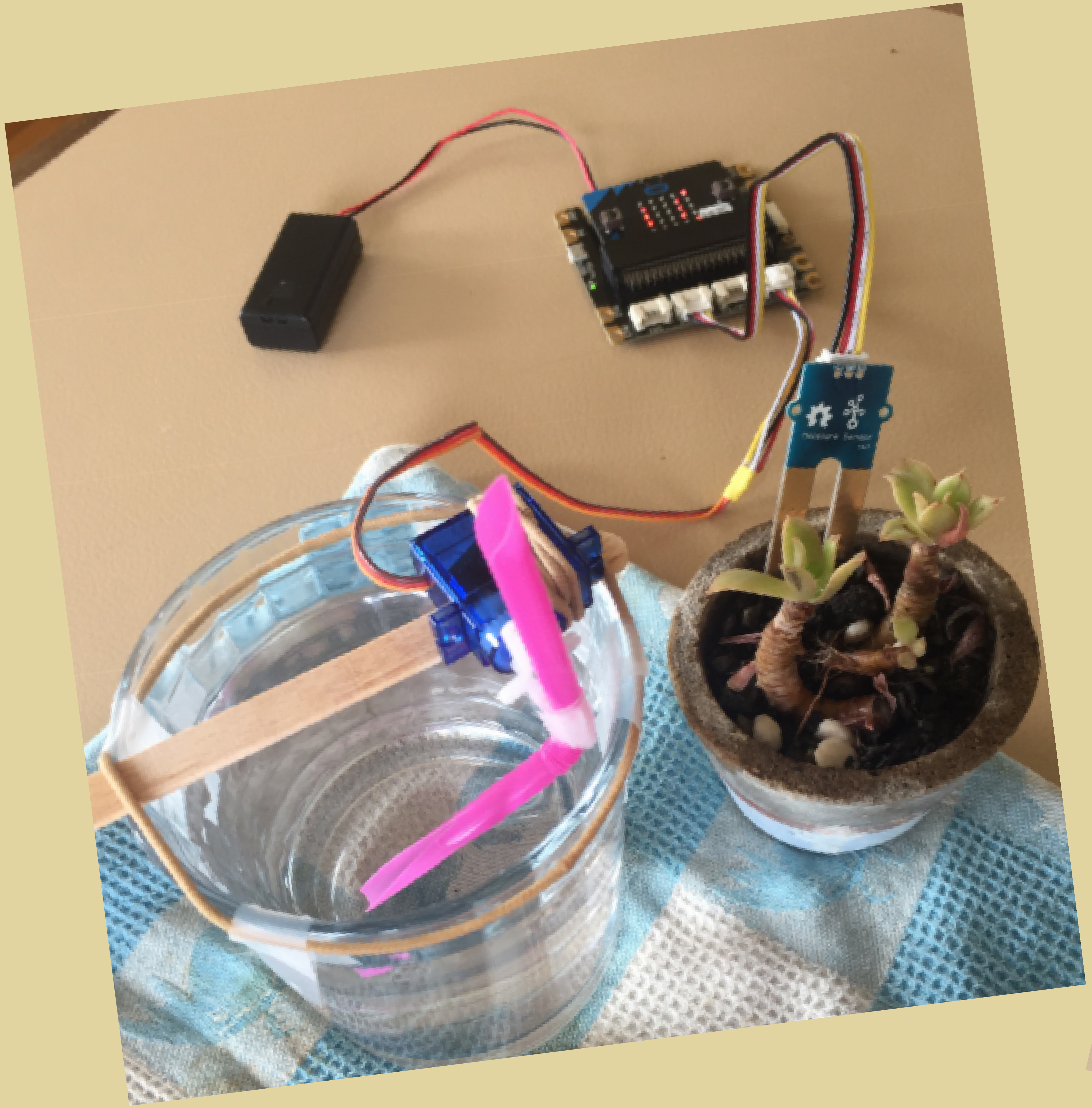
One interesting inclusion was the millisecond wait coded by the students with the thought of preventing constant current in the sensor and preventing the grove sensor from corroding. This was an unexpected learning but very welcomed. Make code was a great scaffold for the students as it allowed them to check their code and refer back whilst extending them to look at it in written form also. Saeli, Perrenet, Jochems & Zwaneveld (2011) support this pedagogy as they also believe that programming using scaffolds is beneficial to students' mastery of coding.

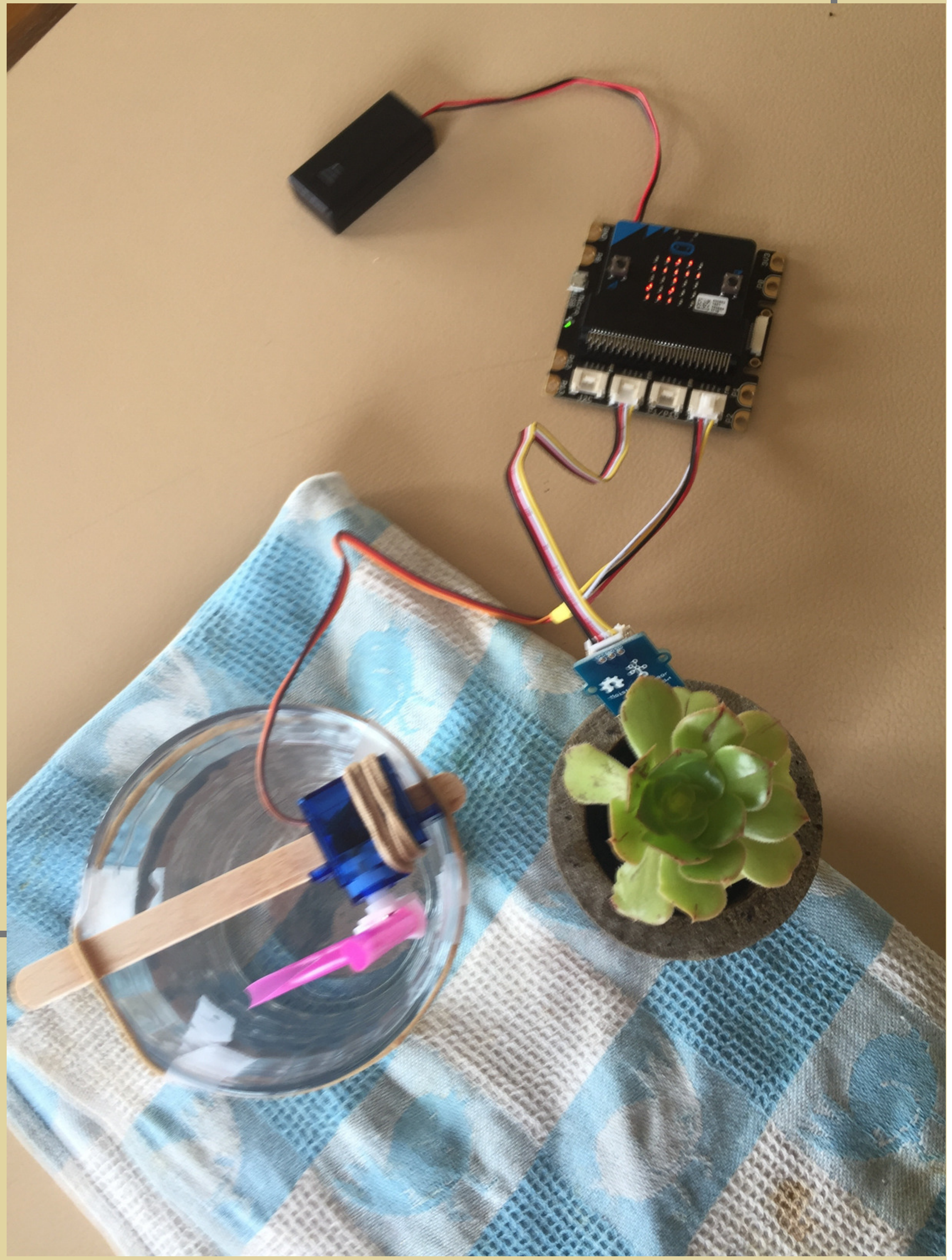
The students enjoyed discussion during the project of how incompetent humans are at understanding plant needs compared machines,, and how emotion and consistency plays a huge part of most flourishing gardens. This is supported by Turing (1950) who discussed a machines accuracy over humans.

```
forever
  analog write pin P1 to 1023
  set reading to analog read pin P0
  analog write pin P1 to 0
  plot bar graph of reading
  up to 1023
  if reading < 473 then
    show number reading

  if reading < 473 then
    servo write pin P0 to 0
    show icon
    pause (ms) 3000
    servo write pin P2 to 120
    pause (ms) 3000
    servo write pin P2 to 0

  pause (ms) 5000
```



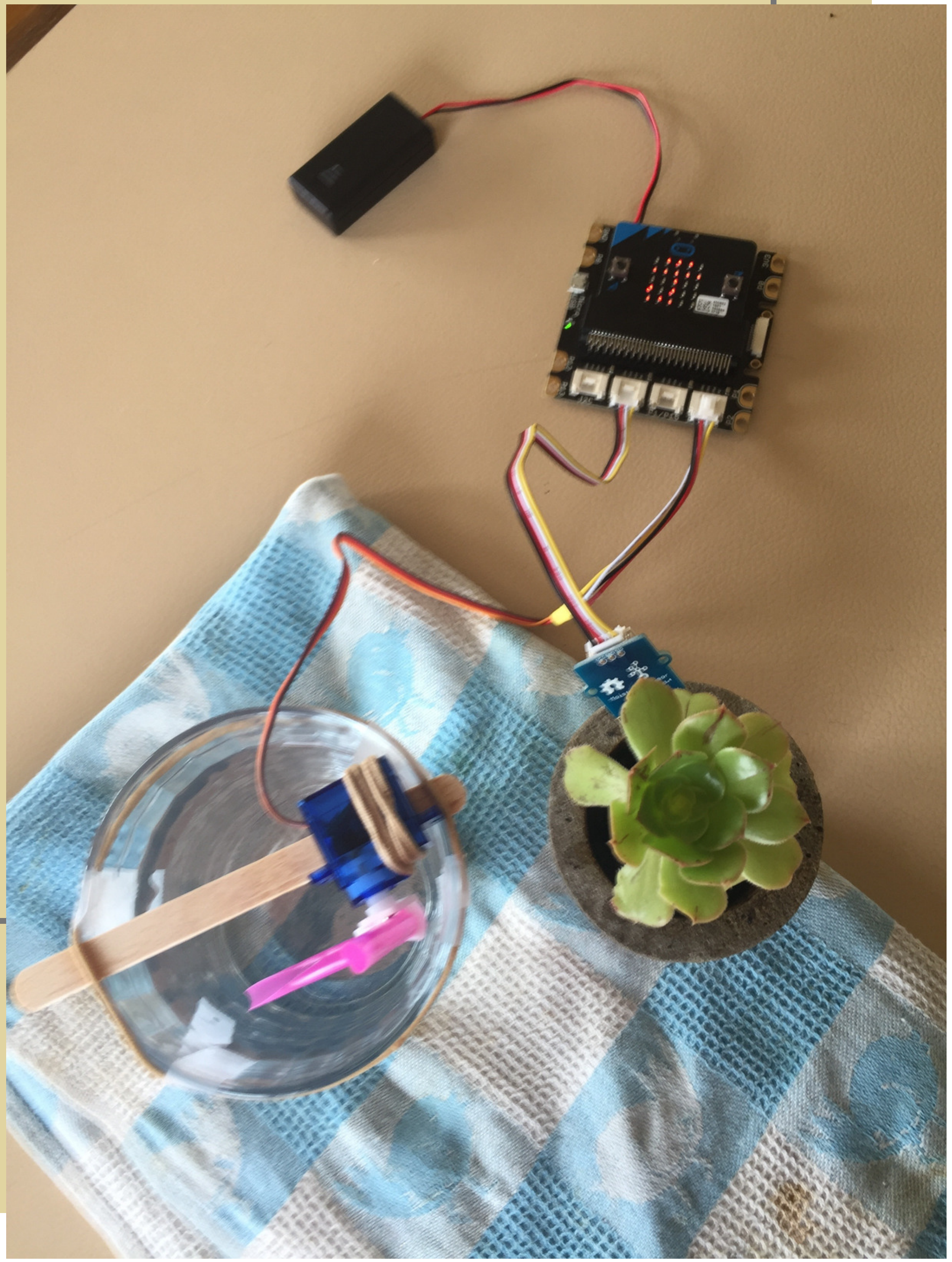


PROGRESS SNAPSHOTS

Evaluating - Lesson 5

The students tested the soil moisture sensor with a pot plant and it worked! The moisture levels are steady and the seedling, at this early stage, seems to be progressing well. How well the product solves the problem is yet to be fully determined. Although initially it seems successful, just how efficient it is with battery life and design will need to be determined over a longer period of time; along with its functionality in relation to environmental, social and economic conditions. Engagement in the project was amazing. This type of wicked problem based project is supported by Mishra & Koehler (2008), who discuss the increased engagement when the technologies, approaches and goals all connect.

This type of approach is why the project was determined by students as a success and also why through their enthusiasm, and outer discussion to peers, other students have shown interest in being a part of the next one.



EVALUATION CRITERIA

Quality of Student Learning Achievements

A celebration of learning is scheduled to be conducted next week so students can show other teachers, peers and community their solution. This also forms part of their assessment; their ability to communicate their design process and product.

A rubric was conferenced as one form of summative assessment to determine student process and evaluate their success.

Students kept a design journal for assessment, detailing their design steps and progress for assessment.

All assessments are based upon the Australian Digital Technologies Curriculum achievement standards. The project's heart surrounds how the Digital technologies curriculum integrates with students understanding of real world problems and through decomposition how they identify key elements and factors to enable them to transform potential solutions in ways otherwise not possible through the use of algorithms, programming and the use of digital systems to acuate change (Curran, 2017). They also evidence the ability to work as part of a team with some autonomy.

Through this project students are also evidencing the use of traditional, contemporary and emerging technologies to become early adopters within their schools and create innovative solutions for current needs (Australian Curriculum and Assessment Authority (ACARA), 2017).

WHERE TO FROM HERE...

Knowledge Is Confidence

Future ideas and modifications for the sensor determined by the students are:

- The attachment of a solar panel to the battery to allow the battery to continually charge and not go flat.
- They would like to conduct the test using the sensor in multiple conditions such as: Glasshouse, Classroom and outside to see what extent other environmental factors play in plant growth.
- With more time the students would like to assist in the implementation and operation of an autonomous water system in a garden setting. They determined to turn a sprinkler on and off you would need put a relay in between a bike battery (12v) and microbit to ensure that there is enough power to turn on water value (solaniod) on the tap and dispense water until above 500 and signal is sensed and water is turned off. They have sourced a Solaniod as pictured and cannot wait to be a part of the project next year.

The project lacked time to fully appreciate the usability of the sensor. With extended time, the object would include students to create flow charts and algorithms for the sensor, quantum quizzes to assist in students understanding of concepts (Project Quantum, 2018), analyse the data presented over time from plant growth in multiple conditions (see above for extension to project ideas) and ascertain which condition best suits the sensors and plant growth. Five sessions was not long enough for the students to fully analyse and evaluate their project. Future planning for this type of project would encourage a full term of weekly 60 minute lessons to ensure enough time was able to be spent on each part of the design process and students able to move between each element as required.

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