Agnetencollege
Peer

STEM-project

T³ VLAANDEREN

Woodlice biotope with the TI-Nspire and BBC micro:bit

Teacher's bundle

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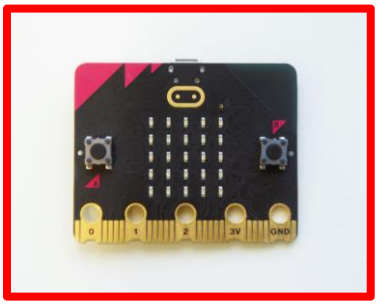
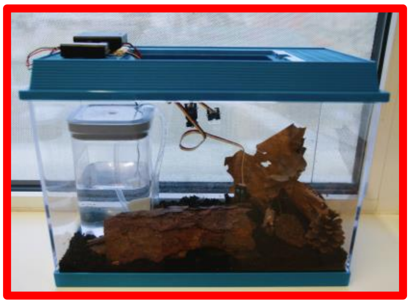
Ann-Kathrin Coenen
& Natalie Dirckx





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T^3-Flanders en T^3-Netherlands

Evelyn Blocken, Ann-Kathrin Coenen and Natalie Dirckx are science teachers at Agnetencollege Peer. They also belong to the teacher network of T3 Flanders that works closely with the Netherlands. T3 stands for Teachers Teaching with Technology. The goal of this organization is to promote the professionalization of teachers in the field of ICT and technology in education using technology from Texas Instruments.

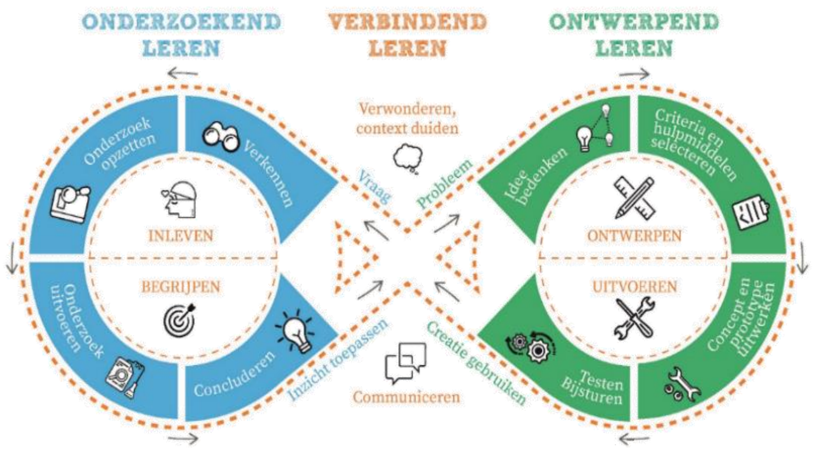
T³ VLAANDEREN

Figure 1: www.t3vlaanderen.be

Introduction

This project builds on the woodlice project in which students investigated the ideal environmental factors for a woodlice biotope. The focus is now primarily on working with and programming the TI-Nspire. In addition, students will have to work out their own experiments and write the lab report, with the method and supplies.

This project is structured according to the STEMOOV model. First, students will go through the investigative component using a literature review and experiments. After this, they will go through the designing part in building the woodlice biotope.



How do we address this in our lessons?

The shared student bundle contains all the lesson topics as one continuous bundle. However, we have chosen in our STEM lessons to break it down into lesson sheets. This way, students can review what is expected of them per lesson and what assignments need to be completed.

We offer the lesson sheets together with all the necessary material in a learning path. This learning path contains per lesson the necessary documents, weblinks, bookwidgets and upload zones. This provides a clear structure for both students and teacher.

Since we believe that the student goes through a learning process within a STEM project, no scores are assigned to the bookwidgets and documents. In addition, their knowledge on certain topics is also already evaluated within the directional subjects. Assignments are reviewed and feedback is shared. Accuracy of completion does factor into the teacher's assessment.

Introducing the BBC micro:bit

The BBC micro:bit is a popular pocket-sized computer or microcontroller. It is an interface for collaboration between software and hardware.

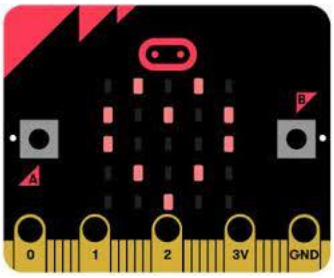


Figure 2: BBC micro:bit

The micro:bit has a 5X5 LED light display, push buttons A and B, touch input buttons, built-in microphone and speaker. In addition, this microcontroller itself contains many sensors including for temperature, light, motion and a compass. Finally, interaction with other devices or the Internet is also possible through a Bluetooth connection.

The micro:bit performs actions after programming instructions. These instructions are written in the Python programming language on the TI-84 Plus CE-T Python Edition or TI-Nspire CX II (Figure 4). In this bundle, the Nspire was chosen to code this project.

Figuur 3: python programming language

Python is an open source programming language that is simple and straightforward yet widely applicable in technologies. Programming in python is recommended for beginners, which makes this programming language very suitable for students.

Figure 4: TI-Nspire CX II

Programming with the TI-Nspire CX II

The TI-Nspire CX II is a graphing calculator with hands-on learning tools for both math and science classes. It can be used via software as well as handheld.

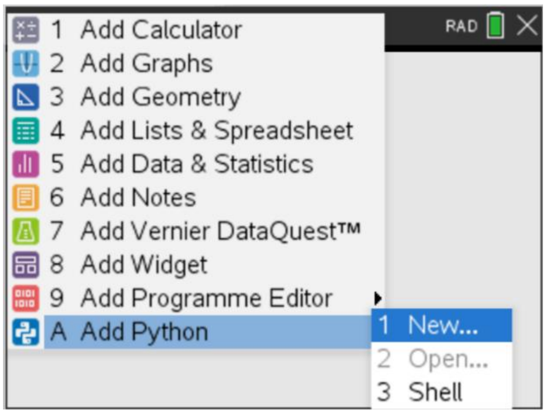


Figure 5 adding a new Python page

The python module will be used for this project. The code can be programmed on either the laptop or the handheld. You write new python code by creating a new document in the home menu and then selecting "Add Python" (Figure 5). Using the menu button, it is possible to add partially prescribed pieces of code. Both the micro:bit and the handheld must be fitted with a module before it is possible to program for the micro:bit.

From the [TI education] website you can download the necessary files (Figure 6) as a zip. You will find all necessary files in this folder including a roadmap for installation. After installing microbit.tns, it is possible to use certain functions of the micro:bit in the Python page of the handheld.

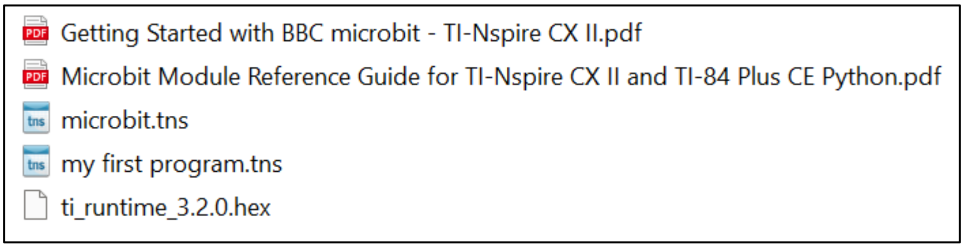


Figure 6: microbit.tns contains the module for the handheld, ti_runtime.hex is the module for the micro:bit

A hex file must be installed on the micro:bit. When the code is successfully placed on the micro:bit, the Texas Instruments logo will appear. The micro:bit can be connected to the TI-Nspire via the USB mini to micro cable.

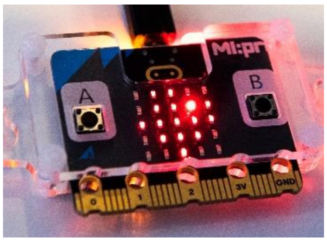


Figure 7: Texas Instruments logo on display of the micro:bit

The survey

Students are introduced to the project using the following problem statement.

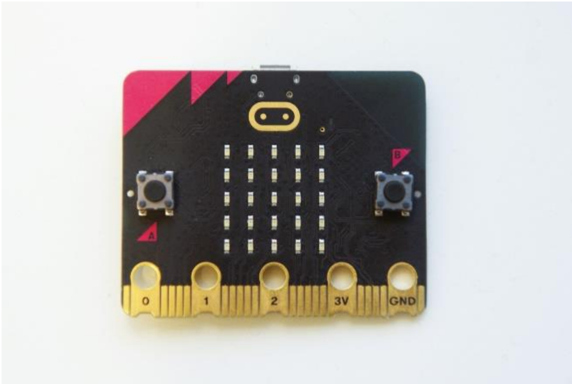
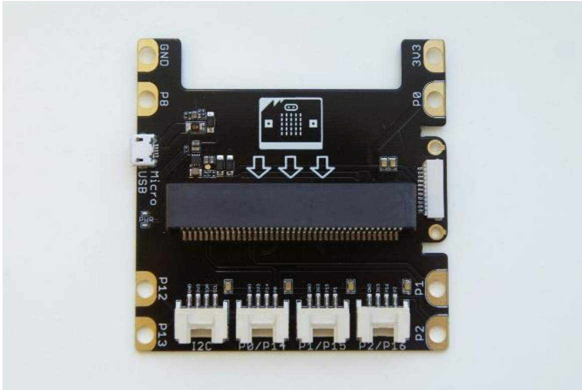
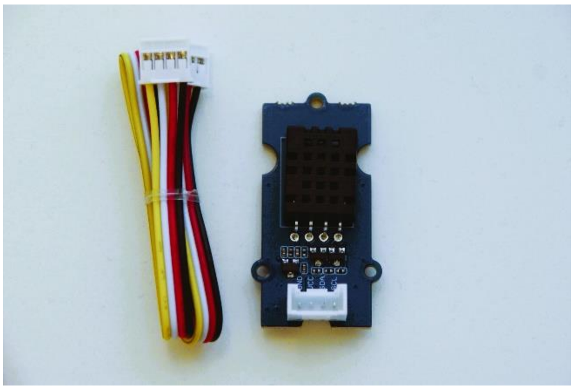
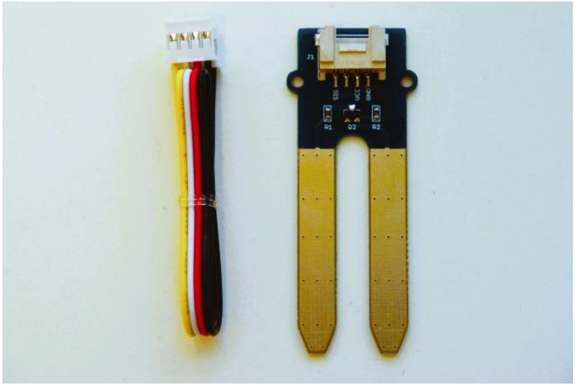
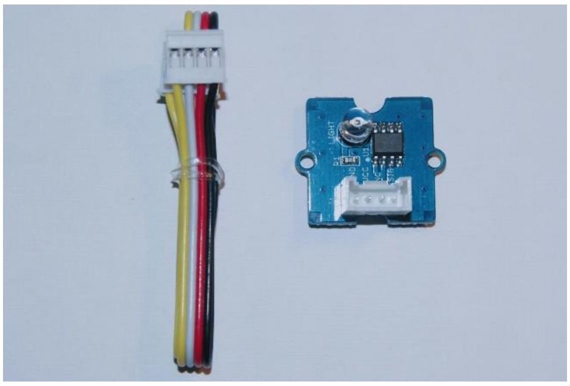
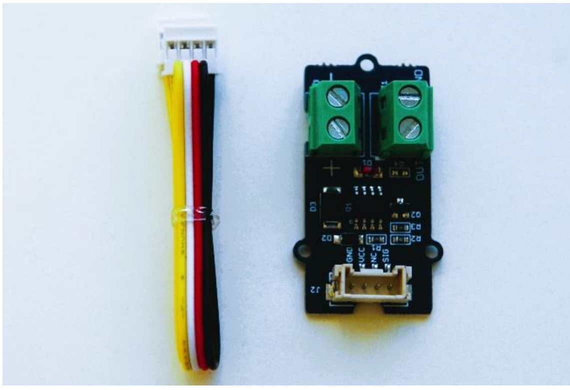
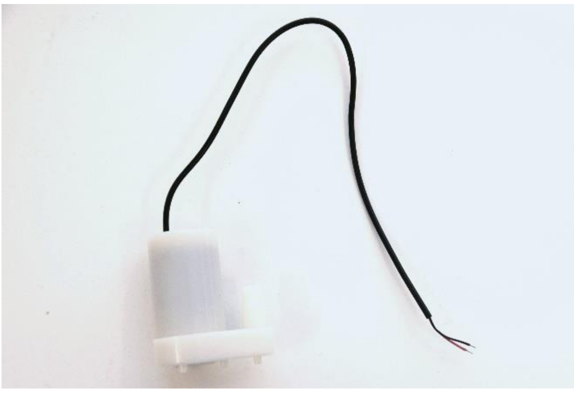
> Do you remember the story of Professor Marijns and her woodlouse research? Last year you helped Professor Marijns' lab very much. Thank you so much for that! Unfortunately, she now encounters a new problem.
>
> Through your research we know what the ideal biotope for woodlice looks like, but now she is looking for a way to monitor these different factors. This way it can be indicated that one or more of the environmental factors are no longer at their ideal levels. She asks for your help for this. Professor Marijns wishes you the best of luck in creating a monitored terrarium!

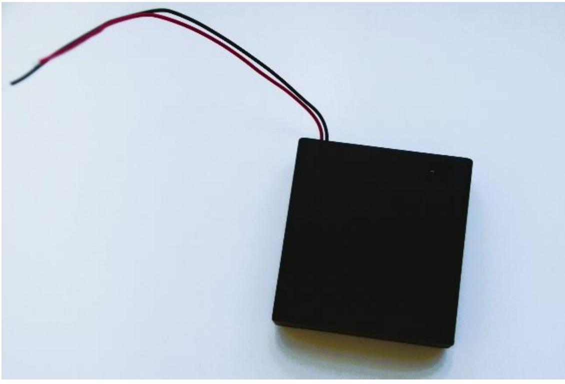
Ideally, students should be divided into groups of 3 to 4 students.

The supplies

The following supplies are required for this project:

- TI-Nspire CX-II-T with USB cable
- A BBC micro:bit with USB cable
- Mini-USB to micro-USB cable
- Grove Shield for micro:bit v2.0
- Grove - Light sensor v1.2
- Grove - Temperature & humidity sensor DHT20
- Grove - Moisture sensor
- Grove - Mosfet
- Kitronik 3V Vertical Submersible Water Pump
- Plastic tube for pump
- 4x AA battery holder with on/off switch
- 4x AA batteries
- Laptop or computer
- Woodlice

	
BBC micro:bit	Grove shield
	
Grove – Temperature & humidity sensor DHT20	Grove – Moisture sensor
	
Grove - Light sensor v1.2	Grove – Mosfet
	
Kitronik 3V Vertical Submersible Water Pump	Plastic tube for pump

	
4x AA battery holder with on/off switch	4x AA batteries

The schedule

The study is structured according to the following schedule:

- Lesson 1: introduction + exploring
- Lesson 2: preparing the experiments: adjusting the sensors to the limits of environmental factors
- Lesson 3: conducting the experiments
- Lesson 4: process the data and conclusion + brainstorm on the biotope
- Lesson 5: building the monitored biotope
- Lesson 6: continued building + testing the biotope

Lesson 1 introduction and exploring

In the first lesson, students are introduced to the project and divided into groups. In doing so, they form a hypothesis on the following research question:

"How can environmental factors be monitored in a woodlouse biotope regulated by the BBC micro:bit and TI-Nspire?"

After this, they start exploring the research using a literature review. This bookwidget is available through the following teacher link.

Lesson 2 exploring and preparing the experiments

From the previous project, students already know that woodlice prefer to live in dark, cold and humid environments. In the literature review, they have also already learned about how the different factors work. The students must now test the limits of these environmental factors in order to program the sensors correctly. For this, they themselves think of an experiment to test this. They write out their own method and list of supplies.

During the practical, students will use the grove sensors to measure the limit values. Depending on prior knowledge in programming, the code can be written in three ways.

1) The code is given completely ready to students.
2) The code is given in part, students are given a step-by-step plan/guide to complete it themselves.
3) The code is programmed completely independently by the students.

To limit the project to only six lessons, it is best to assign one environmental factor to each group. The knowledge found can be shared in class after this.

<u>Starting up a Python environment</u>

Go to the home screen and choose 'new'. Here you can choose 'Add Python'. After that, choose 'New'. Choose a name for your program without using a space. Via the menu button you can add the necessary functions. It is also always possible to type in the code yourself.

1. Temperature sensor

Write the following program. When you run the program you will see that every 5 seconds the temperature is measured and displayed.

The DHT20 sensor is an I2C sensor. Connect it to the I2C pin of the grove shield using the accompanying cable. Slide the micro:bit into this and connect it to the handheld using the mini-USB to micro-USB cable.

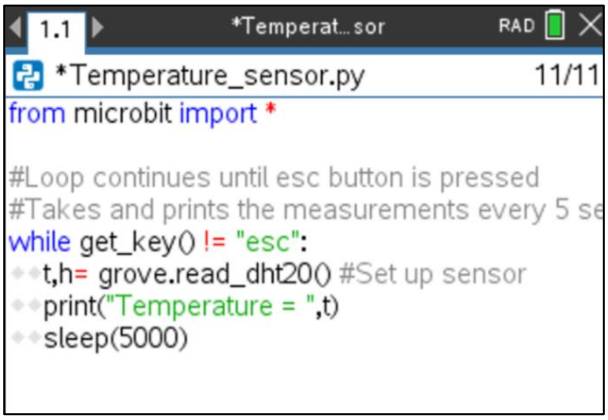


Figure 8: python code for measuring temperature with the DHT20 sensor, micro:bit and TI-Nspire

2. Light sensor

Write the following program. When you run the program you will see that every 5 seconds the light level is measured and displayed.

Using the associated cable, connect the sensor to pin 0 of the grove shield. Slide the micro:bit into this and connect it to the handheld using the mini-USB to micro-USB cable.

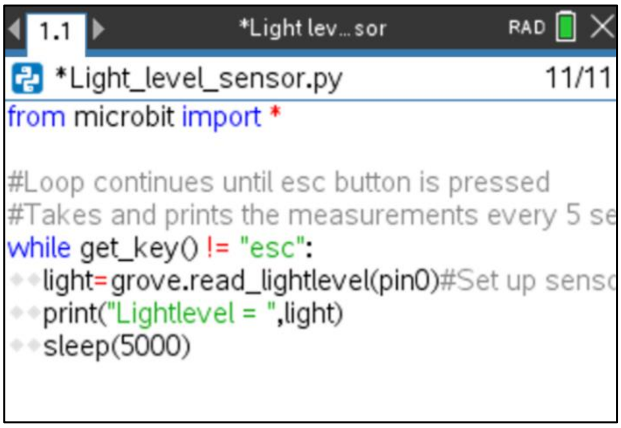


Figure 9: python code for measuring light level with the light sensor, micro:bit and TI-Nspire

3. Soil moisture sensor

Write the following program. When you run the program you will see that every 5 seconds the soil moisture is measured and displayed.

Using the associated cable, connect the sensor to pin 1 of the grove shield. Slide the micro:bit into this and connect it to the handheld using the mini-USB to micro-USB cable.

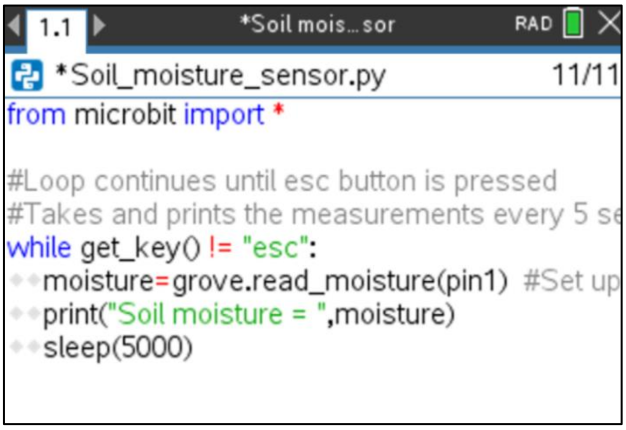


Figure 10: python code for measuring soil moisture with the soil moisture sensor, micro:bit and TI-Nspire

Lesson 3 conducting the experiments

In this lesson, the investigation is conducted. Students follow their predetermined method and record their results in the lab report.

Lesson 4 process the data and conclusion + brainstorm on the biotope

Students study their found results and relate them to the knowledge gained from the literature review of this and the previous project. They form a conclusion and complete their lab report.

Using these results, students build their biotope. They brainstorm about connecting the sensors and make a sketch. In addition, the code for the biotope must also be prepared. A message should appear when the temperature or light intensity is too high and/or to low, and a pump should apply water when soil moisture is too low.

Again, three ways can be chosen to set up the code with the students.

1) The code is given completely ready to students.
2) The code is given in part, students are given a step-by-step plan/guide to complete it themselves.
3) The code is programmed completely independently by the students.

1. The code

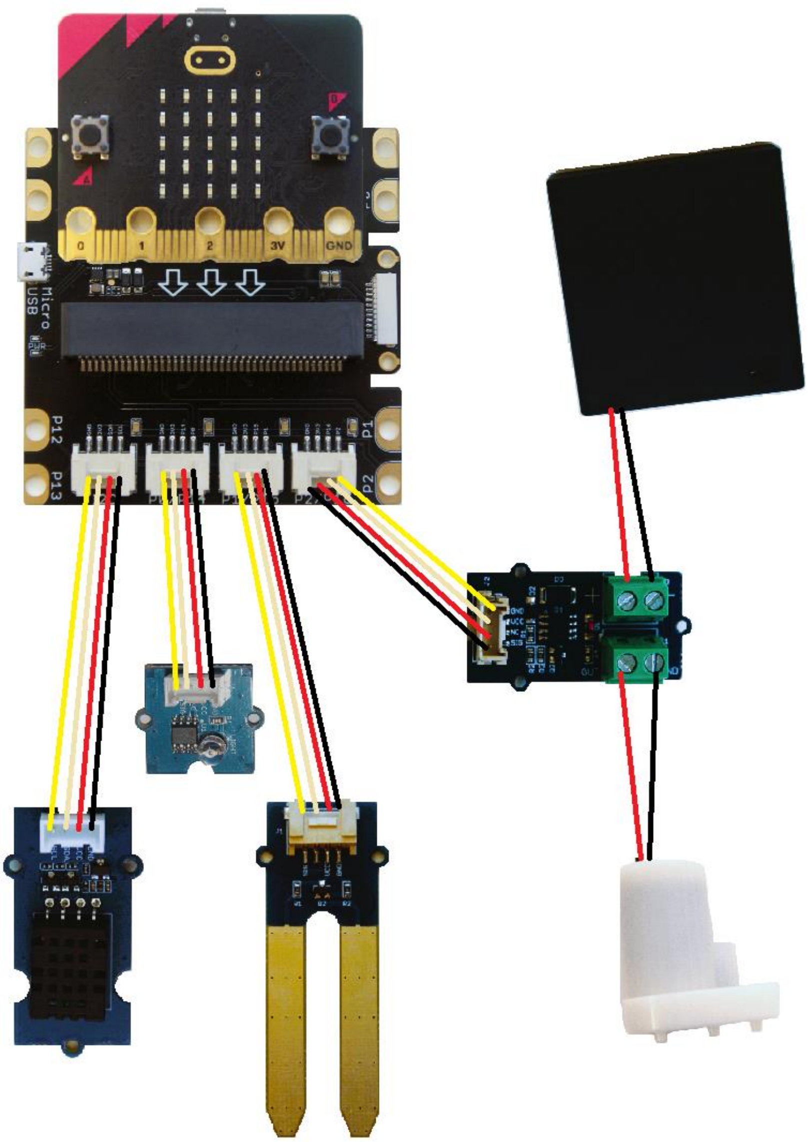
```
1.1        Biotope                RAD
*Biotope.py                      11/34
from microbit import *
#set up while loop
#this will run until esc is pressed
while get_key() != "esc":
  #Set up sensor
  light=grove.read_lightlevel(pin0)
  t,h= grove.read_dht20()
  moisture=grove.read_moisture(pin1)
  pump=pin(pin2)
  #print the measurements
  print("Lightlevel = ",light)
  print("Temperature = ",t)
  print("Soil moisture = ",moisture)
  
  #Set up if-else logic run to check conditions
  if licht>20:
    print("Too much light")
  if t>30:
    print("Temperature too high")
  if t<5:
    print("Temperature too low")
  if moisture<50:
    print("Soil moisture too low, pump on")
    pin2.write_digital(1)
    sleep(5000)
    pin2.write_digital(0)
  else:
    pin2.write_digital(0)
  
  #pause the loop for 5 seconds
  sleep(5000)

#Shut off pump when you escape from the loop
pin2.write_digital(0)
```

Figure 11: python code for monitoring the biotope with the micro:bit and TI-Nspire

Write the following program. When you run the program you will see that every 15 minutes the soil moisture, temperature and light level will be measured and displayed. It will also indicate if the temperature and light level is too high/low. For the soil moisture this will also be indicated and if too low it will mention that the pump is on. Depending on the position of the soil sensor, the water will not reach it immediately. Therefore, the choice was made to run the pump for only 5 seconds and then turn it off again.

2. Connecting the sensors

Using the corresponding cable, connect the sensors to the coarse shield. The light sensor to pin 0, the bottom sensor to pin 1, the mosfet to pin 2 and the temperature sensor to the I2C pin. Connect the pump and battery pack to the mosfet according to the diagram below. Slide the microbit into the grove shield and connect it to the TI-Nspire using the mini-USB to micro-USB cable.



3. Connecting TI-Nspire to micro:bit

When the biotope is finished, the micro:bit can be connected with the mini-USB to micro-USB cable according to Figure 12.

Figure 12: mini-USB to micro-USB cable

Lesson 5 building the monitored biotope
Lesson 6 continued building + testing the biotope

Finally, the biotope is built and the sensors connected correctly. After this, it is important to test for the biotope to work correctly.

Figure 13 a monitored biotope built by students