Air Pollution

Intermediate

Stimulate problem solving	**Silver**	**Stimulate entrepreneurship**	**Bronze**
Stimulate creativity	**Bronze**	**Informal learning enviro.**	**Gold**
Stimulate critical thinking	**Bronze**	**Technology use**	**Platinum**
Stimulate group work	**Gold**		

Practicalities

Preparation: 3u

Duration: 2 u to make sensor
4 u to do research

Material needs:

- NodeMCU ESP8266, CPU/WLAN
- SDS011 Fine dust sensor (formerly PPD42NS)
- DHT22, temperature & humidity (optional)
- Cable
- USB cable e.g.: flat 2m Micro-USB
  Power supply USB
- Cable straps
- Flexible tube, if possible not transparent, diameter 6 mm, length approx. 20cm (DIY store)
- Weather protection, Marley Silent HT Arc (DN 75 87°)
- Computer
- Articles about air quality

Group size range: 20
Ideal sub-group size: 2

Workshop made for: 16+
Easily transferable to workshops for ages between: /

Environment FabLab necessary: No

Educational area:
* Computer science
* Engineering
* Mathematics
* Science
* Technology
* Other

Precognition

It will be interesting to have searched some information already about air pollution. You can find some links at the last pages in the box ‘Content links’.

(see box ‘content links’ below)

Also try-out to install the sensor once before because at some computers there will be difficulties with anti-virus-programs etc.

Differentiated support

This is an idea of 3 students (Charlotte Huttener, Nathalie De Plus and Emiel Van Heule). They also made some small changes on this workshop.

Each student receives 3 help cards (= see example below). If another student asks them a question, they hand over 1 card to that student. When he hasn’t got any cards left, he mustn’t answer any more questions. This way, every student in the classroom must think and answer questions. This avoids that only the involved students put in the work.

Preparation

This workshop consists of two big blocks. In the first block we are going to make a fine dust sensor with an Arduino. In the second block we will look at the things we can do with the data we can get out of the sensor.

For the first block you will need some specific materials. So please buy them beforehand (2 months) because if you will buy them in China, you will need more than a month before you have the stuff.

Workshop Guidelines

Phase 1: News about our air

Material needs:
Essential: Some articles about air quality/pollution
Optional: computers to search information

Goals:
Skill Goals (**Blue**)
(S1) ***Search for (scientific) articles about a specific subject***
Content Goals (**Green**)
(C1) ***Explain in your own words what air pollution is.***
(C2) ***Explain that air quality depends on the amount of different particles in the air.***

Background story:

For this workshop, it would be best to make some links for your country. We have searched some articles about the air quality in Belgium.

https://www.hln.be/wetenschap-planeet/milieu/in-kaart-zo-is-het-gesteld-met-de-luchtkwaliteit-in-jouw-regio~a3007a3c/

https://www.vrt.be/vrtnws/nl/2019/12/30/de-luchtkwaliteit-gaat-er-weer-op-vooruit/

https://www.vmm.be/data/actuele-luchtkwaliteit

https://www.eoswetenschap.eu/natuur-milieu/aardbeiplantjes-brengen-oost-vlaamse-luchtkwaliteit-kaart-dit-het-resultaat

https://www.standaard.be/cnt/dmf20191022_04678007

At the end of this phase, the conclusion should be that it would be interesting to know what the air quality is around the school (on a field-trip) and to see if it's healthy.

Goals	Activities	Duration
S1 C1	In the introduction of the workshop, the participants will get or search some articles or videos about the air quality in their neighborhood. We want to stir their interest in the air quality. Whether they have to search themselves for articles or you provide them, is	20'

	something you can choose depending the level of the participants.	
C2	It’s important that the participants have an idea about the different ways to control the air quality. You can choose to provide this information, let the participants search it themselves or don’t give the information at all.	20’

Phase 2: Make the fine dust sensor

Material needs:
Essential: See long list at the end of this template.

Goals:
Skill Goals (**Blue**)
(S1) ***Make a circuit with Arduino following some guidelines***
(S2) ***Make a design for a cover of a sensor that was to be outside.***

We made a manual, which you can find after this guidelines. It is based on the information of the website https://luftdaten.info/en/construction-manual/. They will explain in detail how the sensor needs to be build. Please try it out before you do it with the participants.

Goals	Activities	Duration
S1	The manual will tell you in detail how you have to connect the different items together. We won't zoom in on this part to much because all the information should be found in the manual. Students of 16 years and older should be able to make the sensor in small groups of about 3 or 4 persons. For younger participants you can make an overview of all the steps in the manual and create workspaces for them. You can also give them a checklist of things to do per workspace. Provide them with pictures or short videos of the required actions.	100'
S2	Possible activity for the fast workers Let the fast participants design a more elegant casing for the sensor. Of course it still needs to be outside so it has to be resistant to several weather conditions. You can provide materials like plastic, wood, paint, …	Extra time

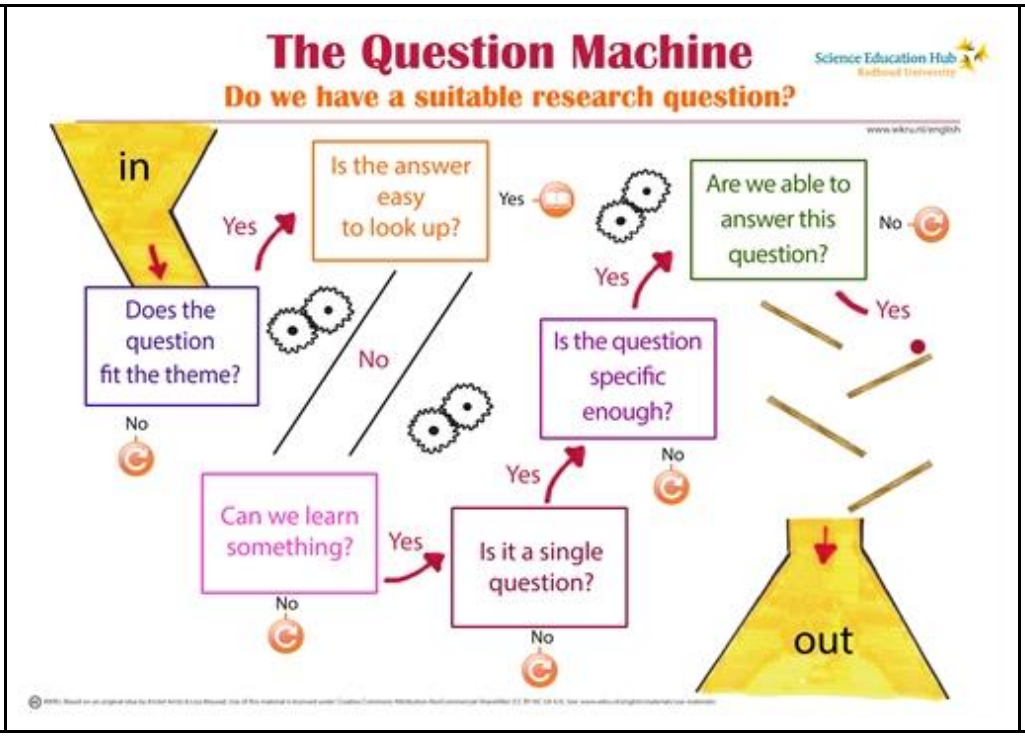
Phase 3: Measurements and experiments

Material needs:
Essential: The sensors who are ready, laptops with Excel.
Optional: Self-made worksheets

Goals:
Skill Goals (**Blue**)
(S1) Formulate your own research question
(S2) Make a research of something you're interested in.

This part will take some time spread in different weeks.

Goals	Activities	Duration
S1, S2	The first time you check the data, we will just focus on if the measurements work and maybe make just a little graphic of the data. Show the students an example. You will have to explain this in detail to younger participants. When we are sure that the sensors work well, we're going to let the participants do their own research with the sensors. They will do this using the steps 'research question, hypothesis, research itself and conclusions'. The best way to do this is by giving them a sheet with some guidelines. An example of a small research report you can let your participants make, can be found on the last pages. You will have to guide your students for them to make a proper research question. The amount of guidance will depend on how many times the students have already created such a question. For example, you can work with a question machine or give them a series of examples of good research questions.	2u at least


The Question Machine
Science Education Hub
Do we have a suitable research question?
in
Does the question fit the theme?
Yes
Is the answer easy to look up?
Yes
No
No
Can we learn something?
Yes
No
Yes
Are we able to answer this question?
No
Yes
Is the question specific enough?
No
Yes
Is it a single question?
No
out

Phase 4: And now? Action!

Material needs:
Essential: Paper or post-it , pencils and other brainstorm-materials

Goals:
Skill Goals (**Blue**)
(S1) ***Formulate proposals to improve the air quality***
(S2) ***Convince other people of your plan***

Goals	Activities	Duration
S1	This is a step which has to come out of the participants themselves. If this doesn't happen, you are not obligated to do this step. This is an important step. Teachers have to encourage students to do this step if they are not interested themselves. In this way students can practically understand about social responsibility, awareness of citizens etc Let the participants brainstorm together what they can do regarding the outcomes of the different researches. Let them make a clear plan about how they think they can change the air quality on the playground. You could steer them in the right direction by making a link to biology lessons about trees and plants for example. Let the participants brainstorm in groups. Afterwards let the groups present their ideas to the class. You can also formulate a few ideas yourself to inspire them.	2u
S2	When the plan is ready, it is time to turn the plan into action. Let the participants (whole class) make a clear plan on how they are going to convince other people to do something which can create a better air quality. Let the participants make a small flyer or poster. (crello.com, postermaker.nl)	2u

Phase 5: Evaluation

Material needs:
Essential: /
Optional: A sheet with smileys

Goals:
Skill Goals (**Blue**)
(S1) ***Make a product evaluation***
(S2) ***Make a process evaluation***

Goals	Activities	Duration
S1	The first thing we will evaluate is the product. So the sensor each group has made. The best way to do this is by making a list beforehand with things it must comply with. This can be that the sensor itself works but also that it's robust and it doesn't break if it rains.	15'
S2	Secondly we are also going to make an evaluation of the process. This will be about how the action took place. Had the action an evolution on the air quality at that place? How did the people of the school react? Etc.	15'
	in addition it's possible to do a product and process evaluation in teams. They can evaluate other teams about their plans and research action/report like the one in the example a the end of this guidelines.	

Pedagogical tips

Give the participants as many options as possible. Give them ownership on their research but help them when it's necessary. Depending on the grade of the participants they will need more or less guidelines.

How to transfer to non-Fablab environment

This is quite easy, except for the Arduino-stuff there isn't a lot of stuff you can only do in a FabLab-environment.

What you can do in a FabLab is make a better casing.

Content links

World Health Organization about Air Pollution:
https://www.who.int/health-topics/air-pollution

https://aqicn.org/map/europe/

Resources

https://luftdaten.info/nl/sensor-bouwen/

https://leuvenair.be/meedoen/bouw-je-eigen-sensor/

Long list material needs

NodeMCU ESP8266, CPU/WLAN	
SDS011 Fine dust sensor (formerly PPD42NS)	
DHT22, temperature & humidity (optional)	

Jumper wires (at least 7) Depending how you will make the connection with the bord you will need male-female or female to female.	
USB cable e.g.: flat 2m Micro-USB	
Power supply USB	

Cable straps	
Flexible tube, if possible not transparent, diameter 6 mm, length approx. 20cm (DIY store)	
Weather protection, Marley Silent HT Arc (DN 75 87°)	

Air Pollution
Instruction manual sensor

By Reinout Putman
Artevelde University College
Belgium

Inspired on luftdaten.info

What are you going to make?

Fine dust is a problem on many places around the world. Certainly in big cities. It causes heart and longue diseases.

If you talk about air quality, you can talk about the amount of many different particles in the air. Nitrogen dioxide (NO2), ozone (O3), soot (EC) and fine dust (PM10 and PM2,5) are the most important ones.

We will focus on that last group: the fine dust. We're going to measure the amount of particles in the air with a diameter of 10 micrometres and smaller and the of particles in the air with a diameter of 2,5 micrometres and smaller

You can spend lots of money on a professional sensor but most of the schools don't have the money to invest in these kind of sensors.

This instruction manual will learn you how to build a sensor for about 35 euros.

It will be cable to measure the temperature, the relative air humidity but most interesting: the PM10 and PM2,5.

What do you need to make the sensor?

NodeMCU ESP8266, CPU/WLAN

Power bank USB (small)

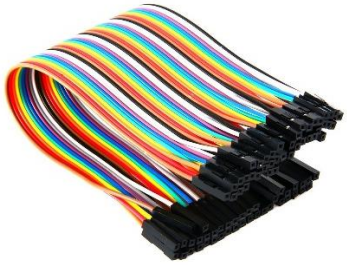
SDS011 Fine dust sensor (formerly PPD42NS)

Cable straps

DHT22, temperature & humidity (optional)

Flexible tube, if possible not transparent, diameter 6 mm, length approx. 20cm (DIY store)

Jumper wires female-female



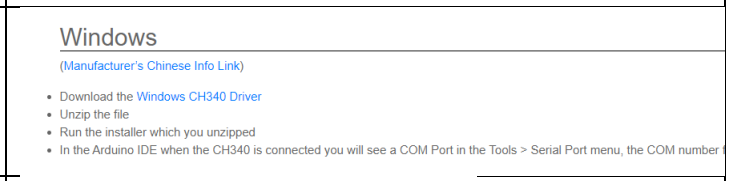
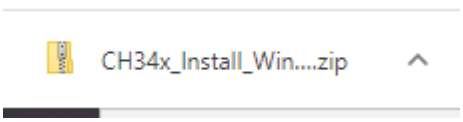
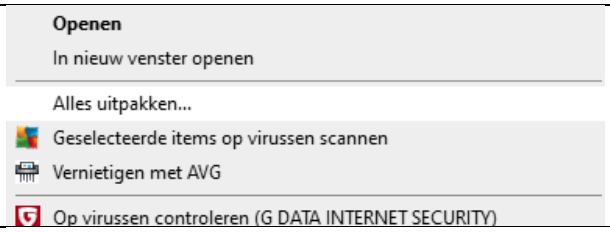
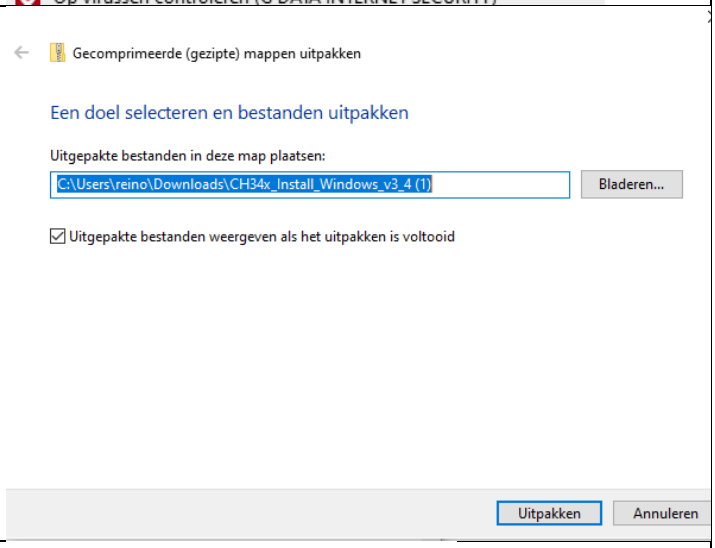
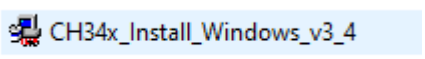
Weather protection, Marley Silent HT Arc (DN 75 87°)

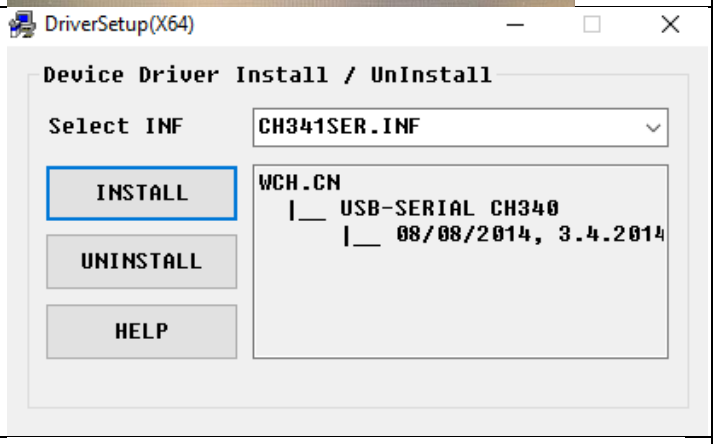
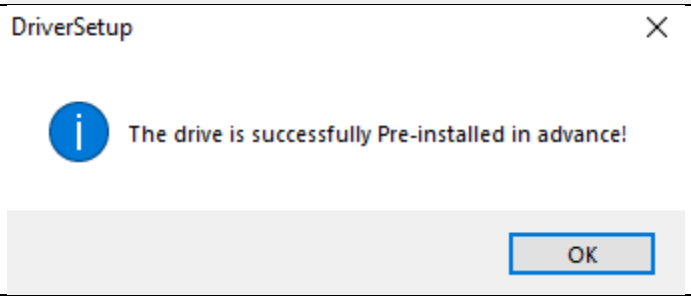
USB cable Micro-USB

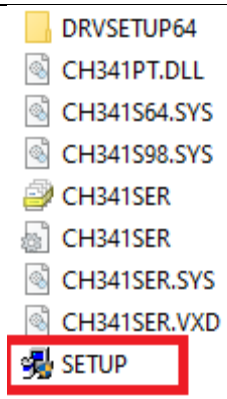
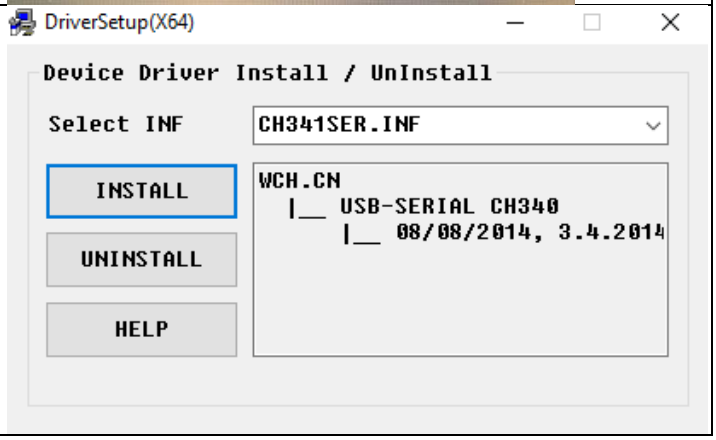
Let's start! Take your computer

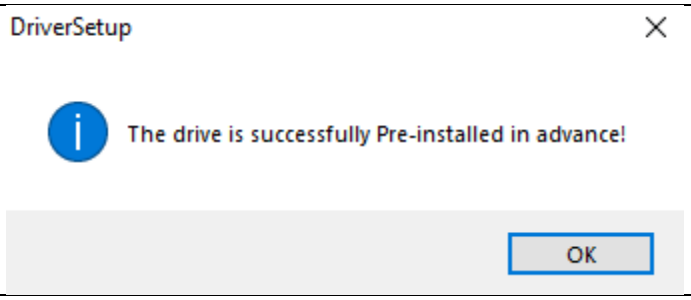
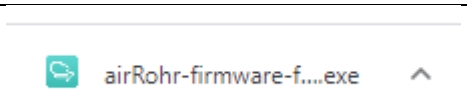
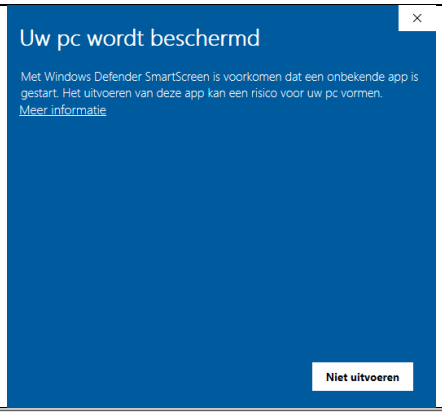
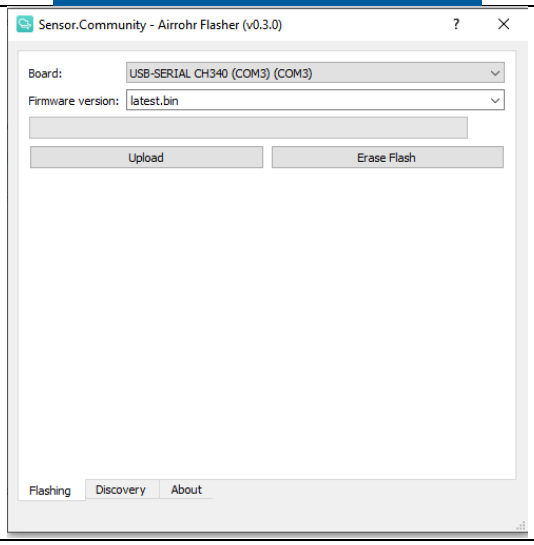
In this manual we will show you how to install the fine dust sensor with a Windows 10 computer. If you have another type of computer, you can find information on www.luftdaten.info

Install driver

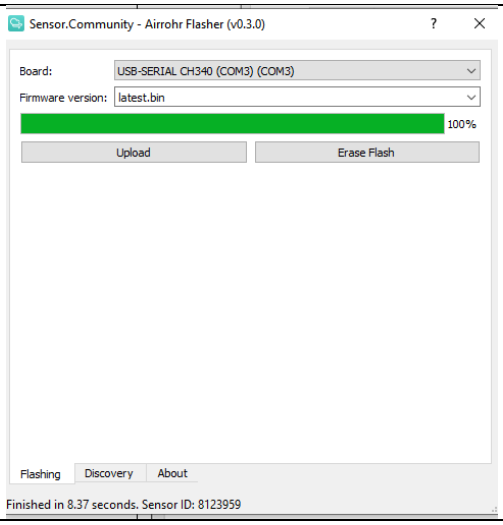
Go to Google and search for "CH341 ESP8266". You are searching here for the driver. I used "https://sparks.gogo.co.nz/ch340.html"	
Download this ZIP-folder.	
You can see now the folder at the bottom off your screen. If not, go to your folders > downloads and there it should be.	
Unzip this folder. You can do this by clicking with your right mouse and then ask to unzip this folder.	
The computer will ask you now, where to put the unzipped-folder. You can put it in the downloads-folder.	
In the unzipped folder you should see this program to install. Click on it twice.	

Your computer will ask if you are sure that this software can be on your device.	
Install the software.	
You will get a message that the driver is installed.	
Install software	
Check the backside of your NodeMCU. This will tell you if it's a version 2 (V2) or a version 3 (V3)	
V2 For a version 2: Go to: https://www.silabs.com/documents/public/software/CP210x_Universal_Windows_Driver.zip	**V2**

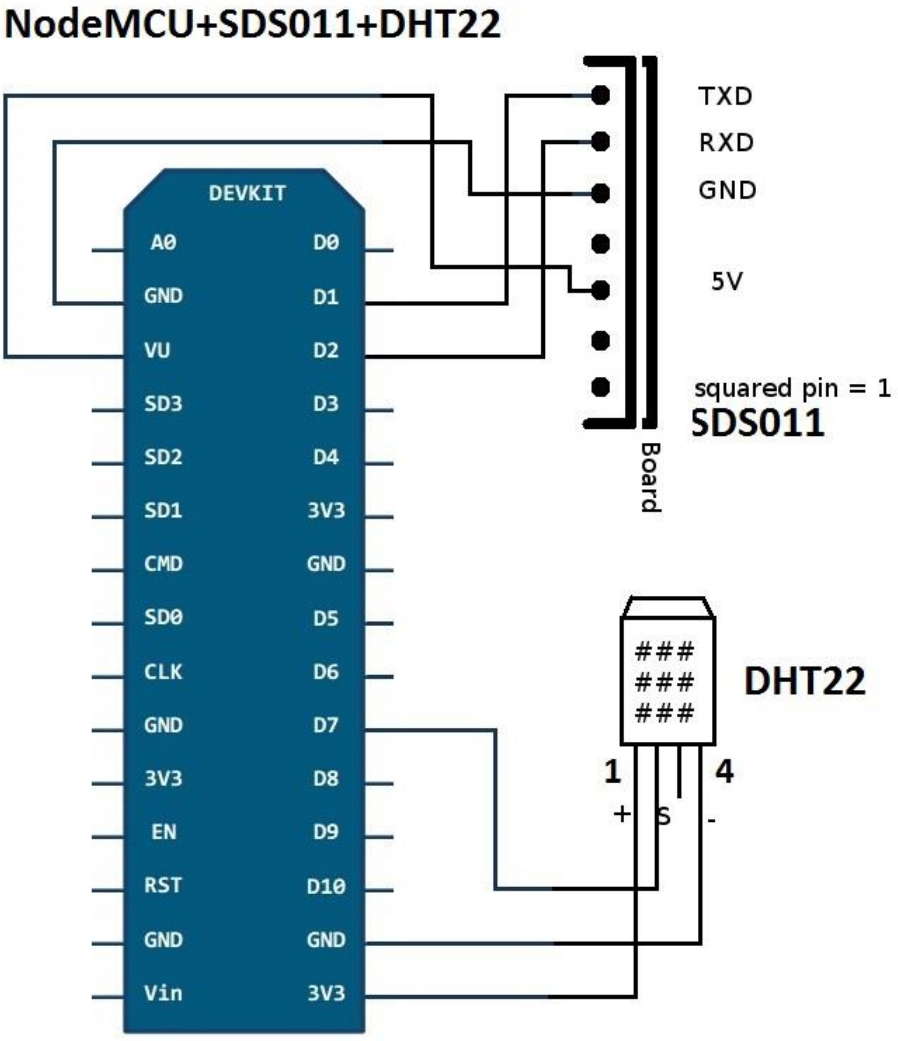
A new zipped-folder will be downloaded.	
V3 For a version 3: Go to http://www.wch.cn/downloads/file/5.html A new zipped-folder will be downloaded.	**V3**
Unzip the downloaded folder, open the unzipped folder and click on SETUP.	
Your computer will ask if you are sure that this software can be on your device.	
Install the software.	

You will get a message that the driver is installed.	
Download firmware	
Go to https://firmware.sensor.community/airrohr/flashing-tool/airRohr-firmware-flasher-0.3.0-Windows_amd64.exe The firmware will be downloaded. **Note**: It's possible that your virusprogram won't let you download this. Put the website on the whitelist so you can go on.	
Try to open the firmware. It's possible that your windows defender will give you this screen. Click on 'more information' and 'do it anyway'	
If it works well, you will see this screen. Take the NodeMCU and connect it to your computer with USB. It should detect the NodeMCU in the USB-port. It will search for the latest version of the firmware. If it works ok, this should come on your screen automatically. Click on "Upload"	

You can see this step is ready when at the bottom of your screen the message “finished” pops-up. You can now close this screen.



Connect elements



You are now going to connect the NodeMCU to the SDS011 and the DHT22.
Use for each connection a different collor of wire.

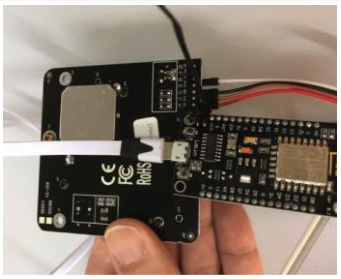
Here follows an overview of each connection for the 3th version of the NodeMCU. If you are using an older version: use VIN in stead of VU, GND in stead of G and be careful because the drawing above is for the newest version.

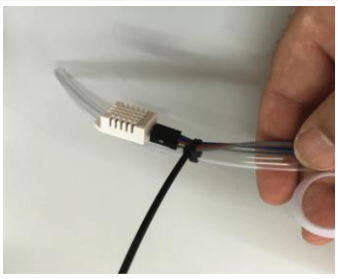
Connections SDS011
SDS011 Pin 1 -> Pin D1 / GPIO5
SDS011 Pin 2 -> Pin D2 / GPIO4
SDS011 Pin 3 -> GND
SDS011 Pin 5 -> VU (NodeMCU v3) / VIN (NodeMCU v1,v2)

Connections DHT22
DHT22 Pin 1 -> Pin 3V3 (3.3V)
DHT22 Pin 2 -> Pin D7 (GPIO13)
DHT22 Pin 3 -> Ongebruikt
DHT22 Pin 4 -> Pin GND

assembling

Tie NodeMCU (ESP8266) and SDS011 fine dust sensor together with a cable tie. Point the Wifi antenna away from the sensor (see picture).



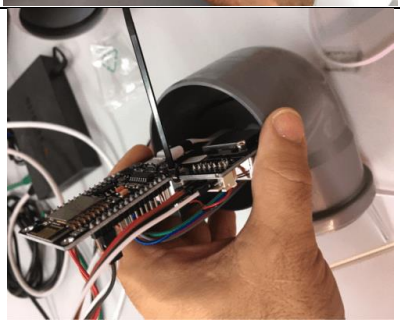


Tie the temperature sensor DHT22 to the tube with another cable tie.

Pull the USB cable through the pipe.
Install the SDS011 particle matter board. The fan is pointing down.

Push parts into the pipe, so that the sensor fixates in the pipe.

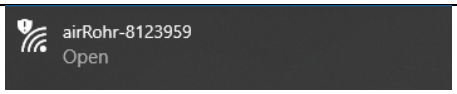
Tube and USB cable should be looking out of the pipe.
Connect the second Pipe. Make sure that no cables are pinched.
Position the temperature sensor at the end, so it still sits inside the pipe.
Cut the transparant tube

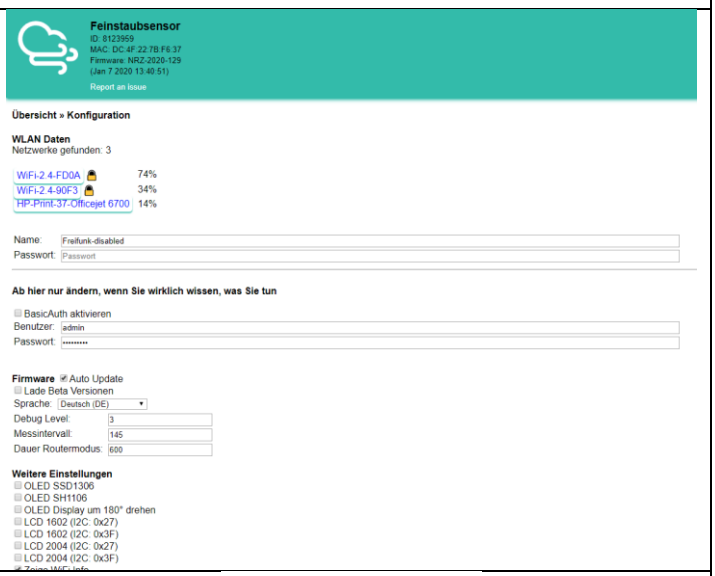
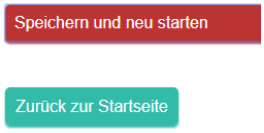


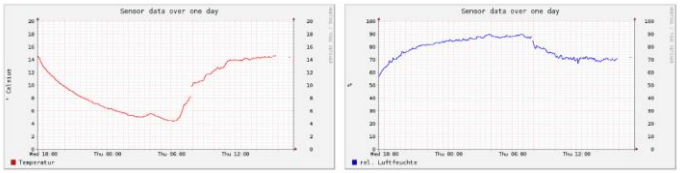
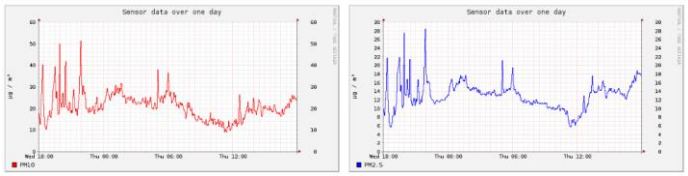
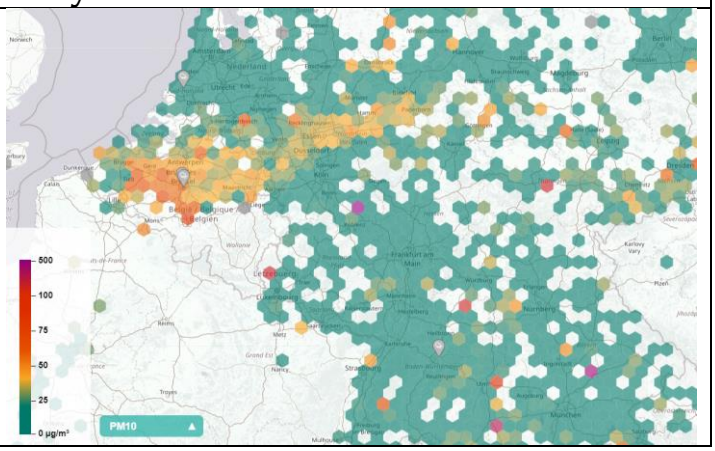
Close the open ends of the pipes with a net or similar, so that the air can circulate but insects stay outside.

Configuration

Go to the place where you will measure the amount of fine dust. On this place you will need a Wi-



Fi signal. Connect the station with a power bank. The station will try to make a connection with your computer using Wi-Fi. **Write down the number you see next to airRohr.** Make connection with this signal by clicking on this network.	
This page should open automatically on your computer. If it doesn't you can go to http://192.168.4.1/ Sometimes you will still have to click on 'configuration' to see this page. You choose the right Wi-fi it has to connect with. You fill in the passwort and afterwards, you scroll down till the end of the page. Don't do anything else.	
If you have chosen the Wi-fi, you can click on the red button which says 'Speichern und neu starten'	
Your device now starts to measure! 😊	
After about 10 minutes, you can go to the website http://www.madavi.de/sensor/graph.php Click at the same time 'ctrl' and 'f', type the number you had to write down. Note: the website won't find your number if it's not on the screen yet. First scroll down till the end of the page and then search your number.	

If your number had been found, the website will guide you to 2 links: one ends with dht. Here you can find information about the temperature and the relative humidity. Tip: safe this page somewhere so you do not always have to search in the long list.	
The other one ends with sds011, this gives you the amount of PM10 and PM2.5.	
You can choose to see graphics from one week, one month, one year and 24 hours (this is an average from the past 7 days)	zeige Wochengrafiken / show weekly graph zeige Monatsgrafiken / show monthly graph zeige Jahresgrafiken / show yearly graph zeige Grafiken mit gleitendem 24h-Durchschnitt über 7 Tage / show 24h floating average over 7 days graph
Share your data	
When you go to http://my.luftdaten.info/ you can share your collected data with other people. You can put your data on this map.	

FAQ

Here is space to answer some questions.

Let's all try to convince people to lower the pollution!

Recources:
https://www.samenmetenaanluchtkwaliteit.nl/zelf-meten
https://luftdaten.info/en/home-en/

Air Quality Ghent 2020

12 JANUARI

Artifex

Made by: Example

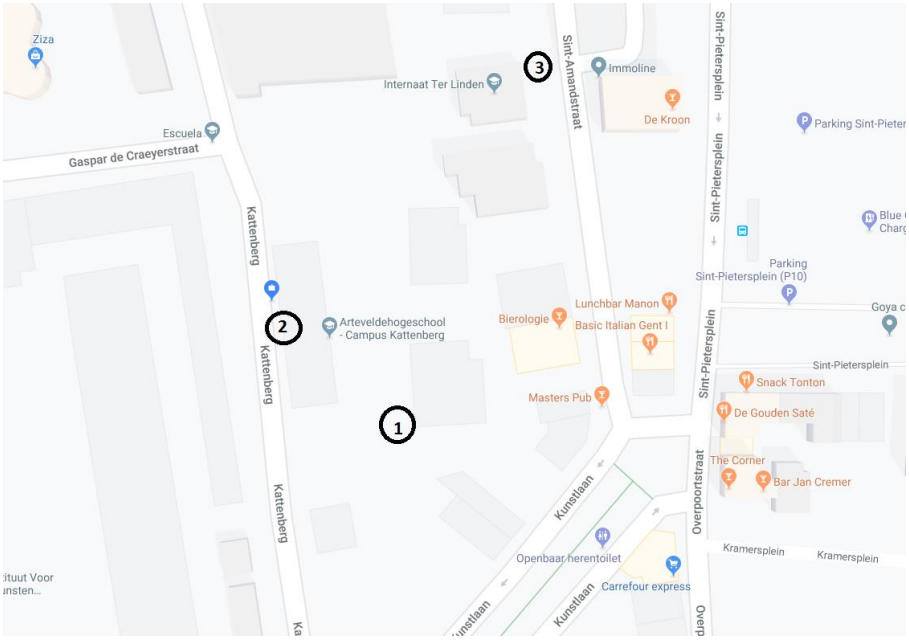
What is the influence of cars near our playground for the air quality

A research done by …

In january 2020 we did a research on the air quality of our playground and what the influence of cars in the Mountainstreet means for the quality.

We did a reasearch with 3 air-quality sensors. They measured the fine dust PM10 and PM2.5.

The air quality sensors where installed at 3 meters high on the following places.



…

…

„We could see a clear difference in PM2.5 at our playground when there were no cars in the Mountainstreet.“

All the measurements can be found on the next pages.

Workshop Air Pollution

Phase 1: News about our air

Each individual group received different articles, videos and other sources about the air quality in our country. Before you start your research, make a **hypothesis** of your expectations about the quality of our air.

Hypothesis:

_____

_____

_____

Now let other students read your hypotheses or explain it to them. Also check out the other students' hypothesis. Is there a big difference? If so, how can you explain this?

_____

_____

Research

Now its time to do some research! Go ahead and check out the sources the teacher handed out.

Note: Make sure you also go online and look up some more information about **different ways to control the air quality.**

How can you control the air quality? Write down at least **one** way.

_____

_____

Phase 2: Make the fine dust sensor

The manual will tell you in detail how you must connect the different items together. We will not zoom in on this part to much because all the information should be found in the manual.

Phase 3: Measurements and experiments

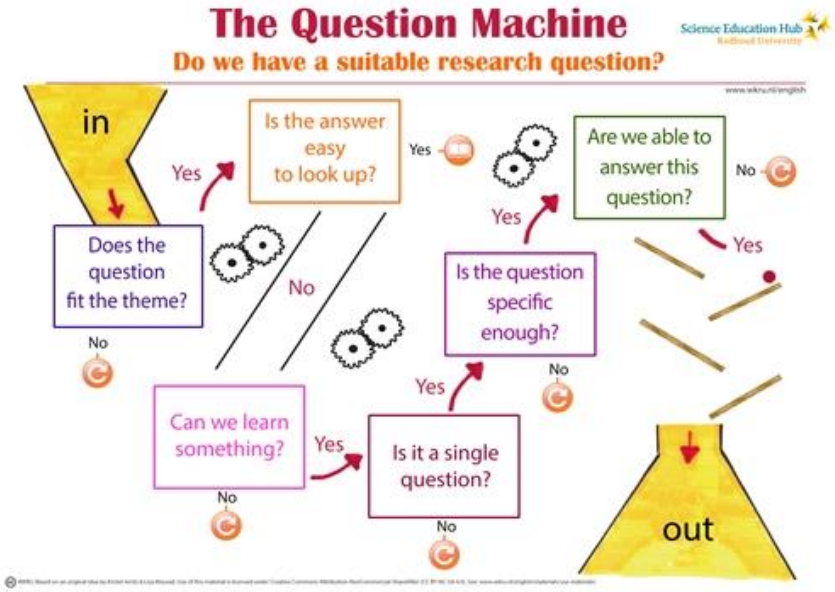
The first time we check our data, we will just focus on the fact whether the measurements work. Make a graphic of the data you receive below.

Graphic

Now that we know our sensors work well, you can do some research on your own. Your research will go as following: Come up with a good **research question**, make a **hypothesis**, do the **research** and write down your **conclusions**.

Research question

To start your research, you need a well formulated **research question**. If you think you need some help you can always use **the question machine** on the right here. This roadmap helps you to come up with a solid research question.



*Write down your **research question** below:*

_____

Now you have your research question, it is time to make a hypothesis again. Write down below what you think the outcome will be.

Hypothesis:

_____

_____

Research

Now it's time to do some research about your research question. Make sure you check as many sources as possible.

Note: Make sure you follow the **guidelines** on the sheet the teacher gave you.

Conclusions

Use the space that is left on this page to write down **your research** and your final **conclusions**.

Phase 4: And now? Action! (optional)

Brainstorm time… Now that all of you did some good researches, it may be nice to listen to each other's ideas. This way we could think of ways to improve the air in our area by working together.

Write down your ideas for improving our air quality in the box below. ↓

Make a plan

Think together and make a clear plan on how you are going to convince other people to do something which can create a better air quality.

Tip: You can make posters or flyers with free software like www.crello.com, www.postermaker.nl,...