PROGRAMMING A LIGHT POLLUTION DETECTOR

Workshop Plan Introducing the "Connect for Global Night" Project

Duration: 90 minutes
Age group: 15–19 years
Number of participants: 5–15 people
Format: in-person workshop
Location: Poland, Tunisia

Main objective

To develop young people's technical and digital competences through designing and programming a light detector, while helping them understand light pollution as a global environmental challenge. Participants will learn how technology can support environmental research, data collection and informed civic action.

Specific objectives

Participants will:

- understand the concept of light pollution and recognise its environmental and social consequences;
- understand how embedded systems and Internet of Things (IoT) technology can be used for environmental monitoring;
- build and program a light detector using an ESP8266 microcontroller and a light sensor;
- connect the device to a Wi-Fi network and transmit measurement data to a cloud platform;
- collect and compare light measurements under different environmental conditions;
- recognise the importance of reliable measurements, calibration and critical interpretation of data;
- understand how local observations can contribute to research on global environmental challenges;
- recognise the value of international cooperation and shared knowledge in addressing environmental problems.

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Polish aid

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Natural Sciences / Physics / Astronomy

After the session, the participant will:

- explain how light sensors detect and measure light intensity;
- understand the relationship between artificial light at night and light pollution;
- identify examples of artificial light sources in their surroundings;
- recognise that excessive artificial lighting affects the natural night-time environment.

Geography / Environmental Education

The participant will:

- understand that light pollution is a global environmental challenge with different local manifestations;
- recognise how urbanisation, infrastructure and access to electricity influence night-time environments;
- compare local environmental observations with information from other geographical contexts;
- understand the importance of international cooperation in researching global environmental issues.

Global Education / Civic Education

The participant will be able to:

- explain why environmental data and scientific evidence are important for informed decision-making;
- identify possible actions to reduce unnecessary artificial lighting;
- recognise their role as young citizens in communicating environmental challenges and promoting sustainable solutions.

Digital and Technical Competences

The participant will:

- explain the basic principles of embedded systems and IoT technology;
- write or modify a simple program to read data from a light sensor;
- connect an ESP8266 microcontroller to a Wi-Fi network;
- send sensor readings to a cloud platform;
- identify and solve basic hardware, software and connectivity problems.

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Social and Intercultural Competences

The participant:

- works in a group;
- presents their own observations and arguments;
- listens to other perspectives;
- recognizes the diversity of environmental and social conditions.

TEACHING METHODS

- **Expository: Short presentations and explanations.**
- **Problem-solving: Technical challenges and troubleshooting.**
- **Practical: Building and programming a light detector.**
- **Experimental: Testing the sensor under different lighting conditions.**
- **Interactive: Brainstorming, guided discussion and reflection.**
- **Collaborative: Group work and sharing measurement results.**

MATERIALS NEEDED

1. ESP8266 (NodeMCU) microcontroller.
2. Digital light sensor (e.g. BH1750).
3. Traffic Light Module (LED module).
4. Female-female jumper cables (approximately 10 pieces).
5. USB-microUSB cables.
6. Laptop with Arduino IDE and/or TUNIOT for ESP8266 installed.
7. Internet access and Wi-Fi connection.
8. Cloud platform for collecting and visualising data (e.g. ThingSpeak or another shared project platform).
9. Instructions for connecting the BH1750 sensor (**Attachment 6**)
10. Instructions for programming the ESP8266 and connecting it to Wi-Fi (**Attachment 7**)
11. Worksheets for recording and comparing measurements (**Attachment 8**)
12. Projector or interactive whiteboard.

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SESSION PLAN

Time	Description	Notes
10 min	**Introduction: Technology as a Tool for Understanding Environmental Challenges**	
	The educator introduces the topic by asking learners: - Where do we encounter artificial light at night in our everyday surroundings? - Can excessive artificial lighting be considered an environmental problem? Why? - How could we measure the amount of light in different places?	Connect the activity with the global dimension of light pollution. Emphasise that local observations are part of a wider environmental picture.
	The educator briefly explains that light pollution is not only an obstacle to astronomical observations. It also affects human health, natural ecosystems and biodiversity.	
	Learners discuss how technology and scientific measurements can help us understand environmental problems. The educator introduces the idea of using a light detector to collect data that can later be compared with measurements from other parts of the world.	
15 min	**Introduction to Embedded Systems and LED Programming**	
	- The educator explains what embedded systems are and presents examples of their use in everyday devices. - Learners identify the main components of an embedded system. - Using TUNIOT, learners create a simple program that makes the internal LED blink. - They upload the program to the ESP8266 and check whether it works correctly.	Resource 1: What is an Embedded System: https://www.youtube.com/watch?v=3AXDli9tQMo Resource 2: Blink the Internal LED: http://easycoding.tn/index.php/nodemcu/video-tutorials/stand-alone/
	Challenge 1: Modify the program to make the LED blink faster.	**Attachment 4:** Challenge answer key.
	Challenge 2: Modify the program to make the LED blink slower, using Arduino IDE.	**Attachment 5**: Challenge answer key.
	The educator explains that the same microcontroller can be used to collect environmental data.	

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15 min	**Building and Programming the Light Sensor**	
	- The educator introduces the BH1750 light sensor and explains what information it provides. - Learners connect the sensor to the ESP8266 using the provided wiring instructions. - They configure the program to read light intensity. - Learners display sensor readings in the Serial Monitor. - They test the sensor under different conditions, for example in a shaded area, under classroom lighting and near a brighter light source.	**Attachment 6**: BH1750 Wiring. **Attachment 7**: Light Sensor Module.
	Challenge 3: Observe how the readings change when the amount of light reaching the sensor changes. Explain the differences.	
5 min	**Introduction to the Internet of Things (IoT)**	
	- The educator introduces the concept of IoT. - Learners discuss how physical devices can collect, exchange and transmit information through the internet. - The educator presents an example of an environmental monitoring system using connected sensors. - Learners identify how a network of light detectors could help collect information about night-time lighting in different locations.	Resource 3: What is IoT?: https://www.youtube.com/watch?v=-M74HobvzGA
15 min	**Connecting the ESP8266 to Wi-Fi**	
	- The educator explains how the ESP8266 connects to a wireless network. - Learners configure the network connection in their programs. - They upload the program and check whether the device connects successfully.	Resource 4: Connecting to Networks: http://easycoding.tn/index.php/nodemcu/video-tutorials/local-network/
	Challenge 4: Modify the program so that the Red LED turns on when the board is not connected to Wi-Fi and the Green LED turns on	Encourage learners to work in pairs and exchange technical support.

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	when the connection is established. Learners test the connection and troubleshoot possible errors.	
20 min	**Sending Environmental Data to the Cloud**	
	- The educator introduces the selected cloud platform (e.g. ThingSpeak). - Learners create or access an account and configure a channel for collecting light measurements. - They test the connection by sending sample data. - They modify the program to transmit actual readings from the light sensor. - Learners check whether the measurements are correctly displayed on the online platform. - They take several readings under different lighting conditions and observe how the results change.	Resource5: Sending Data to ThingSpeak: http://easycoding.tn/index.php/nodemcu/video-tutorials/internet/
	Challenge 5: Collect measurements in at least two contrasting lighting conditions. Compare the results and formulate a preliminary observation.	Learners should record the location, time and conditions of each measurement.
5 min	**Summary: From Technical Skills to Environmental Action**	
	The educator summarises the activity and asks learners to reflect on how their device can contribute to understanding light pollution.	
	Learners discuss: - Why is it useful to collect environmental data? - What can we learn by comparing measurements from different countries? - How could the results be used to raise awareness of light pollution?	Link the technical activity with the next stages of the Connect for Global Night project and the campaign “Start Shading!”.

REFLECTION QUESTIONS

Embedded Systems and IoT

- What is an embedded system and why is it useful in environmental monitoring?
- How does the ESP8266 communicate with other devices and cloud platforms?

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- What role does the BH1750 sensor play in the light detection system?
- What technical challenges did you encounter when building and programming the device?

Light Pollution and Environmental Monitoring

- Why is it important to measure artificial light rather than rely only on our visual impressions?
- What differences did you observe between measurements taken under different lighting conditions?
- Can a single measurement provide sufficient information about the level of light pollution? Why or why not?
- What additional information should be recorded to make measurements more reliable?

Global Interdependencies

- Why is light pollution a global environmental challenge rather than only a local problem?
- How might night-time lighting conditions differ between Poland and Tunisia?
- What can young people learn by comparing environmental data collected in different countries?
- How can local decisions about artificial lighting influence the wider environment?

Solutions and Civic Engagement

- How could the data collected by young people help raise awareness of light pollution?
- What changes in lighting practices could be introduced in your school or local community?
- How could you use the results of your measurements to encourage other young people to take action?
- Why is international cooperation important when addressing environmental challenges?

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