INSPIRING EXAMPLES

8 PROJECT TOPICS FOR APPLYING THE IBL APPROACH

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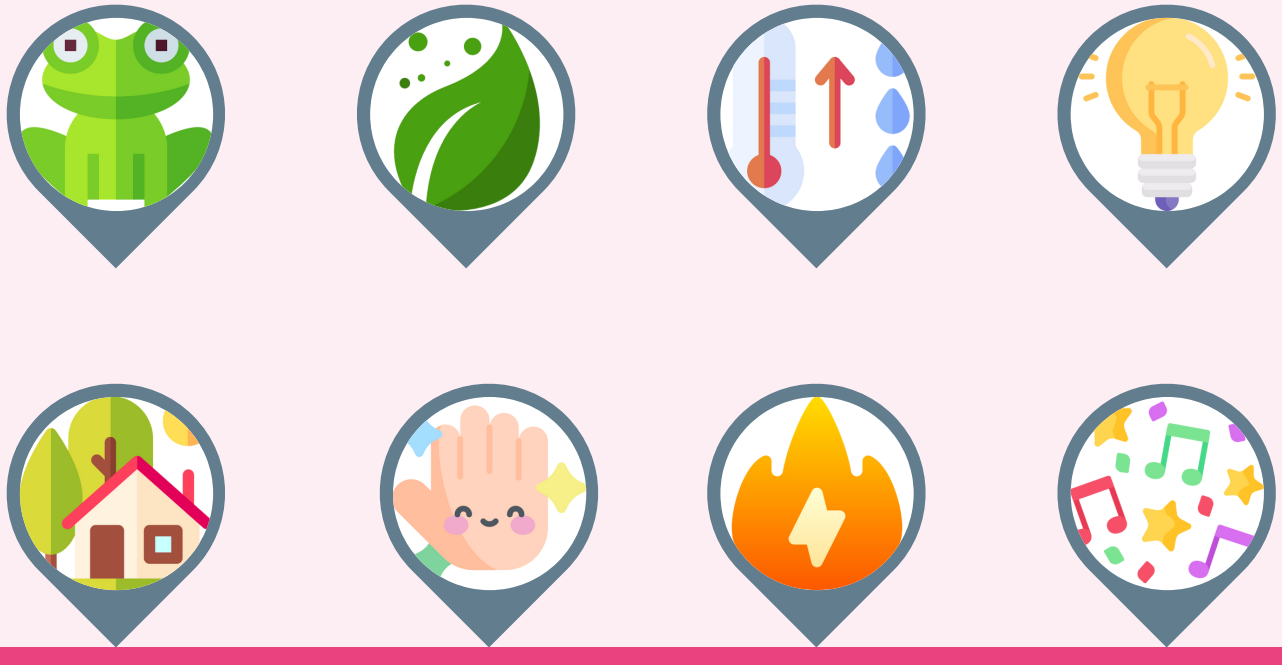
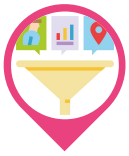


Idea 1: How to make the invisible visible? Reproduce the natural environment of frogs to ensure their survival (complete example)



Collect data thanks to the board and its embedded sensors

In order to reproduce the natural environment of frogs and ensure their survival, different parameters of their living environment must be taken into account. What information do we need to know in order to provide them with the most appropriate living environment? As the main parameter to be controlled to ensure the frog's survival is the temperature, and that it must be between 21 and 26 °C, the solution that seems to be the simplest is to use the temperature sensor integrated into the STM32 programming board.

Display the data to get the needed information

We could see in the previous part how to ask a sensor to obtain information. It would be useful now to be able to make this information known to the user. In order to inform the user of the measured temperature, the first solution that comes to mind is to use the LED display integrated into the board. Other solutions are possible such as a pointer and a dial like on a car speedometer.

Analyse the data and learn from them

We are able to display data instantly. In order to be able to analyze variations in climatic conditions and identify when the temperature level becomes critical for our frogs and the frequency of these alerts, it would be useful to be able to perform this monitoring over a long period of time. In order to be able to analyze the data from the temperature sensor over a long period of time, using spreadsheet software would be a simple solution. For this, it is necessary to be able to retrieve the data from the programmable board. The solution that I will implement will be to write via the serial port the data in CSV format (comma-separated value) which is exploitable by a spreadsheet program.

This project includes a final step: How to notify in case of emergency?

We are now able to measure and analyze the data from the sensors. It would be useful, in case of detection of an abnormal parameter, to be able to alert the user. There are two tasks to perform here: identify a temperature that is too high and alert the user. In order to automatically detect a too high temperature, we will use a conditional "IF" loop. Concerning the user alert, we can use the speaker embedded in the programmable board.

Idea 2: Preserve biodiversity. Monitor the number of plant species in your neighbourhood. Explore the streets and parks in your neighbourhood to find out more about the ecosystem and use technology to make this process easier! Use the STM32 card to record your findings!

Collect data thanks to the board and its embedded sensors

To ensure that the ecosystem in your local area is balanced and healthy, we propose you to monitor the diversity of plants species. How can we register different plant species? The parameter to be monitored is the number of species found in the ecosystem. The simplest solution is to use the STM32 board as a counter, to count the number of different plant species encountered in a walk in the streets, parks etc. of a neighbourhood.

Display the data to get the needed information

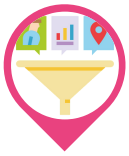
We could see in the previous part how to use an input device to obtain information. It would be useful now to be able to make this information known to the user. In order to inform the user of the number of species, we can add a screen.

Analyse the data and learn from them

The data collected can help us understand a lot about ecosystems and their characteristics. We can compare the biodiversity in neighbourhoods of the same or different cities, within the same or different country. If we collect and monitor these data over a long period of time and along different seasons, we can learn a lot about ecosystems, their characteristics and evolution.

In order to be able to draw conclusions about the biodiversity in our region and make comparisons, we need to share the data collected with our project partners in other cities and countries. We can organize the information collected in an excel spreadsheet and send it to our project partners. When information from all project partners is put together, we can draw very interesting conclusions about biodiversity and create our own map of biodiversity...

Idea 3: Temperature control in the classroom. It is too hot in the classroom. When students come in, they know to close the blinds, but during break time, the classroom gets really hot. How can we create a more autonomous system through programming?



Collect data thanks to the board and its embedded sensors

To make sure the blinds close when we need them to, we need to collect outside information. We need to gather if (and how strong) the sun is shining and we also need to know if the classroom is running too hot. To measure the outside brightness, we need a light sensor. To measure temperature, we need a temperature sensor. We need to think about where we place these sensors: a temperature sensor placed into the sun will give a temperature that is higher than the rest of the room. Assemble a breadboard with a light sensor and use the onboard temperature sensor to measure data. To achieve this, we need to program the board in MakeCode. To collect the data we will use the data logging from the MakeCode environment.

Display the data to get the needed information

After we have measured the light and temperature we need to use these data to keep a nice climate in the classroom. We will learn how to use sensor data and have multiple outputs react based on the data measured. Use the sensor data (from light and temperature sensors) to control the motor. When the temperature gets above a certain threshold, 22°C, the motor should automatically turn on to close the blinds. Likewise, when the brightness is too high, the blinds should also close. When the temperature drops back down and/or the outside light decreases, the blinds should automatically open again. We will also program a button to act as an override so that we can still manually open and close the blinds. We have to program one or multiple motors to act based on certain values the sensors pick up. We also need to program a button (or another kind of witch) to manually override the sensor so that we can close the blinds ourselves.

Analyse the data and learn from them

We now have automatically closing blinds. We have to monitor the system to see if it works in multiple different situations. This might be a process that takes time, as temperature and daylight greatly vary between seasons and we may for example not want the blinds to close in the darker months at all. To improve our system, we need to register the different situations in which our system works.

Idea 4: Build a welcoming classroom. Identify the particular light intensity needs in your classroom to perform a specific activity.

Collect data thanks to the board and its embedded sensors

In building a cosy classroom we need to ensure that we have the appropriate amount of light for the type of activity we need to perform. Which lighting needs do we have?
This activity could also be carried out with many variations, depending on the type of sensors available. For example, with temperature and CO2 sensors we could investigate how to keep a good air quality with a warm enough temperature or keep the classroom to an appropriate level of noise.

This project is focused on achieving good lighting for different types of activity (for example, an activity that needs concentration, and a general activity, such as listening to the teacher). The aim is that students identify that the lighting might need to be different according to the needs (both because of how it makes you feel and for visual health). So the main solution would be to use the light sensor.

Display the data to get the needed information

We need to show the data gathered about light intensity to study the different lighting requirements, or if we need to add an extra light (and where). Different ideas can be implemented, such as the use of a LED to show low levels of light. The optimal solution would be to transfer the data gathered to a computer so we could obtain a graph of the measure in real time.

Analyse the data and learn from them

As we are able to gather and display data, we can learn about different topics as:

- (Bio) Living beings interact with the environment and adapt themselves to external circumstances. A variation of this project could be to study how different plants are adapted to different light intensities, and which features make them to better capture the sun and where do they live so they are adapted to shadow and study these adaptations in relation to plant photosynthesis.
- (Phys) light travels in straight lines. The intensity of light declines as we are far from the light source (that is why in winter and at the beginning and at the end of the day there is less light intensity). We could also study how the light intensity declines (quadratic measure) to study which is the best high to install extra lights.

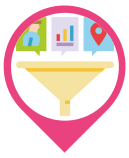
Data can be shown in real-time, but for longer data gathering it would also be good to download the gathered data in a CSV format and use a spreadsheet to analyse it.

Idea 5 - 1/2: Your ideal (and sustainable) home. Dream about where you would like to live, what your ideal home would be like and how this ideal home could be more sustainable.

Collect data thanks to the board and its embedded sensors - 1/2

Dream about what your ideal home would be. Which features? How you would distribute the space in it? And if you had to make it more energy-efficient, how would you do it?

As a first step, it would be better if students would draw their designs. Afterwards, a classroom discussion about their designs could be undertaken, putting a special emphasis on making them more energy efficient. So teachers/educators should guide students in the dialogue to identify different sources of energy (e.g. sun, heating systems...) and what they could do to not waste these energies. The aim of this dialogue would be to focus on the materials used to build the house, as they have a key role in saving energy. Then, students would be invited to reflect again on their own designs and think about which materials do help to save energy (i.e. isolate the heat) and which materials do not help to save energy (i.e. act as a heat conductor) and why students think they are thermal isolators or conductors. Some examples can be provided, such as glass, brick/chalk, metal, plastic, wood... In the end, the teacher would invite students to think about how they could better study if the material is isolator or conductor, introducing the need to use a data-gathering device.



Now that you have identified the relevance of the materials for building and you have to build the first design of your ideal home, we will test how these materials behave and which of them would make your home more energy-efficient. For this, we will need to try how different materials allow or not the transference of heat. Remember that a home in which there is a big heat transference cannot be considered energy efficient: you need to keep the inside isolated from the outside as possible.

Think about which evidences will you need to collect to study if a material is a heat conductor or an isolator. What would you measure? Which other conditions may affect the measure? How would you design an experiment so the heat conductor/isolating capacity of material could be tested?

It is important to guide the students so they can design a proper experiment to collect data about the isolating capacity of different materials provided. Other factors that affect the measure could also be considered here, such as material thickness, time of exposure to the heat, climate... The experiment could be carried out in two different approaches: in summer, where we need to isolate our houses from the sun as a source of heat; or in winter, where we need to isolate our houses so the heat produced by the heating systems is not lost to the environment. Both approaches are valid, but one might be more relevant than the other considering the climate in which the students live.

Idea 5 - 1/2: Your ideal (and sustainable) home. Dream about where you would like to live, what your ideal home would be like and how this ideal home could be more sustainable.

Collect data thanks to the board and its embedded sensors - 2/2

This part is designed to connect to the physics model of particles (matter), in which heat is a way of energy transfer, related to the movement of particles. It is important to identify where the energy source is (sun, heating system) and the transference process (from the source). Two important misconceptions (https://journals.flvc.org/cee/article/download/87720/84517/) in this part are that **isolating materials** "heat" (i.g. a wool jumper "heats" us) and that the **cool also "travels"** (i.e. we can feel how the "cool" enters through the window if we open it during winter). It is important for the teachers to identify if students' are holding these misconceptions and offer alternative experiments to build on these ideas (i.e. explore what would happen if we put an ice surrounded by wool. Would it melt faster?).

Display the data to get the needed information

In the previous section, we built a sensor and design an experiment to test the energy efficiency of our homes. However, in order to assess this efficiency, we would need to gather this information and assess the materials used.
To show the temperature that is measuring the sensor, the first solution could be to use the LED display. Another possibility is to program the board so this information is stored and transferred to a computer in a CSV format afterwards.
A function to interrogate the temperature sensor in the board can be used.

Analyse the data and learn from them

Instant temperature data have allowed us to explore the heating conduction or isolating capacity of different materials. In this part, we will analyse this data and try to imagine how could we explain these different behaviours and use that knowledge to build our ideal home.

If students have decided to analyse the data over a certain period of time, spreadsheet software would be required. In that case, the data gathered would be needed to be retrieved from the board. Otherwise, they can take notes about the temperature of the sensor displayed on the LED. After the data analysis, students should define isolators as materials that help to keep or maintain the temperature on the inside of the home, and a conductor as a material that contributes to modifying the temperature inside the home. It is important in this part that students are able to relate the temperature gathered with the energy the air particles have (which can be described as the movement of the particles). And how this particle movement can be more or less transferred from one particle to another and from the outside to the inside and vice-versa. That is, students should be able to use the particle model to explain heat transferences, so science ideas are developed as well as technical ones.

Idea 6: Washing hands. We need to ensure that children wash their hands when they come back from the playground. Although new routines have been put in place to ensure that all children wash their hands, we are not sure that they do it well enough. How can programming help us stick to the barrier actions?

Collect data thanks to the board and its embedded sensors

A distance sensor will detect when a kid is near the sink and a time counter starts.

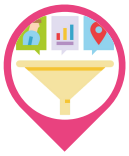
Display the data to get the needed information

When the time count is over, a positive sound is displayed. If the distance sensor detects the kid to leave before finishing to wash their hands, a negative sound will be played.

Analyse the data and learn from them

We can increase awareness of the required time to correctly wash our hands. If teachers identify kids which are not washing well enough their hands they can develop specific actions towards them to improve their behaviour.

Idea 7: Reasonable heating use. Identify the optimum position for using heating appliances at given times to save electricity.



Collect data thanks to the board and its embedded sensors

Using the temperature sensors of the board and installed several boards in different parts of the gymnasium or the classroom. We can also set alarms to notify the users when the temperature riched the min level.

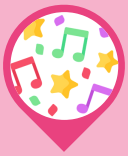
Display the data to get the needed information

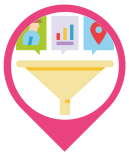
The data is saved in csv files from each board and analysed.

Analyse the data and learn from them

Using the data, we can study the transmission of heat in different points of the gymnasium/classroom with the time needed to heat the points that are situated the most far away from the heating device. The data collected will be used for making maths computations in order to optimise the heat consumption.

Idea 8: Music: Can you play what you hear? Have you ever wished you could play a song on the piano just by listening to it?





Collect data thanks to the board and its embedded sensors

If your students do not own a piano or keyboards, you may use the board to train them to play music by ear. You may play a song (e.g. https://www.youtube.com/watch?v=5M_YKXax2IA) and then ask them to use the board to reproduce the song using the music activity sheet.

Display the data to get the needed information

Ask your students to use the MakeCode blocks to reproduce the melody by setting the beat, tone, volume and tempo.

Analyse the data and learn from them

What have your students learnt about the songs' beat, tone, volume and tempo? Ask them to reflect on the learning outcomes and the difficulties they faced. Try other popular songs for extra practice.

Contact the Let's STEAM members for more info

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