USE CASE 09

The Lighthouse Project

Age & Level

Paola
Ischia, Italy
Science teacher
Teaches 13-year-old students

Paola is an Informatics science teacher in Ischia, Italy. She teaches 13-year-old students whose interests differ a lot in science and ideas as well as motivation for the lessons at school. For the project days, she would like to do some electronics with the kids since one of her colleagues showed her what he did with an Arduino Board in another class. She realized that the students were very excited about this way of learning. Thus Paola considers to do something similar. But since it is the first project of this kind for her, she searches in the internet for rather simple ideas that she can realize with her class even though she is a beginner. Paola has understood that her students are more motivated if she finds something that has a connection to real life.

Primary Actor and Main Goal

At the eCraft2Learn portal she finds a recommendation from a teacher to build a blinking light house. For her teaching in informatics it would be a first simple step towards programming & Do It Yourself electronics for students. She also likes the fact that the students will craft something by themselves.
She enthusiastically realizes that this project offers opportunities for:

1. exploration of primary concepts in electrical circuits and basics in programming
2. construction and expression of creative skills (i.e. by making drawings from observations to analyse the structures of the buildings, looking online at collections or photographs of built structures)
3. reflection & discussion (i.e continuity and change of lighthouses over time/ technological and scientific developments over long periods, maritime history and more).

Topic and Content

Still she is aware that she needs quite some preparation as well as doing some testing before, in order to be able to support the students if necessary. She is also aware of the fact that the steps of a project like this cannot be explicitly foreseen and no matter how well-prepared she is, it might be needed to work with the students and all together to find solutions to emerging problems.

Through this project the students will perform hands-on activities and will be able to construct simple electrical circuit and do the Arduino wiring. They will also understand basic programming concepts (loops, conditional-statements) in Snap4Arduino or any other programming environment that will be selected). They will understand the role of sensors and how to use them in accordance to the project scenario and to read values from an analog input. In addition, the students will practice their crafting and soldering skills.

Description of Environment and Possible Pre-conditions

Before she starts with her own testing of the project, Paola discusses the project with her colleague and what issues they need to consider. For once, her colleague recommends her to block several hours since 45 minutes are far too short for the project unless more sessions are foreseen (i.e. 3 x 45 minutes) Her colleague further explains that it is important to allocate time for hands-on activities and craft-making as a tight schedule may limit students' creativity. Based on her colleague's experience the implementation of the project-based methodology takes time and it does not fit in a single session. Paola has already a plan on how to embed the lighthouse in the curriculum that she is bound to. She makes a list of materials that they will need for the project, and writes a short memory incl. the required connection to the curriculum (including the learning goals and how the students will reach them) to the headmaster for information. Usually she is quite independent with her curriculum, but since the school invested some of its budget for the Arduinos, she would like to contribute to the documentation of the usage and benefit.

Preparatory Work

Since the Arduino Uno Boards were already acquired by the school, there is only the need to get some more wires, breadboards, resistors, potentiometers, photoresistors, and LED pins.

In order to enable students' engagement into crafting, Paola equips also the class with scissors, rulers, silicone pistols, glues and other tools that can support the hands-on activities of the young "makers".

She decides to split the lighthouse lesson in two sessions, forming teams of three students each. As soon as Paola bought the materials, she borrows an Arduino and tests with her colleague the lighthouse project. She realizes that there can be quite some pitfalls but with the help of her colleague she does well with the testing.

In order to scaffold the students without indicating a specific pace of working in the project, Paola prepared a worksheet where key steps and tips were documented. She also identifies useful external resources that can be used to familiarize the students with the tools/technologies that can be used. She enthusiastically realises the circuits on Tinkercad are very good resources for introducing her students in electrical circuit design and showing them the basic wiring actions in their Arduino boards. She makes a list of such resources and further enriches it with videos and web links.

Description of Activity

For the first session, she introduces the kids to the lighthouse project by questioning 'What is a Lighthouse and what is the exact usage of a Lighthouse?'. She also asks the students to discuss within their groups in a lighthouse without a keeper how the flashing light is turned on when it is getting dark? How it is turned off in daylight?

The students are invited to note down their answers after a search in the internet and to start setting up a plan for a lighthouse. The students are then encouraged to make a list of (recycled) materials that can be used for the lighthouse construction and they are advised to take this material with them to the school the next day.

For the last task, she starts familiarizing them with the tools that are going to be used using the list of resources that she has prepared. She encourages the students to hold in their hands the Arduino boards and using the selected resources guides them in exploring 'what is what' (pins, boards, gates, wires, breadboards, resistors, sensors etc.). The students get a first idea and start thinking of the resources that are going to use to construct their lighthouse. As for the next day, Paola has following step-by-step tasks for the students (which are also documented in their worksheets):
"Create your lighthouse with materials and devices available in the lab. Take a photo of your model and upload it to your group folder."

She also asks them to make the lighthouse to blink (to alternate from on to off state) every second.

Paola gives them the tip to use a LED in series with an 1kΩ resistor as well as to open Snap!4Arduino to program their lighthouse. While for some students it is easy to use Snap!4Arduino, others need some more support. But having done so, also the other students understand the basic principles and are able to do some small programming.

As a second step she asks the teams to let the lighthouse blink at different rates by modifying the on and off period duration.

And she launches the question on how read and inspect analog values from the pinA0 of the Arduino Uno board.
Several students have problems with this, thus Paola helps them by pointing out to connect the A0 pin to the ground / 5 Volt / 3.3 Volt pin (each time) using a wire.

As a next task the students are asked to connect (instead of a potentiometer) a photoresistor / 10kΩ resistor to the pin A0 of the Arduino and write down the corresponding values for daylight and darkness conditions.

The classroom is very bright, thus the students use different materials like jumpers, boxes, etc. for covering their photoresistor. This is important, because the next task that Paola gives to the teams is to make the lighthouse to blink only at darkness.

For Paola it is important that the students are able to present their work to their peers, no matter if they completed the project or not. She encourages the students to present the current status of their work including challenges that they may have faced. Thus also for this project, she requests each team to prepare/make a short presentation to their peers.

Other Stakeholders and their Possible Interests

Paola and the students also record with a camera these presentations and share it in the internal folder of the school with other teachers and students. This is an excellent opportunity for students to demonstrate their work and process that was undertaken and reflect upon what worked well and what aspects should be improved or enhanced. They are also encouraged to talk about the challenges that they faced and the way they overcame them providing Paola with additional opportunities to gain an insight into their understanding of the underpinning technical and scientific concepts.

The artefacts (meaning the Lighthouses) that were prepared are going to be presented in the open-day of the school that is organized the month after.

Paola also considers the participation in bigger events and this idea has been embraced by most of the students. She is aware that the participation in bigger events is a valuable educational and social experience for the students but it requires good preparation and support from additional teachers in order to handle challenges related to organizational issues, logistics, coordination and more (i.e. permission and approval for participation in external educational events from the school, the parents).

Success and Condition

All the teams were able to fulfil the given tasks and the variety of the different designs was astonishing for the students.

Failure and Condition

Although all the teams finished their lighthouse, Paola realized that for some students teamwork is more difficult than for others. While some teams found very soon solutions to work with each other, Andrea realized that other teams had rather difficulties to agree on the design, the planning, etc. Also she observed that one student seemed to be not be very involved in the project tasks, independently of the stage and the tasks (making, the design, the programming, sharing).

The project was completed by all the teams. Still Paola realized that some students mechanically connected the wires and the pins in the breadboard without being able to elaborate on their decisions. This was a good point for her to intervene and through prompt questions to help them understand the underpinning science principles in relation to technical practicalities.

Last, Paola realised that in some teams, some students were mostly involved into crafting or into electronics, or programming. Andrea was a bit alarmed. Both her guidelines and the ones provided through the worksheet encouraged all the students to be involved in all the parts of the project and decisions to be taken in a collaborative way. Paola kept an eye on how the role allocation is taking place without putting pressure to the students to undertake specific roles. She would like to see first how the role allocation will be shaped naturally in current and forthcoming project activities and she has already set up a plan on how to foster role rotation for the benefit of the team as a whole.

Barriers/Facilitators

Further reflecting, Paola realized that the time each team spend in the crafting stage varies and depends on their creative mood, interests etc.

Extensions

On the other hand, many teams and students were thinking on further applications of the Arduino board and the photoresistor like Christmas tree lightning, traffic lights, RGB Interior Car Lighting, wearable security cloths, blinkers for cyclists. In addition, the project scenario offers a smooth transition and opens the way to 3D modelling and printing tasks; Andrea realised that in the future she can invite the students to design and print the 3D model of the building of the lighthouse exploring more STEM principles and concepts.

Variations

Concluding the project with the students, many different designs were constructed but obviously the functionality is the same: a led that blinks. Some students were inspired by online resources and tried to do the mock-up of a specific lighthouse. Some others started thinking how to add additional functionalities like sound while other students created also the surroundings (the port, the sea etc.). Thus, the project offered much flexibility.