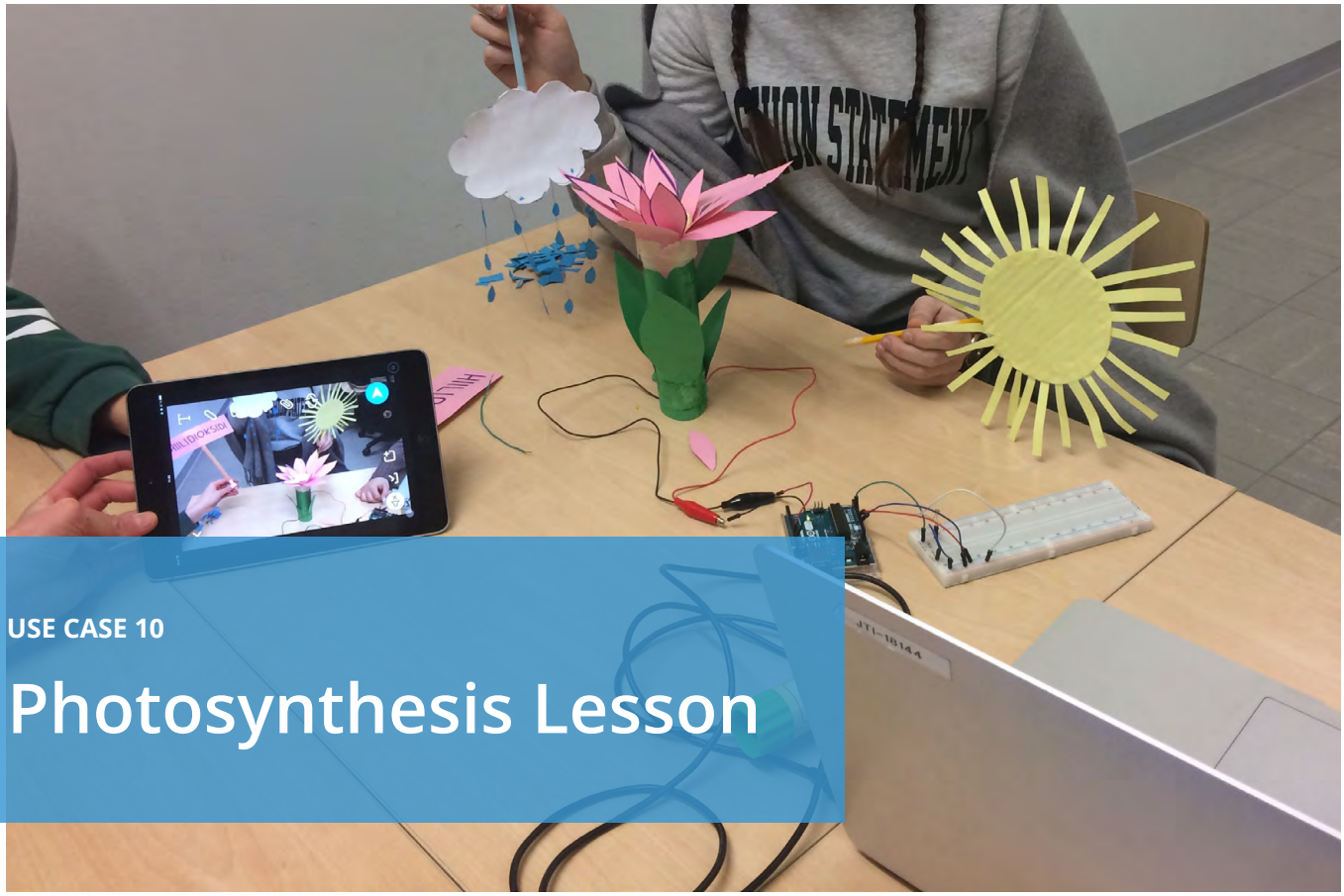

USE CASE 10

Photosynthesis Lesson

Age & Level

Mikka, Finland
Biology teacher

Iida, Finland
Math teacher

Mikka, a Finnish Biology teacher and Iida, his colleague who teaches Math work in a secondary school, teaching 19 fourteen-year–old, 2nd year high school students (four boys and fifteen girls). At school, this group emphasizes Drama as their main study track. They both have done some projects already together.

Primary Actor and Main Goal

In secondary school, the lessons are usually theory oriented. However, in this project Mikka and Iida want to combine biology subject matter with technology (which in turn helps the math teacher develop her subject matter) and emphasize students' active role and hands-on activities.

Mikka and Iida plan and ideate a project where students need to create a representation of photosynthesis using recycled materials for crafting as well as technical/electronic devices through the eCraft2Learn ecosystem.

Photosynthesis is a familiar concept for the students from their theoretical lessons. However, approaching it from the novel angle of technological tools application may be challenging. In the class, few students have used a computer programming application during their earlier school studies and for most of them technology used for crafting and making a physical artefact is unfamiliar.
When Mikka asks the pre-knowledge of students, they notice that students express concerns that the project will be difficult and that they have concerns to fail.

The teachers allow their students to self-organize into groups. They were wondering about the fact that the students decide not to form mixed-gender groups. Also, all the groups decided that they would distribute the tasks and defining roles for each team member (e.g. one is responsible of programming, other of documenting) and that these roles would change in each session. In that way, every student would have the chance to try each role. Mikka and Iida are fine with these arrangements and see the advantages in this settings the students decided: finally the students would not get bored or tired of being always in the same role.

Topic and Content

Ida and Mikka explain the student teams their overall task: to create a representation of the process of photosynthesis. The representation can contain a plant, for example, where it is indicated the impact of the elements needed in the photosynthesis process, particularly water, sunlight and carbon dioxide. The students should understand how each one of these elements affect the photosynthesis process and provide a suitable representation of it.

For the development of the photosynthesis project Mikka and Iida provide a variety of tools and recycled/craft materials that the students can choose from to use in their representation. The students use electronic components and circuits, computer programming, 3D modelling, 3D printing and craft materials (e.g. cardboard and playdough). During the project students shall enhance their technical, social and communication skills through exploration and collaborative work. Mikka and Iida plan the project to take 3 weeks (2-3 hour sessions once a week).

Description of Environment and Possible Pre-conditions

Their school is very open to the incorporation of new pedagogical and didactic ideas for teaching. The school principal gives freedom to the teachers to plan their subjects' projects in a manner the teachers consider most appropriate to implement. Mikka and Iida are guided by the national and local curricula and the content to be covered during one school year is vast. Thus, the task to be develop within the eCraft2Learn pilots has to align with the curriculum. Both are enthusiastic to integrate biology and mathematics subject matters to technology and arts.

Still, for safety reasons, Iida has to arrange the installation of the 3D printing program with the IT coordinator of the school. The photosynthesis project is held in the media classroom which has been designed to serve as a flexible space for teaching and learning. Tables, chairs and electricity plugs are easy to move and modify based on the needs of the student teams. There is an iPad storage cart in the classroom where students can take iPads when needed (e.g. for information search and 3D modelling). All electronic devices such as 3D printer, monitors, keyboards and mice are stored in one corner of the classroom whereas smaller electronic components such as Arduino, Raspberry Pi, breadboards, cables and sensors are stored in a cabinet. The equipment is assembled by student teams in the beginning of each session, taking only 3 to 5 minutes to setup. The school also has cardboard and recycled materials in the craft classroom.

Preparatory Work

The biology teacher gathers necessary materials for crafting.
The eCraft2Learn technical cores (i.e., monitors, Arduino, Raspberry Pi computer, keyboards and mice) are made available in for assembly before the sessions. Smaller electronic components (e.g., resistors, breadboards, sensors, etc.) are also available for use.

Description of Activity

The first two-hour session starts with orientation. Mikka and Iida introduce the project topic and start a discussion about photosynthesis. What does photosynthesis mean? What is needed for it to successfully happen? What is the result? Next, they introduce the equipment to be used. Their students get familiar with the technical core and the basics of electronics and programming through different hands-on activities and tasks including short introductions. These tasks start from easy exercises and progress towards more advanced ones. First task is to connect one LED to Arduino and program it with Snap4Arduino to light up. Next, students need to get the LED to blink. After the testing Mikka sees that the students understood the meaning of a digital pin, and the students are able to explore the analogue pins in the Arduino board. This is done by connecting a photoresistor to the LED circuit.

Iida provides a list of possible sensors that the students could use in their projects. The students are allowed to test and work with several sensors for some time. Soon they understand the principles behind the sensors. Now, students' task is to start ideating which sensors they could use and how for their project. Mikka and Iida poses a question how to represent photosynthesis using technology such as electronic components and 3D modelling and printing in the representations. Immediately the students ideate and plan how will their solution look like, what materials they need, which sensors they will use to model the different elements influencing photosynthesis. Iida realizes that the ideation part is challenging for the students who are not use to work in this manner. The teacher facilitates the process by asking students to find information about photosynthesis and by proposing possible concepts for the representation. All student teams decide to create a model of a flower.

During the second session, the teams start creating the models. Some teams use recycled materials, and one team decides to 3D model and print their flower. Simultaneously, some teams start creating and programming electronic circuits where students include the wires and sensors in the flower model.

The first hour of the third and final session is used for adding the final touches to the model. During the last hour students share teams' work by recording videos and explaining the functions of the representation to others. These videos and the instructions which each group made was uploaded in the UUI shared space. Automatically all the files show also up at the to school's Moodle plattform, dedicated for sharing and accessible also by other teachers of the school. During the following lesson, the biology teacher discusses with students about the project and asks the students what they learnt about photosynthesis.

Other Stakeholders and their Possible Interests

Curious what is going on in the IT room, other teachers and students are passing by the classroom and getting curious about the project. Also, some students uploaded their video presentation on their private facebook website and received many 'likes'.

Success and Condition

Mikka and Iida reflect on their project and they realize that the role of them as a guide and facilitator is vital for the students to work as main actors in the classroom, collaborating with each other. In just eight hours and by providing sufficient background knowledge, the students are able to create physical representations of photosynthesis using technological devices. The final models exceeded teachers' expectations by being creative and unique and students are proud of their work.

The students learnt how to program small circuits and how to use 3D modelling and printing by combining software and hardware technology. They also strengthened their knowledge about photosynthesis. Students shared ideas and combined different opinions into a joint vision of the final product. This helped improving the group dynamics of the class.

Mikka and Iida were able to give students positive feedback often and in real time which helped to engage and motivate students. Through the project students experienced technology as makers and this helped to diminish fears or doubts towards technology. The flower concept was attractive for girls to engage them in using technology as well. Both believe some students could continue studying the technological field in the future.

The role of a coach in the classroom is familiar for both teachers that carried out the photosynthesis lesson, they are not afraid of admitting they do not know everything. They agree that they are now more confident to implement this type of pedagogical process that integrates technology into the development of subject lessons. They are excited to implement the hands-on activities and project-based learning in their teaching in the future.

Variations

Mikka and Iida realize that the representation of photosynthesis can be much more than just a physical model of a flower. The variations are limitless. For example, a tree or a scale model of a greenhouse could be possible to create. Thus for further projects there are many different exciting options.