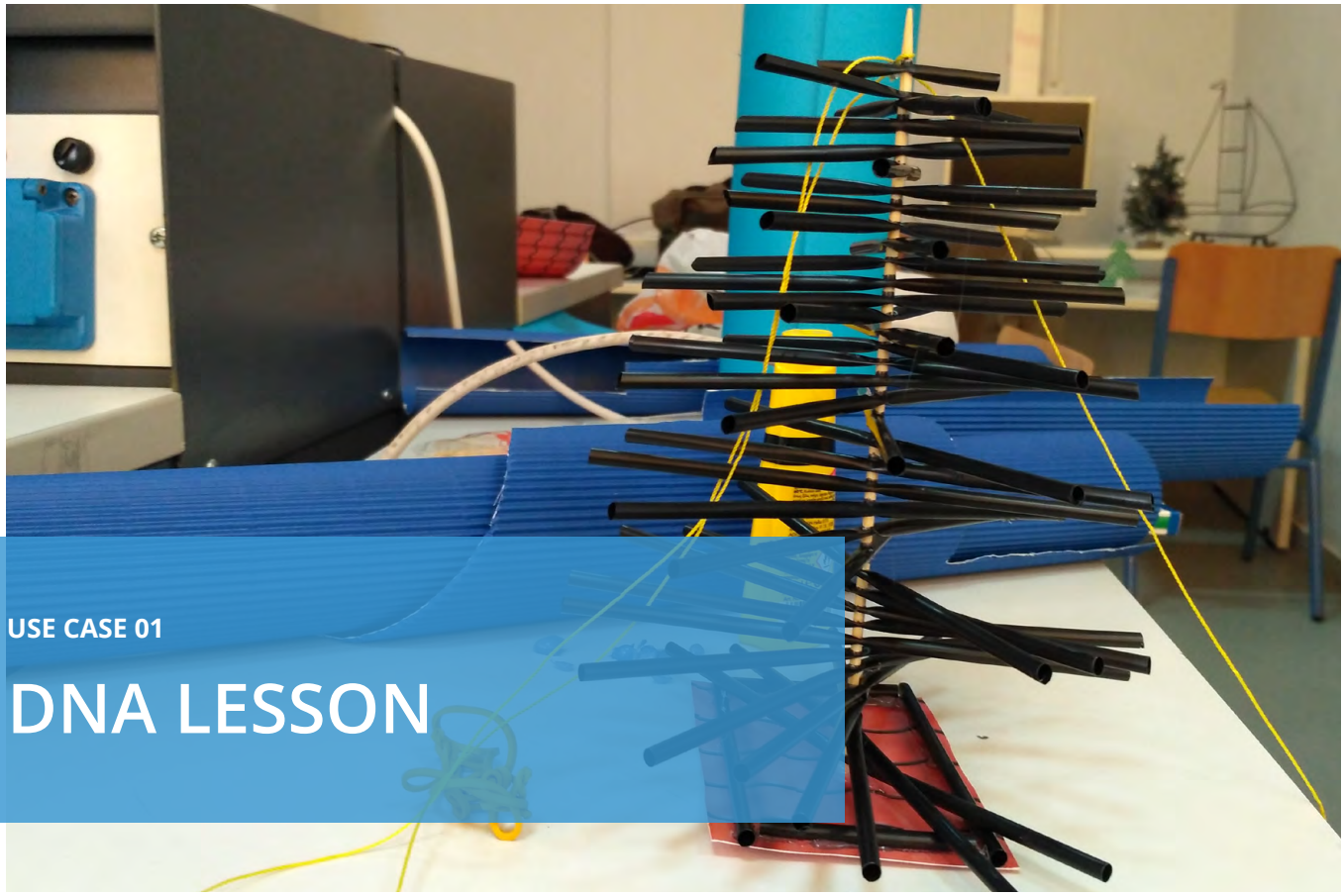

USE CASE 01

DNA LESSON

Age & Level

Susan, Finland
Science teacher
Teaches 15 years old

Susan, a Finnish secondary school science teacher, has a class of 20 fifteen-year-olds. Half of her class are female students.

Primary Actor and Main Goal

She plans to teach DNA for the next week. She knows how to combine technology-driven hands-on projects with pedagogical concepts as she learned about in her professional development courses.

The topic is difficult and the students are not motivated to study biology. However, the use of technology may be attractive especially to the boys, but having students working in groups in order to enhance social interaction might also be attractive to the girls.

Moreover, allowing the students to discover the topic by themselves through a technological lens, being active, exploring and trying out, and producing interactive DNA models, the students learn more and become more interested in the topic. Teacher assigns the groups as she normally does in her classroom activities.

Topic and Content

For the DNA lesson she decides to use 3D modelling, 3D printing, computer programming, and assembly instructions for electronic components and circuits. Her idea is to let the students build wireframe models of a DNA sequence.

During the development of the project the students will be learning and applying knowledge from electronic components (e.g., Arduino) assembly, 3D modelling and printing, programming, collaborative skills and presentation skills. Susan is planning for the development of the project to take 2 weeks (3 times a week sessions 1.5 hours).

Description of Environment and Possible Pre-conditions

Her school is pretty open for new ideas and projects, and there is a high trust in the teachers that the projects align with the curriculum. Still for security reasons, Susan needs to arrange the installation of the 3D modelling program with the IT coordinator from Happy Lab of the school.

The school also has a designated space where the 3D printing machines are, alongside available electronic components such as Arduino, Raspberry Pis, resistors, breadboards, cables, and recycled materials (e.g., cardboard, clothes, pet bottles, etc.) for the students to use

Preparatory Work

Susan knows well the people from Happy Lab, and they set up the 3D printer for her. The people there explain her in detail how the 3D printer works and also how she could solve issues that might appear. She also organizing the necessary materials that the students would need for building their 3D model.

Other Stakeholders and their Possible Interests

An IT teacher from the Happy Lab at school is happy to support Susan with any queries that she may have in setting up the project. She also offers support when needed during the working sessions.

Description of Activity

During the first session, the activity starts through ideation and planning. A group of students, Paul, Kelly, and Julian begin to work on their project on the DNA model. Susan supports the students with the 3D printing of the model's pieces from the wireframe models they made since a number of questions appear.

Also, during the creation of the model, there are a lot of errors to resolve at the beginning of the process to get the 3D model to print correctly. During the second session, they had to download drivers for the right 3D printer hardware model. However, once in a while, the printing process would fail, and they would have to discard the spoiled material and start the sequence again. User errors would also occur, such as miscalculations of scale between the software model and the printed result.The IT teacher offers assistance with the proper settings of the printer.

Kelly and Julian wonder what will happen if they will modify the model shape. Kelly changes the parameter of the X and the group starts to see interesting results they will ask to the teacher Susan.

During the third session, the students then assemble their pieces into a physical 3D model. The 3D-printed model give them a much different sense than the 3D computer images, because they could hold the model with their hands, rotate it directly, and combine their own model with other students' models.

In the fourth session, Susan asks the students to to give "life" to their 3D models by programming in them some functionalities. Susan uses the guidebook included with the STEAM "packet" to explain different ways they could vivify their physical models with Arduinos. Each group selects a project and start to work on it. To design the circuits, students are facilitated by paper template circuits, and examples of codes which are ready to be used and modified easily. This activity takes two sessions to complete.

For the presentation and sharing final session, Paul, Kelly, and Julian took turns explaining why they wanted to animate their physical models using LEDs in a particular way, and teaching their classmates how they did it. They then explain to the class how they programmed the Arduino for their project, e.g. how they solved the tricky part with creating a sequence to highlight repetitive structures, and how they overcome the 3D printing issues. This peer learning process continued with each group presentation.

Susan now feels the students would be able to understand more about DNA than before. The following day, she asks each group to present their model to the rest of the class, to discuss what they learned about how molecules form the famous double-helix structure.

Extensions

Paul, Kelly, and Julian explain how to highlight the different proteins that connected the DNA strands by assigning different coloured LEDs to each. They show that it was difficult to see that certain protein sequences were repeated. By lighting up the coloured LEDs, everyone could easily see the patterns. Protein sequences become even more evident when the LEDs associated with them flashed at the same time.

Failure and Condition

- Making sure that there is enough support available for all the learners/groups.
- Online communities should be introduced as a source of knowledge crawling
- The outcome of programming is not what is expected
- Sufficient material (technology)
- There is not enough time to complete the project due to-the knowledge level of the students.

Success and Condition

In just two weeks, Susan was able to foster student interest in DNA, while students learned how to use 3D models and printing, and how to program small circuits, including elementary programing statements such as sequences and loops. The students also gained experience in collaborating with each other, and in using software and hardware technology to realise ideas that began in their own imagination. Susan feels empowered by these tools, which facilitated the transformation of classroom roles and activities, and ultimately helped her achieve a progressive pedagogical approach in her classroom.

Failure and Condition

Time considerations for taking the project to completion. For instance, during the SciFest experience, there was one group, where one of the group members had to leave earlier and the other two were not able to decide how to continue with the activity. Their robot head was a simple one and it seemed that the two members were not happy about the result: it was not the product they designed in the first place.

Barriers/Facilitators

- The gender-based preferences – girls are more interested in social interactions
- Every learner is making something personally relevant
- Students with varied skills.
- Using the mixed-gender groups (different interests of males and females) to support the peer learning.
- Lack of previous experience of using different technologies.
- Creativity