Which student group is your best educational practice designed for? Ages 10-13 (Secondary school)

What are the learning objectives of your best educational practice?

With industrialization, rural areas are on the decrease while urbanization is on the rise. This causes a loss in agricultural land, contamination of soil, air, and water, and negatively affects agriculture. Given that, it is our main goal to raise and spread awareness about the reduction of agricultural land, to produce and implement projects to develop alternative solutions such as smart greenhouse, hydroponic agriculture to be able to farm in urban areas. To this end, a sustainable development project titled, **The Story of Tastes That Remain in an Ever-Changing World "Omniscient Foods"** was carried out by our students. The project aims to have our students use their skills of the 21st century (such as critical thinking and problem solving, communication and cooperation, entrepreneurship, ICT literacy) to increase environmental sensitivity, raise awareness about greenhouses and agricultural lands, and use technology (Arduino) to farm in urban areas and to enable them to produce alternative solutions and contribute to the process with the products they put forward.

- **How does your best educational practice relate to the curriculum?**

The project includes interdisciplinary cooperation. dec. It was based on courses in science, mathematics and information technology. The achievements of these courses are as follows:

Mathematics:

- Shows the square and cube of a natural number as an exponential expression and calculates its value.
- Calculates the area of the rectangle.
- Creates different rectangles with a given area.
- Determines that when a whole is divided into 10, 100 or 1000 equal parts, the units of the resulting fraction can be expressed in decimal notation.
- Performs addition and subtraction operations with numbers given decimal representations.
- Recognizes units of length measurement.
- Recognizes the prism of rectangles and determines its basic properties.
- Solves problems that require calculating the surface area of a prism of rectangles
- Creates research questions that require data collection.

- Collects data on research questions, displays them with a frequency table and a column chart. • Solves problems related to interpreting data represented by a frequency table or a column chart. **Sciences:**

- Gives examples to living beings and classifies them according to their similarities and differences.

- Makes inferences based on the data obtained from experiments that substances can change their state under the influence of heat.

- Classifies substances according to their VLT (Visible Light Transmission).
- Expresses the importance of man and nature interaction.
- Makes inferences about environmental problems that may occur in the future as a result of human impact.

Information Technologies:

- Uses the electronic circuit simulation program.
- Performs general operations in the electronic circuit simulation program.
- Uses components and measuring instruments of electronic elements in an electronic circuit simulation program.

- Knows how to install and operate various electronic circuits in an electronic circuit simulation program.

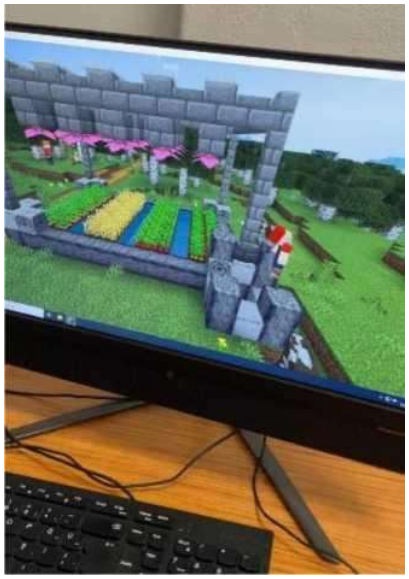
- Performs operations related to the open-source operating system.
- Makes numerical electronic applications.
- Creates codable robotic designs.
- Develops applications with object-based programming architecture.

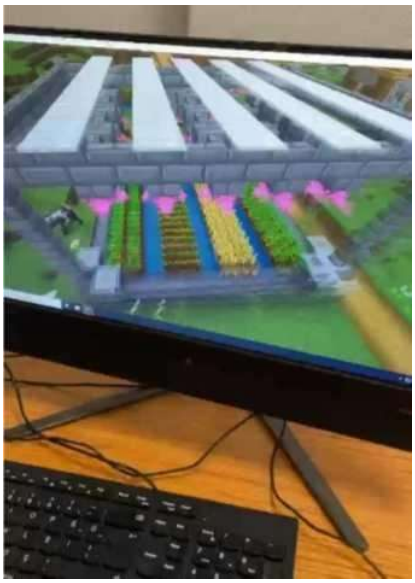
How do you implement your best practice step by step? Business calendar

Group	Task	Date
5th Grade Science and Mathematics Clubs	Smart greenhouse decision stage, geometric design and prototyping	04.10.2021 – 25.10.2021
	Production of soil reservoir in accordance with the measurements and supply of	25.01.2021 – 08.11.2021

7th grade Science-Informatics Club	Smart greenhouse Arduino operation, installation, and seeding	10.11.2021 - 08.12.2021
6th grade Science Club	Smart greenhouse evaluation and	19.11.2021 - 10.12.2021
	Preparation, material supply, and installing the suitable environment for soil-free	13.12.2021 – 30.12.2021
5th grade Science and Mathematics Club	Information about hydroponic agriculture, placement of seedlings collected from a smart greenhouse in a hydroponic agricultural area, and daily monitoring	03.01.2022 -

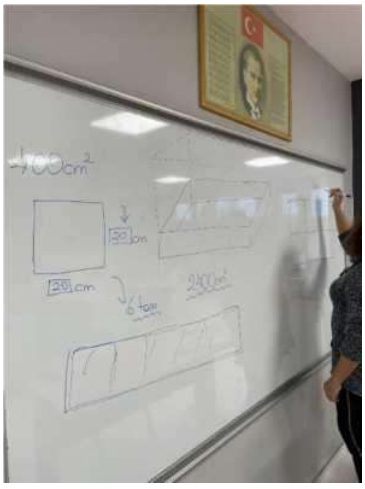
With our 7th grade Science-Informatics Club students, research on the land, material, and climate requirements for traditional greenhouse cultivation was conducted and greenhouse designs were made using Minecraft Education Edition. Alternative solutions were produced by holding a large group discussion on the suitability of today's land, soil, and climatic conditions. It was thus decided to build a smart greenhouse in order to be able to produce crops in school and the climatic conditions we are in (Ankara, Oran).





Smart Greenhouse geometric design was made by our 5th grade Mathematics and Science Club students. *First, official data on the increase in urbanization and the decrease in agricultural lands were shared: "According to the results of the year 2000 general census, it is seen that between 65% and 80% of Turkey's population lives in urban areas. The population living in cities continues to grow at a great pace. The annual rate of population growth in cities in the period 1990-2000 is about 6 times the rate that in villages. In other words, most of the population in Turkey lives in the city, and urbanization continues to augment at a rapid rate. This situation leads to an increase in the valuation of land in cities and increased structuring. According to TUIK's (Turkish Statistical Institute) data, in the early 1990s, about 36% of Turkey's land size was made up of agricultural*

areas, while we see that this rate has declined to 30% due to the impact of structuring. Therefore, agricultural areas in cities are being depleted very quickly, and the decrease in the population in villages is again negatively affecting agriculture. In the future, there awaits a greater rapid reduction of agricultural land." After the exchange of information on fertile soil reduction, and how soil, water, and air pollution affect agriculture, we have also contemplated the "What now?" aspect to find a solution. A brainstorming session was held on how we can realize production indoors in the cities by optimizing needs with the help of technology. Based on the student answers, we concluded that smart greenhouses can be placed on top of each other to provide the necessary water, temperature, and light needs with automation and to gain space, primarily indoors. We have chosen to grow curly lettuce and mathematically calculated the dimensions of the smart greenhouse skeleton, based on the area we need to grow curly lettuce. After the calculation, a prototype study was performed with unit cubes and the amount of material required for the greenhouse production along with the amount of soil to be placed in it was also calculated.



We have decided that our 7th grade Science-Informatics Club students would design the smart greenhouse, for which the skeleton design was made by our 5th grade students. In order for our students to get detailed information about the greenhouse and find answers to their questions, we have invited Agricultural Engineer Caner Yilmaz to be a guest speaker via the Microsoft Teams platform.

Our 5th grade students prepared the greenhouse skeleton by mounting steel rods at the corners of the soil reservoir with a base of 60 cm x 40 cm and a height of 10 cm, with a height of 30 cm from the soil level. In order to connect the lighting (LED) to the skeleton, our 7th grade ScienceInformatics Club students put a tight rope on the upper part of the skeleton and covered it with nylon so that the part in contact with the soil would not fill with water. The LED, engine, humidity sensor, drip irrigation system, and circuit boards were installed. After the soil reservoir was filled with a height of about 8 cm, the seeds were sprinkled, topped with 1-cm thick soil, and lastly, the first watering was done. When designing the circuit of the smart greenhouse project, encodings were made using the “Information Garage” codes used within the scope of the Information Technology course. Using the Arduino UNO board, the students developed their applications in the Scratch for Arduino program by running the motor from the intelligent circuit elements for the greenhouse, the RGB led for the light, and the soil moisture sensor for irrigation with the codes they saved electronically to their processor. On average, it took three weeks for the seeds to germinate. In order for the germination of curly lettuce to develop healthily, dilution was performed.

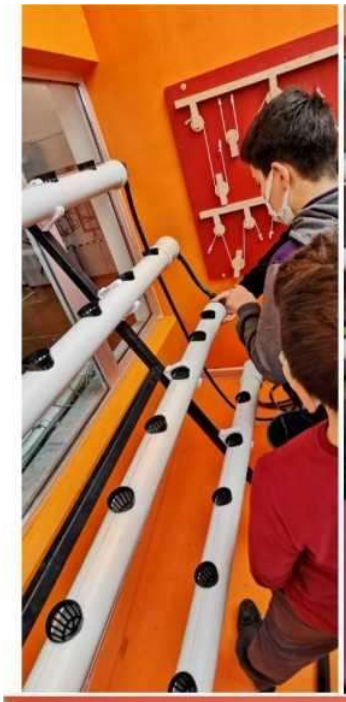

& CREATE!
g things."
Steve Jobs


STEAM

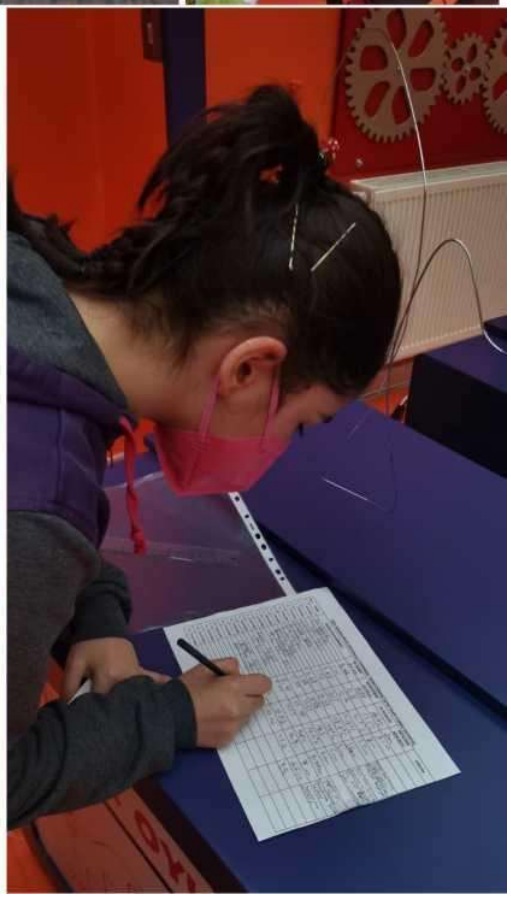

The initial findings, exchanges, discussions, and solutions we have worked on with our 5th and 7th grade students were then shared with the 6th grade Science Club students. The students were asked to monitor the steps closely during the process and evaluate the pros and cons. Following the evaluations, it was predicted that the sustainability of this project may not be achieved in the future due to soil loss and pollution of the planet. It was decided that soil-free agriculture, which was implemented in order to avoid soil loss, soil fatigue, weed problems, ensuring the ideal use of inputs such as water, fertilizer, and pesticides, could be put into use. Hydroponics, which is also involved in space research, is ideal for creating artificial production environments such as schools, but it is not suitable for germination alone, thus we have come up with a solution that merges smart greenhouse and hydroponics. While continuing to work on the smart greenhouse, we determined a suitable area to practice soil-free agriculture in school and precised the matters of infrastructure (determining the needs, supply, determining the place to be placed).

After the necessary materials were procured, the hydroponic agricultural area was built. The 5th grade Mathematics and Science Club students took the lettuce from the smart greenhouses along with their roots attached in a controlled manner, purified them from the soil, and transferred them to the plant reservoirs located in the hydroponic agricultural water channels. The students investigated the PH value, the number of nutrients and minerals in the water, and the temperature values needed for curly lettuce to grow should be. The students were shown how to measure these data with PH meters and EC meters in a hydroponic farming device. A table was created containing these data, the average height of the lettuce (from the sample taken), and student observations. The students, who were assigned in turns, made their measurements at the exact same time in the morning every weekday and recorded their data in the created table. Other students from our school

also visited the field of hydroponic agriculture in science courses and gathered information on the subject.



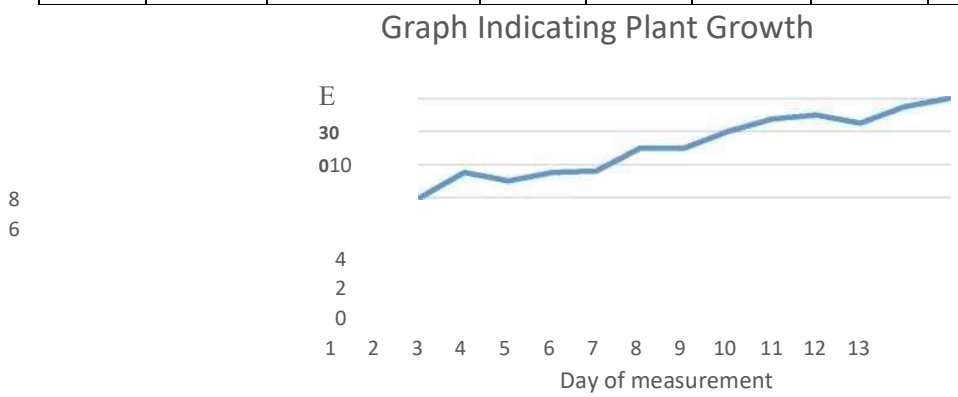




PRIVATE ANKARA MAYA SECONDARY SCHOOL HYDROPONIC AGRICULTURE STUDENT PLANT TRACKING FORM
(CURLY LETTUCE [Lactuca sativa])

NUMBER	DATE	NAME OF THE STUDENT WHO TOOK THE MEASUREMENT	PH VALUE (5.5 - 6.5)	NUTRITIONAL VALUE (12-14) EC	WATER TEMPERATURE °C	*** AVERAGE PLANT HEIGHT cm	Observation
1	3.01.2022	The first measurement with all students	5,42	11,28	18,4	2	
2	4.01.2022		5,6	12,16	17,2	3,5	
3	5.01.2022		5,73	12,72	16,7	3	
4	6.01.2022		5,72	13,68	17,13	3,5	There is a darkening on the second plant from the left and the fifth from the right.
5	7.01.2022		5,68	11,58	18,7	3,6	The plants are growing.
6	10.01.2022		5,88	13,06	17,9	5	Some plants seem to grow, while others don't.
7	11.01.2022		5,8	13,33	18,3	5	There seems to be no difference in height compared to yesterday.
8	12.01.2022		5,78	13,78	19,6	6	
9	13.01.2022		5,79	13,53	16,1	6,75	The leaves seem to be brittle and etiolated.
10	14.01.2022		5,86	13,53	14,9	7	Some of them have started to darken.
11	17.01.2022		5,57	12,64	15,2	6,5	The yellowing is gone.
12	18.01.2022		5,62	13,17	17,6	7,5	The curls have started to grow sideways.
13	19.01.2022		6,4	13,57	15,2	8	The plants are growing very well.
14	20.01.2022		5,80	14,49	15,7	10	They seem to have grown visibly taller.
15	21.01.2022		5,8	13,16	15,5	10	
16	28.01.2022	School Staff	6,11	13,15			
17	2.02.2022	School Staff	6,42	13,18			
18	3.02.2022	School Staff	5,79	13,8	14,02		

19	4.02.2022	School Staff	6,08	13,55	14		
20	5.02.2022	School Staff	6,22	13,3	14,03		
21	7.02.2022		6,44	13,2	14,4	12 cm	They have grown much taller.
22	8.02.2022		6,54	12,6	16,37	12,25	
23	9.02.2022		6,73	13,02	15,8	15	Some leaves have dried up. The ones in the bottom
24	10.02.2022		6,94	13,3	15,6	14,75	row look greener.
25	11.02.2022		6,74	13,18	16,2	14,5	



****Since the plant sample chosen by our students who made observations and took measurements to calculate the average plant height differed due to the large number of plants, there were acceptable deviations in the results.*

Our students conducted research to find alternative solutions to a present problem (or likely to be experienced in the future depending on today's conditions). To this end, they came up with a solution that would use technology in line with their knowledge, skills, and possibilities. Our students have developed collaborative learning, problem solving, critical and creative thinking skills on the way to becoming future entrepreneurs. Our students not only had the opportunity to observe all the steps from germination to the development of curly lettuce, but they also took measurements, recorded data, and gained in-depth knowledge and experience in growing plants.

It was ensured that all secondary school students throughout the school visited the project area during science classes, raising awareness about the reduction in agricultural land and observing the development of plants, as well as informing about the design and development of projects. It was observed that these studies increased student motivation to actively create and manage projects.

The lettuce cultivated from the project will be made use of in our school cafeteria for our students to enjoy. Moreover, in order to ensure the sustainability of the project, some of the lettuce germinated in the smart greenhouse will be further processed to cultivate the seed, and the resulting seeds will be germinaed again in the smart greenhouses and taken to hydroponic agriculture area.

✓ **How do you evaluate your best educational practice?**

A group evaluation was conducted of alternative measurement and evaluation approaches that are student-centered, taking into account the evaluation of the process as well as the product. This evaluation aimed to improve the affective characteristics of the students, to enable them to evaluate the study objectively, and to provide a perception of success.

The following open-ended questions were directed to the groups and they were asked to answer them.

- What were the steps you followed carrying out the project?
- What were some of the strengths and weaknesses you have observed during group work?
- What were some manageable and challenging aspects of the project?
- What suggestions do you have to further develop the project?

The tables for the evaluation of the groups (8 Groups) carrying out hydroponic agriculture are given below.

	Percentile Value
GROUP STRENGTHS (ACCORDING TO THE GROUP MEMBERS)	
Interest and willingness	62,50%
Taking the task seriously	12,50%
Putting on effort	12,50%
Displaying mathematical processing skills	12,50%
Mastering the subject	12,50%
Communicating with others	12,50%
GROUP WEAKNESSES (ACCORDING TO THE GROUP MEMBERS)	
Coping with the undesirable situation	12,50%
Performing the necessary experimental steps	62,50%
Not considered to have any weaknesses	37,50%
MANAGEABLE ASPECTS OF THE PROJECT	

Making a design	25%
Making observations	25%
Taking measurements	37,50%
Performing mathematical operations	12,50%
CHALLENGING ASPECTS OF THE PROJECT	
Performing the necessary experimental steps	62,50%
Making a design	12,50%
Saving data	12,50%
Choosing the material	12,50%
SUGGESTIONS TO FURTHER IMPROVE THE PROJECT	
Growing other types of plants	50%
Using a solar panel to generate electricity	25%
Enlarging the greenhouse and expanding the space	50%
Re-designing and repeating the project by changing the variables and observing the effects	25%
Ensure to spread the word and sustain the project outside the school environment	12,50%

The percentile table for the evaluation of the groups (4 groups) carrying out smart greenhouse practices is given below.

	Percentile Value
GROUP STRENGTHS (ACCORDING TO THE GROUP MEMBERS)	
Coding (mastering computer skills)	50%
Having experience in setting up a circuit	25%
We don't have a strong side	25%
GROUP WEAKNESSES (ACCORDING TO THE GROUP MEMBERS)	
Ability to assemble	50%
Ability to communicate	50%
MANAGEABLE ASPECTS OF THE PROJECT	
Coding	100%
CHALLENGING ASPECTS OF THE PROJECT	
Circuit installation and assembly	75%
Communication	25%
Coding	25%
SUGGESTIONS TO FURTHER IMPROVE THE PROJECT	
Generating electricity using a solar panel	50%
Increasing the illumination by increasing the LEDs	50%
Designing a system that can self-correct when there is an error	25%

What kind of equipment or resources are needed to run your best educational practice?

IT:

- Arduino
- Led
- Water engine
- Soil moisture sensor
- Cables
- Fan
- Heat sensor
- Water pump
- PC (for programming)

Science and math:

- Fiberboard (for manufacturing greenhouses)
- Steel Bar (for manufacturing greenhouses)
- Greenhouse grow bags
- Soil
- Bucket
- Paper
- Pencil
- White board
- Unit cube

Hydroponic agriculture

- 6 m 80' PVC pipe
- 8 80' pipe caps (To keep water in the pipe and close the head of the pipes)
- 4 sliding sleeves (for connecting pipe caps)
- 8 80' pin clamps (for connecting the pipes to a metal skeleton)
- 40x40 profile tube (for metal casing)
- 20 pcs water pipe and 20 pcs elbow (for installation)
- 1pcs aquarium motor
- 5 cm perforated mesh pot (40 pcs)
- 1 pcs pH meter
- 1 pcs EC meter
- pH-regulating chemical
- Liquid fertilizer for curly lettuce

- 1 large bucket

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