DataScEd4CiEn Project number: 2023-1-CY01-KA220-SCH-000164724)

Co-funded by the European Union

# Scenario: Design thinking. Droughts! no?

# Introduction

## Title

Design thinking, Drought!, no?

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## Summary of the scenario

Students will civically engage in understanding and looking for solutions to the shortage of water in the locality where they live. They will participate in a design thinking process of four phases: empathize to research if the water shortage at the school could be due to the drought, define which are the causes and consequences of the droughts through their understanding of the research of the empathize phase, ideate what they can create to mitigate the consequences of drought at school, prototype a cistern container to collect the rainwater, present their prototype and the design thinking process developed and self-assess their learning and dispositions.

## Age of the students

The scenario has been designed to be implemented with grade 10 students (ages 15-16). It can be adapted to be implemented with students of grade 7 (ages 12-13), 8 (ages 13-14) or 9 (ages 14-15).

# ‘Data Science Content in STEAM for Civic Engagement and Social Justice from the Early Years’

## Subjects and topics

The scenario is designed to be implemented in the next subjects: Geography, Science, Arts, Mathematics and Technology

# Real-life questions

The real life questions that students will be asked to answer are classified:

- General question: How can we help to combat drought in our schools?
- Empathize questions:
    - Could it be due to the summer drought?
        - What do we know about droughts in the Mediterranean?
        - What do we know about droughts in the world?
    - What investigative questions on data can we pose to research on the droughts?
        - Where can we find data to answer the investigative questions?
    - Which statistical measures summarize how the drought affects the locality of our school?
        - Are the precipitations or droughts related to other variables?
        - Can you predict the droughts?
    - How do we interpret the documentary information and the analysed, modelled and predicted data?
- Define questions
    - Which are the causes and consequences of droughts?
        - Which are the consequences of droughts in our school?
        - How can we categorize the information about droughts?
- Ideate questions
    - What can we create to mitigate the consequences of drought at the school?
- Prototype questions
    - How do we design a cistern container?
        - How do we use Tinkercad?
        - What volume of water will it hold?
        - How much will the prototype cost?
- Test questions
    - How will you present your prototype?

# Objectives and aims of the scenario

The objectives of the questionnaire are:

- Empathize in which are the causes of the shortness of water at the school, locality of the school and world
- Research on the local and global causes of droughts and the scarcity of water
- Statistically investigate on the weather conditions to interpret the droughts at the locality of the school
- Define which are the school needs in relation with the shortness of water
- Ideate how to civically engage in solving the problem of the shortness of water
- Prototype a cistern to collect data
- Test by presenting to the classmates, the authorities the suitability of the prototype
- Self-assess the knowledge about design thinking processes, data science practices and students dispositions.

## 21st Century skills

The scenario aims to develop these 21 century global competencies

- Creativity through engaging students in ideating solutions and creating a prototype to look for solutions to the shortness of water.
- Critical thought of the causes and consequences of droughts and how they can help to mitigate climate change through their actions and self-assess critically their learning.
- Collaboration in the initial brainstorming, in researching about the causes and consequences of climate change, ideating solutions, prototype the solution and present the results.
- Communication of their documentary research, data science practices and presentation of the results.

## Teaching approaches and learning strategies/theories

The STEAM teacher approach consists in the interdisciplinary implementation of the scenario by four subjects: geography, natural sciences, mathematics, technology and arts. The methodology on this STEAM approach is an engineering design thinking process consisting of five phases: empathize, define, ideate, prototype, test. In each of these phases, students are applying the techniques of cooperative learning.

## National curriculum

The Spanish national curriculum and the curriculum of the Andalusian Autonomic Community, where the school is located, is open to innovations in which students should be confronted with the challenge and problems of the XXI century (such as, the degradation of the environment, the uncertainty, the society and culture in the digital age). Moreover it dictates that students' learning should be immersed in interdisciplinary STEM scenarios. In this case, the inclusion of art in the ideation of the prototype is an opportunity to go beyond legislation. The subjects of biology and geography include the knowledge on climate change, causes and consequences with an analytic approach. The subject of technology and digitalization encourages students to use design thinking approaches to create new prototypes. And, the curriculum of mathematics is designated with the aim that students develop the stochastic sense consisting in the understanding of data collection and analysis, informal inference, and the understanding of the uncertainty and the role of probability in measuring this uncertainty.

Although data science is not described as a Secondary School subject, the interdisciplinary STEAM approach provides an opportunity to innovate in this field.

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# Educational Scenario planification

Description of the lesson plan: name of the activity, subject, procedures, time, resources. Complete the next table and include the links to the Annexes section with the detailed description of the activity.

## Lesson plan

| **Name of the activity** | **Procedures** | **Time/Annex** |
|---|---|---|
| Lesson 1: Motivation to the project | | |
| **STEAM subject**<br>Natural sciences or Biology | Reading the learning motivation<br>Analysing the phases of the design thinking process<br>Brainstorming the ideas about: *Could the water shortage at the school be due to the drought?* | 20’<br><br>Genially pages from 1 to 4 |
| **Learning outcomes** | List of brainstorming ideas | |
| Lesson 2: Empathize. Documentary research | | |
| **STEAM subject**<br><br>Natural sciences, biology, geography, social sciences | Understanding a local social issue: What do we know about droughts in the Mediterranean?<br>● Readings:<br>Regular droughts could become the Mediterranean’s “new normal” due to climate change<br>Drought, the silent enemy of the Mediterranean<br>Understanding a global social issue: What do we know about droughts in the world?<br>● Readings:<br>What Is Climate Change?<br>What you need to know about Climate Change and Drought<br>Desertification, land degradation and drought<br>13. Take urgent action to combat climate change and its impacts sustainable development goals of United Nations<br>Rainwater Harvesting in Yemen: A Durable Solution for Water Scarcity<br>Summarize the causes and consequences. | 40’<br><br>Genially pages from 5 to 7 |
| **Learning outcomes** | Summary of the causes and consequences of droughts | |

| Lesson 3: Empathize. Does the drought affect the locality of your school?<br>Data Science Practices I.<br>Pose questions | | |
|---|---|---|
| **STEAM subject** | Pose questions: What investigative questions on data can we pose to research on the droughts?<br>● Think on investigative questions<br>● Create a map with these questions | 60’<br><br>Genially page 9 |
| | ● Analyze the features of these questions: look at the question, variables in the question, relationship between data and question. | Annex |
| **Learning outcomes** | Answers of the task | |
| Lesson 4: Empathize. Does the drought affect the locality of your school?<br>Data Science Practices I.<br>Consider, explore and visualize official data | | |
| **STEAM subject**<br>Mathematics | Consider, explore and visualize official data: Where can we find data to answer the investigative questions?<br>● Gather data from official WebPages and analyze where the data comes from, who has collected the data, which is the purpose of the data, what do you know about the trustworthiness of the data source, is there any bias<br>● Analyze the relationship between the question posed in the previous session and the data.<br>● Explore and visualize the graphs to look for modal clumps, gaps, clusters, outliers, skewness and any pattern.<br>● Analyze which questions have not been able to answer and what kind of additional work they need.<br>● Oral presentation of the results of the research to the other team | 60’<br><br>Genially page 10<br><br>Annex |
| **Learning outcomes** | Answers of the task | |
| Lesson 5: Empathize. Does the drought affect the locality of your school?<br>Data Science Practices I.<br>Gather, move, explore and model data | | |

| | | |
|---|---|---|
| **STEAM subject**<br>Mathematics | Gather, move, explore and model data: Which statistical measures summarize how the drought/precipitation affects the locality of your school?<br>A. Gather data from meteosat.net and insert in CODAP<br>B. Analyze and clean the dataset<br>C. Explore the patterns of data-precipitation<br>D. Explore the frequency of precipitations by intervals<br>E. Analyze central tendencies and variability in precipitations | 120'<br><br>Genially page 11<br><br>Annex |
| | F. Analyze statistical position measures with a boxplot<br>G. Analyze the measures of central tendency, position and variability for precipitation over 10mm<br>H. Analyze the measures of central tendency, position and variability for droughts/precipitation under 10mm<br>I. Depure your analysis of droughts<br>J. Conclude about the analysis | |
| **Learning outcomes** | Conclusions about does the drought affect the locality of your school | |
| Lesson 6: Empathize. Does the drought affect the locality of your school?<br>Data Science Practices II.<br>Pose questions, regression model and interpret | | |
| **STEAM subject**<br>Mathematics | Pose questions, regression model and interpret: Are precipitations or droughts related to other variables?<br>A. Questions that relate precipitations with other variables<br>B. Is there any relationship between the temperature and the precipitation?<br>C. Is there any relationship between the wind direction and the precipitation?<br>D. How does the relationship between the temperature minimum and maximum affect the precipitation?<br>E. Extend your research<br>F. | 60'<br><br>Genially page 13<br><br>Annex<br>' |
| **Learning outcomes** | Conclusions about does the drought affect the locality of your school | |

| Lesson 7: Empathize. Does the drought affect the locality of your school?<br>Data Science Practices II.<br>Use algorithm, prediction model | | |
|---|---|---|
| **STEAM subject**<br>Mathematics | Use algorithm, prediction model: Can you predict droughts?<br>A. Use the arbor algorithm for prediction<br>B. What is the probability of droughts if the minimum temperature is under 10ºC?<br>C. What is the probability of droughts if the minimum temperature is over 24ºC?<br>D. What other predictions can you make that relate precipitation/droughts with other attributes? | 60’<br><br>Genially page 14<br><br>Annex |
| **Learning outcomes** | Predictions done | |
| Lesson 8: Define | | |
| **STEAM subject**<br>Biology<br>Natural sciences<br>Social sciences<br>Geography | How do we interpret the documentary information and the analyzed, modeled and predicted data?<br>• Pose: Which are the causes and consequences of droughts?<br>• Collect: Which are the consequences of droughts in our school?<br>• Mapping: How can we categorize the information about droughts? | 60’<br><br>Genially page 15, 16, 17 and 18 |
| **Learning outcomes** | Design thinking mural | |
| Lesson 9: Ideate | | |
| **STEAM subject**<br>Biology, technology, arts | Brainstorming: What can we create to mitigate the consequences of climate change? | 20’<br><br>Genially page 19 |
| **Learning outcomes** | List of ideas | |
| Lesson 10: Prototype. Tinkercad | | |

| | | |
|---|---|---|
| **STEAM subject**<br>Technology and digitalization | How do we design a watertight container (cistern)? | 60''<br>Genially<br>page 21 |
| **Learning outcomes** | Tinkercad design | |
| Lesson 11: Prototype. Cost | | |
| **STEAM subject**<br>Mathematics | Knowing the volume that the cistern can contain, the lateral area, how much 3D printer thread will we need, how much money will it cost. | 60''<br>Genially<br>page 22 |
| **Learning outcomes** | Computations | |
| Lesson 11: Prototype. Preparing the presentation | | |
| **STEAM subject**<br>Any subject, preferably technology<br>and digitalization | How will you present your prototype? Design a Google Slide, Canva or Genially presentation<br>Share the presentation with your teacher | 60'<br><br>Genially<br>page 23 |
| | | |
| **Learning outcomes** | Presentation | |
| Lesson 12: Test. Presenting | | |
| **STEAM subject**<br>Any subject, preferably technology<br>and digitalization | Presentation the prototype to the classmates and autorities | 60'<br><br>Genially<br>page 25, 26 |
| **Learning products** | | |
| Lesson 13:Test. Self-evaluation | | |
| **STEAM subject**<br>Mathematics | Fill the form with justified reasons about the scenario | 60'<br><br>Genially<br>page 27<br><br>Form |

| | |
|---|---|
| **Learning outcomes** | Google form answers |

## Timing

Describe for each category the time planned for its implementation

**Preparation time: 20' included in biology or geography lesson**

**Teaching time:**

STEAM Biology/natural sciences/social sciences/geography: 2 sessions of 60'
STEAM Mathematics: 7 sessions of 60'
STEAM Arts: 20'
STEAM Technology and digitalization: 3 sessions of 60'

**Assessment time:**

## Teaching resources (materials & technological tools)

The materials have been linked as annexes in the sessions that are needed

### Online tools

- Genially: https://view.genially.com/667d3c7600cf7a0014536739/learning-experience-di dactic-unit-mab4sadesign-thinking
- CODAP: https://codap.concord.org/app/static/dg/es/cert/index.html ● Padlet, Mindminster

# Evaluation

## Initial assessment

The initial assessment will be done through the brainstorming of lesson 1: *Motivation to the project.* Students will be asked to answer the following question: Could the water shortage at the school be due to the drought?

## Formative assessments

The formative assessment will be done through the learning products of each session and using the rubrics:

| | Insufficient | Enough | Not bad | Notable | Outstanding |
|---|---|---|---|---|---|
| **Emphasize** | Inability to discover the causes of the problem raised | Ability to discover some causes of the problem posed | Ability to discover how these causes of the problem originated | Ability to discover and communicate with appropriate technical language what the causes are and how the problem originated | Ability to discover and critically communicate the causes and how the problem originated. |
| **Define** | Inability to interpret the causes of the discovered problem | Ability to interpret some of the causes of the problem posed | Ability to interpret such causes and organize them into categories | Ability to organize and communicate such causes into categories | Ability to critically and creatively categorize the information discovered |
| **Ideate** | Inability to come up with strategies to solve the problem | Ability to come up with some strategies to solve the problem but not find how to execute them | Ability to devise strategies and know how to execute them | Ability to creatively devise strategies by communicating how they should execute them | Ability to critically anticipate the validity of ideas and their execution |

| | Insufficient | Enough | Not bad | Notable | Outstanding |
|---|---|---|---|---|---|
| **Prototype** | Inability to select an idea that is feasible and develop a prototype with the resources we have<br>Inability to determine the volume, lateral area, quantity and price of the 3D thread. | Ability to select an idea that is feasible but need help designing the prototype<br>Ability to recognize shapes that allow you to determine the volume, side area, quantity, and price of 3D thread. | Ability to select an idea that is feasible and execute the prototype.<br>Ability to know how to determine the volume, side area, quantity, and price of 3D thread. | Ability to select an idea that is feasible and execute the prototype being aware of the knowledge you are putting into play<br>Ability to properly communicate the process of determining 3D thread volume, side area, quantity, and price. | Ability to select an idea that is feasible and execute the prototype, critically assess its validity and improve it if necessary.<br>Ability to generalize the process of determining the volume, side area, and quantity and price of 3D thread |
| **Test** | Inability to present what the prototype consists of | Ability to present what the prototype consists of, what functionalities it has | Ability to present what the prototype consists of, what functionalities it has, how it can solve the problem detected | Ability to creatively present what the prototype consists of, what functionalities it has, how it can solve the problem detected | Ability to present in a creative and critical way what the prototype consists of, what functionalities it has, how it can solve the problem detected and how the prototype promotes actions for the achievement of the sustainable development goals on clean water and sanitation |
| **Design thinking** | Inability to execute design thinking processes autonomously | Ability to recognize what the purpose of any of the design thinking phases is | Ability to know how to apply the phases of design thinking | Ability to know how to communicate how to apply the phases of design thinking | Ability to critically and creatively identify where, when and how to use the phases of design thinking |

## Final evaluation

The final assessment will be done by the self-assessment test included in the form: https://forms.gle/4sN1E2LvsiVcXSwR8