

STEM out of the BOXE

a **STEM** approach to **non-STEM** subjects

# **Roots all around us**

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The work presented in this document has received funding from the European Union's H2020 research and innovation programme – project Scientix 4 (Grant agreement N. 101000063), coordinated by European Schoolnet (EUN). The content of the document is the sole responsibility of the organizer, and it does not represent the opinion of the European Commission (EC), and the EC is not responsible for any use that might be made of information contained.





#### Scientix Learning ScEnario

Roots all around us

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#### Summary

The topic of Roots all around us provides students with real-life problems for them to experience and discover and emphasizes the importance of mathematics in everyday activities.

#### Keywords

Mathematics, Roots, STEM, Collaborative, Science

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#### Overview

Subject(s)	Mathematics Health Astronomy Biology Art
Topic(s)	Square root and cube root Body mass index Fulton's condition factor Orbital period of the planet
Age of students	14-18 years old
Preparation time	Mathematics -30 min Health-30-min Astronmy-30min Biology -30min
Teaching time	Mathematics -90 min Health-135 min Biology-135min Astronmy-45min





Online teaching material	Internet connection ✓ Collaborative tools such as Microsoft Whiteboard, Microsoft Forms, Kahoot ✓ Video conference tools such as Google Meet or Microsoft Teams
Offline teaching material	Notebooks Books Coloured pencils Pencils Board, chalk Worksheets and assessment forms (in annexes) Computers/laptops/tablets/smartphones (depending on availability)
Resources used	https://www.youtube.com/watch?v=GzJxxHASg_g https://www.youtube.com/watch?v=XMcab1MFaLc https://www.calculator.net/bmi-calculator.html https://globalflyfisher.com/fish-better/fultons-condition-factor-calculator

### Aim of the lesson

By the end of the learning scenario (LS), students will be able to explain the use of square and cube roots (Mathematics) in different fields of science and everyday life.

#### Trends

**Lifelong learning** – learning never stops, it is a continuous process over a lifetime. **Active learning** – students are actively engaged with the lessons through discussions, observation, problem-solving, role-playing etc.

**Collaborative learning** – students focus on group work and interaction.

Peer learning - students learn from peers and give each other feedback.

**Student-centred learning** – students and their needs are at the centre of the learning process.

Project-based learning: students solve problems in groups.

**STEM learning**: learning in which mathematics relates to science, art, biology, astronomy, and problems from everyday life





#### 21<sup>st</sup> century skills

This learning scenario intends to increase the development of the 21st-century skills in students as follows:

**Communication** – students will work on their reading, writing, speaking, and listening skills to engage in productive discussions.

Collaboration – students work in pairs and groups to complete activities and tasks.

**Creativity and innovation** – students create and develop new ideas and learn how to address challenges.

**Critical thinking** – students explore ideas and discuss, respect, and credit other points of view.

**Problem-solving** – students engage in solving real-world problems and develop the ability to find a solution/answer.

**Leadership and responsibilities** – students develop the ability to guide and motivate each other.

Information, media, and technology skills: students use these skills to access and assess information and to present data.

Health literacy: students learn about health, exercise, healthy food.

Initiative and self-direction: students create their own survey and organize group work.

#### **STEM Strategy Criteria**

Please indicate which Criteria correspond to the specific Learning Scenario, contributing on a broader scale to the development of a STEM School strategy, and briefly explain how you applied the specific Criterion: <u>https://www.stemschoollabel.eu/criteria</u>

Examples:

Connections with industry: in the context of this Learning Scenario, a school visit to a research centre will be scheduled, either physically or virtually, so students can directly discuss with professionals about the recent developments in the field.

Interdisciplinary instruction: in this Learning Scenario, we will examine and implement a variety of activities in a wide spectrum of subjects, ranging from ethics and philosophy (non-STEM) to biology and chemistry (STEM).

Elements and criteria	How is this criterion addressed in the learning scenario		
Instruction			
Personalization of learning	The learning scenario includes different options for some activities, keeping in mind students with special educational needs (SEN).		
Problem and project-based learning (PBL)	Students work on problems in groups, focusing on finding their own solutions.		
Inquiry-Based Science Education (IBSE)	Students are presented with problems (exploring, creating, and analysing)		
Curriculum implementation			
Emphasis on STEM topics and competencies	STEM topics are covered through mathematics (square and cube roots), fields of biology-health- Body Mass Index, astronomy, ICT, art.		





Elements and criteria	How is this criterion addressed in the learning scenario				
Interdisciplinary instruction	There is an interdisciplinary approach by implementing activities from STEM (biology, astronomy, science, ICT) and non-STEM (communication, art).				
Contextualization of STEM teaching	Real-world problems and experiences are presented to the students.				
Assessment					
Continuous assessment	Students' progress will be permanently assessed.				
Personalized assessment	Personalised assessment is carried out according to the pace of learning and the instructional approach				
Professionalization of staff					
Highly qualified professionals	Connecting with teachers of physics, biology, chemistry, English language.				
Existence of supporting (pedagogical) staff	Supporting staff play an essential role in providing a safe and encouraging learning environment for the students.				
Professional development	Opportunities for staff professional development to improve their teaching strategies.				
School leadership and culture					
School leadership	Management board and teams.				
High level of cooperation among staff	Staff members are encouraged to work together and support each other.				
Inclusive culture	All colleagues' views and opinions are valued and respected.				
Connections					
With industry	A talk with a nutritionist, sports trainer or zoologist can be scheduled, either physically or virtually, so students can access information directly from an expert.				
With parents/guardians	The learning scenario includes a survey involving parents/guardians. It also lists an additional task for parents.				
With other schools and/or educational platforms	The learning scenario is presented to other schools/colleagues from other schools at a school visit, workshop, or talk.				
With universities and/or research centers	/				
With local communities	The learning scenario is presented on the school webpage, so it is accessible to the public.				
School infrastructure					
Access to technology and equipment	Learning is supported and enhanced with authentic, relevant use of technology (using school computers/laptops, searching for information, etc.)				
High quality instruction classroom materials	The teaching materials are in line with the school curriculum.				

# Lesson Plan





Name of	Procedure			
Name of activity Square root and cube root	1. activity: SQUARE ROOT         Students explore the artwork Large Composition A with Black,         Red, Gray, Yellow and Blue by the Dutch painter Mondrian. They watch video:         https://www.youtube.com/watch?v=GzJxxHASg_g         This warm-up activity allows students to ask questions naturally, increasing their curiosity on what they are about to learn. Students are told what items will be used for and presented the topic Square root         In math class, students in pairs create a work like Large Composition A with Black, Red, Gray, Yellow and Blue.         They enter data for areas of rectangular spaces. Students hand over their work to another pair of students who then calculate the sides of the polygons in the picture. Students connect the arithmetic operations of squaring and rooting. Students discuss their art works and the results of the mathematical problems they solved.	Duration 90 min		
	<ol> <li>activity: CUBE ROOT</li> <li>The teacher gives instructions for using the 3D Geogebra Calculator. Students create cubes in the 3D Geogebra Calculator. Students explore the volume of a cube in the 3D GeoGebra Calculator, they are connecting the sides of the cubes with volumes of cubes. They calculate the sides of cubes by using cube root.</li> <li>activity: KAHOOT QUIZ or MICROSOFT FORMS QUIZ Students are given a link to an online quiz that is used to assess their work and progress. The teacher quickly goes through the questions to clarify any issues. They do the quiz for homework (or</li> </ol>			
	in the classroom if time allows). Math problems for Kahoot quiz: The areas of squares are: 16 cm <sup>2</sup> , 25 dm <sup>2</sup> , 121 mm <sup>2</sup> , 1 m <sup>2</sup> . Calculate the sides of squares. Cube volumes are 27 cm <sup>3</sup> , 125 dm <sup>3</sup> , 64 mm <sup>3</sup> , 1 m <sup>3</sup> . Calculate the sides of cubes. Each math problem is assigned separately within the quiz.			





The first wealth is health	<ol> <li>activity: The activity with the students is carried out by the mathematics and physical education teacher.</li> </ol>	135min
	Students are watching video: <u>https://www.youtube.com/watch?v=XMcab1MFaLc</u>	
	<ul> <li>The teachers encourage discussion among students about the importance of healthy eating and playing sports.</li> <li>The teacher asks the students questions:</li> <li>In your opinion:</li> <li>Do you eat healthy?</li> <li>How often do you eat unhealthy food?</li> <li>Does your family have healthy eating habits?</li> <li>Students make a list of healthy and unhealthy food that they eat.</li> </ul>	
	- Do you play sports enough?	
	2. Activity	
	Students work in groups of three or four (in this activity, the students create the groups themselves, the focus is not on mixed ability groups, students are given an opportunity to choose their teammates). Each group is given a sheet of paper A4. The task is to explore what the body mass index is and how to calculate BMI on the Internet. After writing down the information from the Internet, the students choose a group representative. The group representative presents the group's work to the other students.	
	Then the students get the following tasks:	
	Calculate your body mass index. Calculate body mass index for each member of your kin family by using: <u>https://www.calculator.net/bmi-calculator.html</u> Students can do the tasks at home with their family members and write a report on the activity.	
	3. activity :	
	Students are encouraged to think about the results of calculations.	
	Together with the physical education teacher, the students make a nutrition and training plan for seven days:	





	Students make a menu: breakfast, lunch, dinner, healthy snacks. Students plan their physical activities in their free time. Students plan exercises with the physical education teacher that they will do in physical education classes. Students keep a diet and physical activity diary. They take a critical look at their work.	
Fish health level	The activity with the students is carried out by the mathematics and biology teacher.	135 min
	1.activity: Students watch the video: <u>https://www.youtube.com/watch?v=v5bcqR-20IM</u>	
	Students work in pairs (in this activity, the students create the pairs themselves, students are given an opportunity to choose their pair). Each pair is given a sheet of paper A4. The task is to explore what the Fulton's condition factor is.	
	After writing down the information from the video, the students choose a pair representative. The pair representative presents the notes to the other students.	
	The teacher evaluates the students formatively to determine the level of the students' knowledge of the topic. Students solve math problems that include knowledge about calculating the Fulton factor. Math problem: What should be the length of an ideally healthy fish	
	weighing 6 kg?	
	1. Activity Students choose between two activities:	
	a) Fish in the aquarium	
	Students assess the condition of the fish in the aquarium. Data on the type, weight and length of the fish are recorded in tables and the Fulton factor is calculated to determine the condition of the fish in the aquarium.	
	If students have an aquarium with fishes at home, the activity can be carried out at home. The students will present the works with the results at school to other students and critically reflect on their work. The activity can also be carried out in the zoo. It can be arranged that the zoologist gives a short lecture to the students on	





the topic.

#### b) Fish in the fish market

Students assess the condition of the fish from the supermarket. Data on the type, weight and length of the fish are recorded in tables and the Fulton factor is calculated to determine the condition of the fish. The activity can be carried out at home or in school.

Students write a report on the activity. They present their work to other students and critically reflect on their work.

Report sheet:	
Activity	
Type of fish	
Lenght L	
Weight W	
Fultons factor	
Condition of the fish	
Report	
Critical review	





		-
How far is Mars from the Sun	<ol> <li>The activity with the students is carried out by the mathematics and physics teacher.</li> <li>Students watch the video, or they choose another video: https://www.youtube.com/watch?v=libKVRa01L8</li> <li>1. activity</li> <li>Students work in groups of three or four (in this activity, the students create the groups themselves, the focus is not on mixed ability groups, students are given an opportunity to choose their teammates). Each group is given a sheet of paper A4. The task is to explore Solar system.</li> <li>After writing down the information from the Internet, the students choose a group representative. The group representative presents the groups work to other students. Physics teacher formatively assesses students' knowledge with Kahoot quiz.</li> <li>Mhat is the fifth planet from the sun?</li> <li>Which planet is not a gas giant?</li> <li>What is the Earth's radius?</li> <li>Which moon is a moon of Mars?</li> </ol>	45 min
	<ul> <li>2. activity</li> <li>Worksheet with math problems: <ul> <li>a) Research the distance between the Sun and Mars.</li> <li>b) Explore how to calculate the orbital period of the planets.</li> <li>c) Write down the distance between the Sun and Mars. Calculate the orbital period of Mars.</li> </ul> </li> <li>The teacher offers help if needed and encourages students to discuss.</li> </ul>	





### Assessment

Formative assessment is done using different methods depending on the activities. Evaluation worksheets, drawings, and free discussions are used to express students' level of understanding of the topic. Students will also be guided to think about their own learning. Students are evaluated by the teacher using the assessment form Annex3. Peer assessment-students evaluate their peers.

Fish health level

**Report sheet:** 

Activity	
Type of fish	
Lenght L	
Weight W	
<b>Fultons factor</b>	
Condition of the fish	
Report	





Critical review	

Activity: Square root and cube root:

Math problems for Kahoot quiz:

The areas of squares are:  $16 \text{ } cm^2$ ,  $25 \text{ } dm^2$ ,  $121 \text{ } mm^2$ ,  $1 \text{ } m^2$ .

Calculate the sides of squares. Cube volumes are  $27 \text{ } cm^3$ ,  $125 \text{ } dm^3$ ,  $64 \text{ } mm^3$ ,  $1 \text{ } m^3$ . Calculate the sides of cubes.

Each math problem is assigned separately within the quiz.

How far is Mars from the Sun:

Kahoot quiz:

- 1. How many planets are there in the Solar System?
- 2. What planet is closest to the sun?
- 3. What is the fifth planet from the sun?
- 4. Which planet is not a gas giant?5. Which planet has the largest ring system?
- 6. What is the Earth's radius?
- 7. Which moon is a moon of Mars?

Worksheet with math problems:

- d) Research the distance between the Sun and Mars.
- e) Explore how to calculate the orbital period of the planets.
- f) Write down the distance between the Sun and Mars. Calculate the orbital period of Mars.





#### Student feedback

Students give feedback on their work through regular and continuous discussions during lessons. They also give feedback through the assessment process. To improve the teacher's teaching process, students are asked to explain why they liked/disliked the activities.

#### Teachers' remarks

The learning scenario can be adapted for teaching any foreign language. The worksheets can easily be modified and translated into any language. This learning scenario went mostly as planned. Since I planned every activity in detail, most tasks lasted for the expected period. The learning scenario is adaptable and flexible so it can be used for different levels of knowledge. After this project, they are now more aware of the importance of math (square root and cube root) in everyday life and activities.

#### **About Scientix**

Scientix, the community for Science Education in Europe, promotes and supports a Europewide collaboration among STEM (Science, Technology, Engineering and Mathematics) teachers, education researchers, policymakers and other STEM education professionals. If you need more information, check the <u>Scientix portal</u>, or contact either the Scientix National Contact Point or Scientix Ambassadors in your country.

#### Annex(es)

Annex1





## Annex2





Annex3

What can I do after the lesson?	1	