



Title of the STEAM Unit: From volume to density

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RELATED SUBJECTS	GRADE RECOMMENDATIONS	TOTAL ACTIVITY TIME	LEARNING OBJECTIVES DURING THE LESSON SUBJECT-SPECIFIC COMPETENCIES	LEARNING OBJECTIVES AFTER THE LESSON
<p>Mathematics, science (physics), IT/technology, art (class)</p>	<p>Age 12 / grade 6</p>	<p>540min = 12x45min lessons</p>	<p>Teamwork, cooperative designing, constructing, inter-disciplinarity understanding.</p>	<p>To understand how the density of a solid/matrix relates to volume. To understand the relationship between small and large units of density. To gain an understanding of the size of a cubic meter in space and increase of its density.</p>





OVERVIEW: TOPIC & PURPOSE

In successive steps we go from plane to space, from surface to volume.

Pupils first cut out squares with side length 1dm and try to construct a 1m surface. They should realize that it is not in the power of one to cut out 100 squares and must divide the work. Then comes the volume of the solid with side 1m. Pupils need to make paper cubes with a side of 1dm, but they find that it is not in the power of one class to make a complete cubic meter either, as they would each have to make more than 30 cubes. Pupils come to this realization when modelling using small/playing cubes, where the need for cubes per solid increases greatly as one cube is added to the length of the side.

Pupils then create a cubic meter in space using only a string to get a better spatial idea of the cubic meter. Following mathematics, we move on to physics where pupils need to get an idea of how density can be increased in a space with a volume of 1m³. Pupils create 1m³ in the classroom or schoolyard using a string. In the classroom, they will form two teams to take turns to enter the cubic meter space and report what density in kg/m³ the cube has at that moment. In this fun way, including a physical activity, they can more easily understand what the unit of density kg/m³ means.

The pupils should then discover the relationship between the unit kg/m³ and g/cm³. This should happen in mathematics linked to art, where each pupil should make at least three cubes with an edge length 10cm/1dm. In art, pupils should design cubes according to their preference, for example, using tempera paint, patchwork, collage or create cubes using the origami folding method.

Pupils then build up a square meter area with the cubes they have made. They get an idea of the underlying surface. They can then build a column of cubes up to one meter high in one corner. The set of activities will end with a physics lesson, where pupils will use a model of a cubic meter made from the cubes and, if necessary, fill in the missing edges with a string to understand how many cubic centimeter cubes they would have to put on a scale if they wanted to put a cubic meter of a substance on it and find out how much it weighs - i.e. to determine its density in units of kg/m³. By doing this, pupils can discover how to convert density in g/cm³ to kg/m³ and vice versa.

Pupils will then practice these unit conversions in a team competition.





Pictures 1- 3

Construction of a square meter area from parts of the size of one decimeter quarters (squares made by pupils)



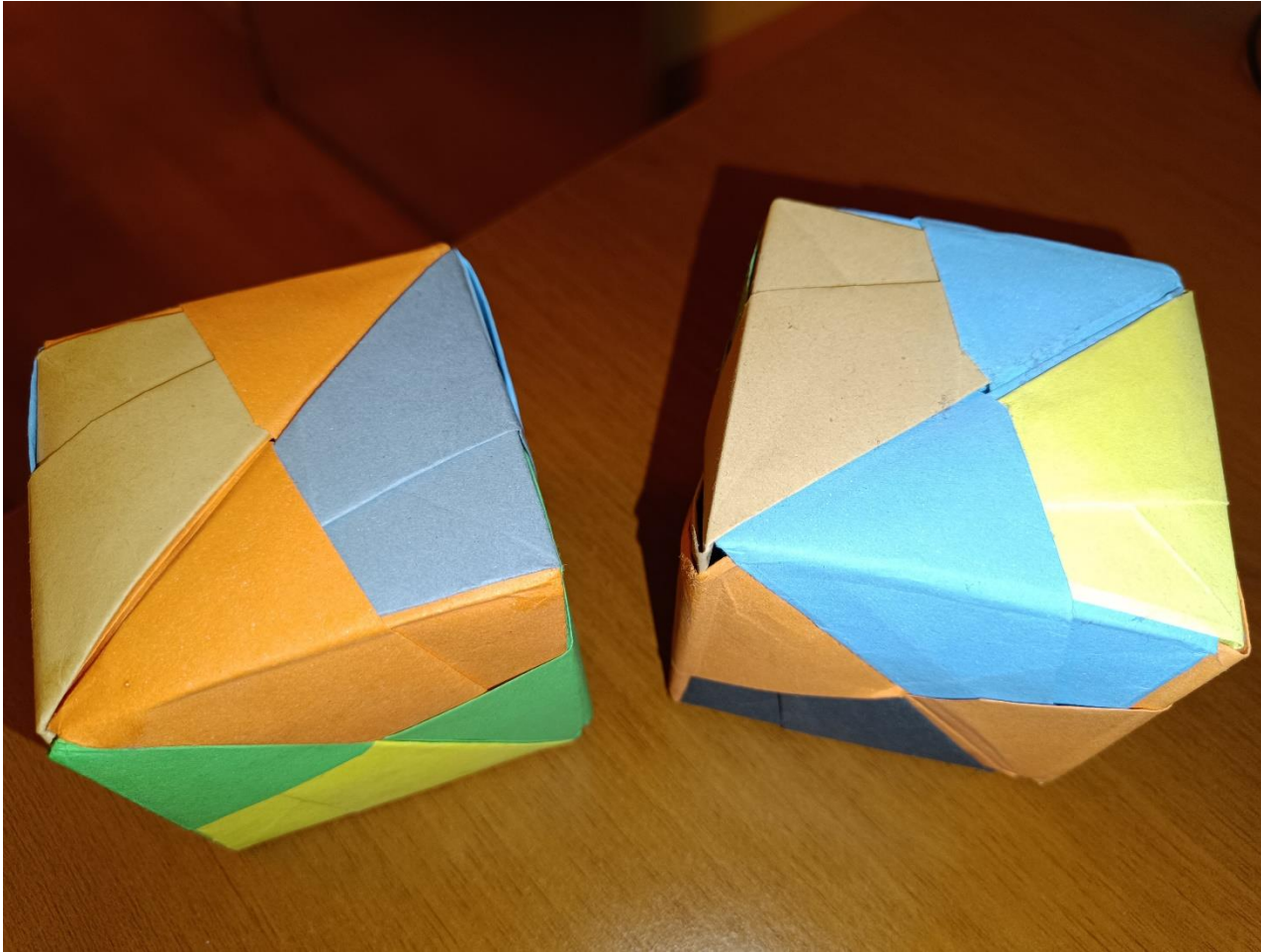
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Pictures 4-5

Construction of a larger volume - an idea of the number of cubes that is needed for the solids - preparation for the cubic meter



Picture 6 – origami cube





Pictures 7–8 construction of m^3 Pupils' in the density game - increasing the density of $1m^3$, team 1



Pictures 7–8 construction of m^3 Pupils' in the density game - increasing the density of $1m^3$, team 2





ACTIVITY PREREQUISITES

Pupils need to know the units of length and should be able to practically determine the density of different objects in the unit of g/cm^3 in physics.

STEAM ELEMENTS

ELEMENT 1: context presentation	How long is the path from area to volume? And how far is it from volume to density?
ELEMENT 2: creative design	Invent, design and build area square meter, volume cubic meter.
ELEMENT 3: emotional and social learning	Prepare and present the outcome, acknowledge among each other that communication is very important if we want to cooperate in groups.

STEAM SUBJECT ELEMENTS

STEAM SUBJECTS	SCIENCE	TECHNOLOGY	ENGINEERING	ARTS	MATHEMATICS
SHORT INTRODUCTION TO RELATED SUBJECT ELEMENTS	Understanding the relationship between the units of density g/cm^3 and kg/m^3	Taking pictures of a row of ten cubes made by pupils and using suitable softwares to construct, model or animate how to build a body with a volume of one cubic meter.	Modelling a cubic meter first from building blocks, then from cubes and a string made by pupils.	Folding cubes in an origami system and artistic design of cubes made by pupils (paint, patchwork, collage).	Understanding the relationship between dm^2 and m^2 and consequently between dm^3 and m^3





SYLLABUS

LESSONS	SUBJECTS	TOPIC OF THE UNIT	LEARNING OBJECTIVES DURING THE LESSON: SUBJECT SPECIFIC COMPETENCIES	LEARNING OBJECTIVES AFTER THE LESSON: STEAM COMPETENCIES
1	Mathematics	Units of area	Understanding relations between cm^2 , dm^2 , m^2	Pupils are able to convert area units.
2	Mathematics	Units of volume	Understanding relations between cm^3 , dm^3 , m^3	Pupils are able to convert area units.
3	Science	What is density	Building pupils' perceptions of increasing density in the volume of one m^3	Pupils have an idea of the relationship between small and large units of density (g/cm^3 , kg/m^3).
4	Art	Construction of cubic decimeter a model of cubic meter	Construct and artistically design cubes of volume dm^3 and create one building with volume cubic meter.	Pupils divide the cubic meter into decimeter cubes and, depending on the number of pupils in the class, each pupil constructs 3-4 cubes to make a total of 100 cubes - bottom/side - base/side m^3 .





5	IT/Technology	Animation cubes 1m^3	Take a picture of a row of 10 cubes made by pupils and use suitable software to construct, model or animate how to build a body with a volume of one cubic meter.	Pupils have finished the whole cube, they know what it looks like, how many small cubes make it up.
6	Science	Units of density	Understanding relations between small and large units of density (g/cm^3 , kg/m^3).	Pupils are able to convert units of density and understand the principles.

INSTRUCTIONAL PLAN BY LESSON

LESSON 1 Math (90 min) Units of area

TIME PLAN	TEACHING & LEARNING ACTIVITIES	MATERIALS	LEARNING OBJECTIVES
INTRODUCTION (15 minutes)	Detecting pupils' preconceptions about area units.	whiteboard, ruler, scissors, drawing = 1dm squares	Pupils are able to conceptualize and present their preconceptions. Prepare paper squares 1dm^2
LEARNING ACTIVITIES (60 minutes)	Creation of a square meter area out of paper squares that have a content of one decimeter square. Convert units cm^2 , dm^2 , m^2	Made paper squares Worksheet - convert units mm^2 , cm^2 , dm^2 , m^2	Pupils are able to convert units cm^2 , dm^2 , m^2





WRAP-UP & EVALUATION (15 minutes)	Presentation of measurement results.	interactive board/white board	Pupils are able to present the principles of conversion of area units.
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LESSON 2 Math (90 min) Units of volume

TIME PLAN	TEACHING & LEARNING ACTIVITIES	MATERIALS	LEARNING OBJECTIVES
INTRODUCTION (10 minutes)	Detecting pupils' preconceptions about different volume units.	whiteboard or interactive board	Pupils are able to conceptualize and present their knowledge about units of volume m^3 etc.
LEARNING ACTIVITIES (65 minutes)	Conversion of units.	worksheet made by teacher	Pupils are able to understand and apply the principles of transfer of units of volume ,conversion of units mm^3 cm^3 , dm^3 , m^3
WRAP-UP & EVALUATION (15 minutes)	Solving the transformations of volume units in the worksheet.	worksheet made by teacher	Pupils are able to understand and apply the principles of transfer of units of volume convert units mm^3 cm^3 , dm^3 , m^3

LESSON 3 Science (90 min) What is density

TIME PLAN	TEACHING & LEARNING ACTIVITIES	MATERIALS	LEARNING OBJECTIVES
INTRODUCTION (20 minutes)	Pre-activity preparation of one m^3 made from string and gluing it to the floor.	scissors, string, adhesive tape (thick carpet tape), measuring tape (length gauge),	Pupils are able to prepare and check the necessary tools for the construction of the model one m^3





LEARNING ACTIVITIES (55 minutes)	Density game.	Worksheet (included) calculator, paper, pen	Pupils improve their understanding and visualization of the increase in density in a 1m^3 volume.
WRAP-UP & EVALUATION (15 minutes)	Reflexive dialogue between the teacher and groups of pupils about results of the density game.	recorded results of pupil groups in the density game	Pupils reflect on their learning and develop their understanding and visualization of the increase in density in a 1m^3 volume.

LESSON 4 Art (90 min) Construction of cubic decimeter a model of cubic meter

TIME PLAN	TEACHING & LEARNING ACTIVITIES	MATERIALS	LEARNING OBJECTIVES
INTRODUCTION (10 minutes)	Pre-activity dialogues between the teacher and groups of pupils about features of an artistic design of cubes.		Pupils are able to agree in groups on the draft of an artistic design of the cubes.
LEARNING ACTIVITIES (70 minutes)	Constructing and artistic designing of cubes of volume dm^3 and creating one building with the volume of cubic meter.	paper, color paper, paints of various kinds, glitter, glue, or natural materials according to the pupils' design	Pupils are able to divide the cubic meter into decimeter cubes and, depending on the number of pupils in the class, each pupil constructs 3-4 cubes to make a total of 100 cubes - bottom/side - base/side m^3 .
WRAP-UP & EVALUATION (10 minutes)	Dialogue between the teacher and groups of pupils if the construction is possible.		Pupils are able to evaluate the possibility of building a cubic meter out of manufactured cubes and





			present suggestions on how this would be possible.
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LESSON 5 IT/Technology (90 min) Animation cubes 1 m³

TIME PLAN	TEACHING & LEARNING ACTIVITIES	MATERIALS	LEARNING OBJECTIVES
INTRODUCTION (10 minutes)	Pre-activity dialogue between members of group.		Pupils are able to agree in groups on a draft of the virtual design of the cubes.
LEARNING ACTIVITIES (60 minutes)	Taking pictures of a row of 10 cubes made by pupils and using suitable software to construct, model or animate how to build a body with a volume of one cubic meter.	camera or mobile phone, computer, possibly graphic tablet, suitable software	Pupils are able to depict the whole cube, they know what it looks like, how many small cubes it is made of.
WRAP-UP & EVALUATION (20 minutes)	Group presentations about the procedure and results of creating.	Interactive board with projector	Pupils are able to reflect on their learning and present the final artistic design of the cube.

LESSON 6 Science (90 min) Units of density

TIME PLAN	TEACHING & LEARNING ACTIVITIES	MATERIALS	LEARNING OBJECTIVES
INTRODUCTION (10 minutes)	Giving instructions for the second and third round of the competition.		Pupils are able to understand the rules of the competition.





LEARNING ACTIVITIES (35 minutes)	Competition of teams – density game part two and tree.	Worksheet for two teams in class.	Pupils are able to understand relations between small and large units of density (g/cm^3 , kg/m^3)
LEARNING ACTIVITIES (30 minutes)	Converting units of density.	Worksheet made by teachers	Pupils are able to understand relations between small and large units of density (g/cm^3 , kg/m^3)
WRAP-UP & EVALUATION (15 minutes)	Evaluation of teams results	Completed worksheets, Whiteboard/Interactive board	Pupils are able to convert units of density and understand it's principles and reflect on their learning.

EVALUATION PLAN BY LESSON

LESSON	EVALUATION CRITERIA	EVALUATION METHOD
1	Do pupils understand the relationship between unites of square?	Dialogue between the teacher and pupils.
2	Do pupils understand the relationship between the units of volume cubic?	Explaining the relationship between different units of volume to each other.
3	Do pupils understand how it is possible to increase the density of volume 1m^3 ?	Dialogue between the teacher and pupils.
4	Are pupils able to artistically design constructed cube models?	Checking the pre-final stage of the artistic design of the models according to revision and criteria of creativity and originality.





5	Are pupils able to design a virtual model of a cube made from one thousand cubes made?	Checking the finalization of the artistic design of the models according to revision and criteria of reliability.
6	Are the pupils able to use/convert different unites of density?	Evaluating worksheets.

NOTES

ACTIVITY SHEETS TO BE LINKED

Worksheet for lesson 3 PL1+2_ZahrajmeSaNaHustotu_PL_PRAVIDLA_TothovaR_FINAL2

Worksheet for lesson 6 PL2_ZahrajmeSaNaHustotu_2a3kolo_TABULKY_FINAL4-preZiakov_POUZIT

EVALUATION MATERIALS TO BE LINKED

REFERENCES / SUPPORTING MATERIALS TO BE LINKED

