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STEAMTeach

Science | Technology | Engineering | Arts | Mathematics

PROBLEM-BASED LEARNING: DIDACTICAL AID IN THE EXAMPLE OF TEACHING "MASS, WEIGHT AND GRAVITY" IN A STEAM APPROACH

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PROJECT

PROJECT ACRONYM	STEAMTeach
PROJECT TITLE	STEAM Education for Teaching Professionalism
PROJECT REFERENCE	2020-1-ES01-KA201-082102
START DATE	1st October 2020
KEY ACTION	Cooperation for innovation and the exchange of good practices
ACTION TYPE	Strategic Partnerships for school education

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Problem-Based Learning

Didactical Aid in the example of teaching “Mass, weight and gravity” in a STEAM Approach

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STEAM areas	physics, mathematics, languages, technology, history, IT, integrated science, biology, health studies, astronomy, metrology, engineering, PE, astronautics

Summary

Subject	Physics
Topic	Mass, weight, gravity
Age of students	14–19-year-old
Project time	7 x 45 classes (for 8-12 students)
Number of participants	3-30 (preferably 8-12) students
Online teaching material	The links are all listed in the related content of the programme
Offline teaching material	All are listed in the related content
21st century skills	• Innovation • Creativity

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- Problem solving
- Active learning
- Critical thinking
- Decision making
- Improving skills in presentation
- Evaluating content
- Discussion

Learning objectives

The students can get familiar with the latest results in physics:

- Classical mechanics
- Modern physics
- Contemporary research projects and results

They take great advantage of the use of classical secondary physics

Project Plan

Name of activity: Mass, weight, gravity

	Procedure	Time
 Questioning	What is the history of the topic?	1st class
	Who are the researchers of the topic?	
	Are there any scientists in our nation?	
	What is the main idea of the topic?	
	Can we observe gravitational and inertial phenomena?	
	What is the connection between simulation and real-life phenomena?	
	What do we already know about the topic?	1st class
	What subtopics can be the focus of our interest?	

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Brainstorming

 Prepare	What topics do we revisit? What topics do we investigate? What online/offline information can we use? What tools do we need?	2nd class
 Predict	There are some in situ experiments we can make or do. We can learn about proven science and the cutting edge of contemporary science investigations.	2nd class
 Plan	What content can we learn? How can we find relations to our everyday life and experience? Can we make any product like • In-situ experiments • A collection of online materials • An artistic interpretation of what we have learned • Any crafts • Demonstration	2nd class
 Explore	Investigating the aspects of the appointed topic on a wide range of scales.	3rd & 4th class
 Record	Record what material you met. Evaluate them. Suggest for others interested in the topic.	3rd & 4th class

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Also record if you found them useful or not.

Note why.

Some areas that can be great examples: 5th & 6th class

Area 1. History

Demonstrate

Some students find understanding concepts easier when familiar with the historical background. It is worth it for all to find out what questions arose and when, how scientists made efforts to figure out science. Main steps of science at the international level:

- Aristotle
- Newton
- Cavendish
- Eötvös
- Einstein
- the SI system, standards
- the LIGO experiment

Area 2. Basic notions in science

There are some basic notions that appear in most secondary curricula, yet very important in our topic.

We should study or revise these:

a) secondary level

- Mass
- Density
- Force
- Weight
- Gravity
- Weightlessness
- Types of fields: homogenous and radial

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- Pendulum

b) applied level

- Inertia
- Particle physics
- The standard model
- The higgs boson
- Error propagation
- Pendula
- Gravito-magnetism

Area 3. Mathematics in use

The great book of nature is written in mathematical language.' wrote Galileo Galilei We still believe that mathematical relationships reflect real aspects of the physical world. Science declares we live in an ordered Universe, and also that it is a subject to mathematics.

- scalars and vectors
- solving equations
- calculating the volume and surface
- inverse square laws
- direct proportionality
- algebra with the normal form of numbers
- maxima and minima of functions

Area 4. “In-situ” experiments

- making a cylinder
- making a sphere
- demonstrating the curved space-time
- mathematical pendulum
- the Párkányi machine

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- use of PC to measure gravitational field strength
- tearing a thread with a mass slowly or rapidly

Area 5. IT

- searching for and evaluating materials
- making a list of recommended materials

Area 6. Artistic creativity in action

- jewellery set
- poems
- essays
- jokes
- fashion

 Reflect	What material was useless for you? Why? What did you learn? What did you find interesting? What ideas were reinforced? What ideas had been overridden?	5th & 6th class
 Presentation	Present the result of your investigation. It can be ○ a game, ○ an artistic activity, ○ a presentation, ○ a crossword, ○ an experiment, ○ a video, etc.	5th & 6th class

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Product

- ppt
- video
- hand-out
- poem
- essay

5th & 6th class

Re-design

Overview of the notions and methods that we used. Evaluate them.

Suggest or substitute

7th class

Stations

Science station

- measuring mass
- demonstrating inertia
- measuring weight
- demonstrating gravity

Research station

- Problems in science history
- problems and results of contemporary research
- astronomy and physics
- engineering and physics
- metrology

Technology station

We highlight active pedagogy, and promote hands-on, minds-on didactics also in problem-based learning.

There are a number of possible solutions also in this very field, like

IT-related	Others
• PC	• Scissors
• Smartphones	• Ruler
• Digital camera	• Glue
• Internet	• Blank paper

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- YouTube
- Calculator
- Plasticine
- Rubber sheet
- Heavy loads
- Small balls
- Wrap paper
- Markers
- Pendulum
- Párkányi machine

Engineering station

- Pendula
- Fishing scales
- Scales

Tools and materials

- Calculator
- Pc
- Internet
- Cardboard paper, ruler, pencil

Art and Design station

- Poems, novels, jokes, anecdotes, etc.
- Fashion
- Jewellery
- Farewell and retirement cards

Tools and materials

- Paper and pen
- Video recorder
- Plasticine
- Scissors
- Cloths, thread, buttons, etc.

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Math station

- Hand-out
- Maps
- Calculator
- Pc, laptop or smart phone
- Paper, markers

Recording station

- Paper, pen or pencils (different colours)
- Digital camera
- Pc or laptop
- Smart phone

Experiences

Students can recognize the difference and relation among the notions of mass, weight, gravity

Students can learn about facts and models relating natural phenomena

Students can reflect and show how the results and methods of science can reflect their conceptions regarding the topic

Annexes

In Hungarian:

- A tömeg és a súly, mint különböző fogalmak - YouTube
- 4 ProFizika A tömeg fogalma és mérése - YouTube
- 6 ProFizika A gravitációs erő, a súlyerő és a tömeg - YouTube
- A Gravitáció Lenyűgöző Világa - Az Életünket Formáló Erő - [HD 720p] - YouTube
- LIGO – Wikipédia (wikipedia.org)
- Gravitációs hullámot észlelt a LIGO | WIGNER Fizikai Kutatóközpont
- Kibble-mérleg – Wikipédia (wikipedia.org)
- Itt a legújabb gravitációshullám-hegy! | csillagaszat.hu
- Mi a gravitációs hullám? | magyar felirattal - YouTube
- Dálya Gergely: Csillagászat gravitációs hullámokkal (2019.10.10.) - YouTube
- Raffai Péter: Csillagászat gravitációs hullámokkal (Atomcsill, 2017.04.06.) - YouTube
- Mik is azok a gravitációs hullámok és hogyan fedezték fel őket? - YouTube
- Frei Zsolt - A gravitációs hullámok felfedezése (Mindenki Akadémiája) - YouTube

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- veto_b.pdf (elte.hu)

In English:

- What is Mass? (eschooltoday.com)
- Your Weight on Other Worlds | Exploratorium
- Are Mass and Weight the same thing? | Physics | Don't Memorise - YouTube
- What is Gravity? | Physics | Gravitation | Don't Memorise - YouTube
- Mass and weight clarification (video) | Khan Academy
- Mass vs Weight - The Difference Between Mass and Weight (sciencenotes.org)
- Why Are Astronauts Weightless? - YouTube
- RIP 'Grand K' - YouTube
- Gravity - Wikipedia
- LIGO Lab | Caltech | MIT
- The Kilogram Is Dead. Long Live the Kilogram! - The New York Times (nytimes.com)
- Kibble Balance I How we re-defined Kg? - YouTube
- Gravitational wave - Wikipedia
- What Is a Gravitational Wave? | NASA Space Place – NASA Science for Kids
- Sources and Types of Gravitational Waves | LIGO Lab | Caltech
- Mi a gravitációs hullám? | magyar felirattal - YouTube
- b_veto.pdf (elte.hu)

+ many pictures, videos from the internet

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