Subject group and discipline: Sciences (physics)

Age: 10-14

A lesson plan on:

Learning outcomes:

- Introduction to fluid dynamics and the related terminology
- Reflection on the applications of fluid dynamics

Content

Introduction to fluid dynamics and familiarization with terms related to physics and in particular to fluid dynamics. The students engage with and respond to oral, written and visual impulses, in order to gain information as well as to draw conclusions from the information provided.

Created by:

- Maxwell Brunhart, PhD researcher / Delphi Technologies and CITY, University of London
- Amalia Petrova, educator / CITY, University of London

HORIZON2020 Marie Skłodowska-Curie actions

Delphi Technologies

CITY UNIVERSITY LONDON

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Learning process

The learning process takes under consideration Howard Gardner's theory of the multiple intelligences. The main source of information is a song about the scientific field of fluid dynamics and the tasks aim to safeguard that the learners are not restricted to one modality of learning. They are designed to help students activate one or more of the following intelligences: musical-rhythmic, linguistic, logical- mathematical.

There is also a variety in the modality of the stimulus provided to address the different learning types of the students: aural, visual, aural and visual at the same time. A large number of exercises focuses on verses that rhyme so that the student memorizes the content without much effort.

All tasks facilitate inquiry. Students should have access to online sources. In all tasks the students are offered the opportunity to develop various skills, as research, literacy, thinking and reflection skills.

If this lesson plan is used in the classroom, then it is recommended to facilitate group work. This way the students could develop their communication and collaboration skills as well but also retain the new knowledge as they would engage with it in a very active way.

Resources:

- Worksheets for students in pdf and in Word form (to allow modifications)
- Worksheets for teachers
- The lyrics of the song (pdf)
- Link for the song "Fluid Dynamics" (YouTube)
- Link for the karaoke version (YouTube)
- The class set-up should facilitate inquiry and should allow students to work independently or in groups. Students could be taken to the library so that they can use online as well as paper-based resources for carrying out the planned activities.
- All online sources that should be visited by the students to carry out the planned activities are to be found in the students' worksheets.

Teaching strategies (S=Student, T=Teacher)

Exercise Nr.	Learning experiences/teaching strategies	Answer Key
1	Warm up: S listen to the song. No lyrics to be seen. T asks for the S' ideas.	All titles are valid, if logically justified
2	S listen to the song and read the lyrics on the screen to answer 2a-2c	a) Fluid dynamics b) *"It's about showing how fluids flow"*, according to the lyrics. Similar explanations are also correct c) Yes, because fluid dynamics is a sub-discipline of fluid mechanics that describes the flow of fluids
3	S listen to the song and read the lyrics on the screen. They should try to identify the words that are related to fluid dynamics. This could be done as a group work: first, S listen and take notes individually. In the end they exchange the info they have gathered. T doesn't need to add the words missing. This will be achieved by the students in the next exercise.	density, mass, volume, viscosity, velocity, internal friction, surface tension, droplets, interface, temperature, fluid properties, simulations, eddies, turbulence, lift, drag, aerofoils Other words are also acceptable, if there is a logical connection, e.g. liquid, water, air etc.
4	S receive handout with the lyrics. The related words are **bolded**. S should compare the bolded words in the handout with the words in the list and should add the ones that are missing from their list.	
5	S search in the lyrics. The exercise gives the T the opportunity to explain that fluid dynamics deals with the behaviour of liquids and gases as well.	And don't forget about the air that's all around Yeah, that's a fluid too, keeps us safe and sound
6	S are free to choose a unit title that matches the content of this lesson.	<u>many options:</u> fluid dynamics, fluids in motions, how fluids flow etc.

Exercise Nr.	Learning experiences/teaching strategies	Answer Key
7	S read the lyrics (handout) to identify the sentences	a) Liquid fills your body up to the brim b) The earth is mostly covered by water c) Droplets in a spray are always round, because the interface keeps them bound d) Without temperature what does this all mean? For fluid properties it's like the Dean. e) And don't forget about the air that's all around. Yeah, that's a fluid too, keeps us safe and sound
8	S see the videos and choose the ones that match the lyrics. If the S do the exercise online they just ctrl+click to follow the link. If they have received a handout, then the T should show the videos on YouTube. Titles for each video: 1: Surface Tension - MeitY OLabs 2: Measuring Viscosity 3: The Ups and Downs of Air Turbulence 4: Denser Than You Think - Science Experiment	a) video 4 b) video 2
8.1	S should describe orally what they see in videos 2 and 4. Aim of this exercise is to let the S talk about the experiments, so that their memory gets activated. Additionally, it is an opportunity for a class discussion, where the T might need to clarify, if something has been misunderstood.	
8.2	This exercise can be in written or oral form. It aims to help S understand the content of the lyrics in exercise 8.	

Exercise Nr.	Learning experiences/teaching strategies	Answer Key
9	S try to connect the words. They can find the connection by reading the lyrics. T can ask students to explain why the words are connected. He can also add info or clarify.	computer-simulations viscosity-velocity, surface tension-interface internal friction-restriction aerofoils-lift and drag
10	This exercise gives an opportunity to T to clarify the term fluid properties. If S want to find out, if there are more fluid properties, T could go straight to the next exercise and let S start their own inquiry.	density viscosity surface tension

	Exercises 11-14 aim to motivate S to start their own inquiry on fluid dynamics. **According to the age, prior knowledge and motivation of the S and taking after consideration the time allocated for this lesson plan, the T can encourage students to search for the answers in the classroom or at home, individually or in groups. The results of the S's search should be discussed in the classroom.** *Please note that the lists in 11-13 are not exhaustive.*	
11	specific volume (density^-1) compressibility speed of sound vapour pressure further define dynamic or kinematic viscosity	thermal expansion thermal conductivity

12	Weather: • Weather forecasting can use computational fluid dynamics as the atmosphere and oceans are fluids. • Hurricanes, rains, ocean streams Boats: • From propellers that drive the boat to the shape of the hull, fluid dynamics are essential for making efficient boats and ships. • Exploration of oceans with submarines Cars: • Automobiles need to be aerodynamic as well to maintain efficiency • Emission control technology from various engines like catalysts and particle traps • Gasoline and Diesel engine burn fuels to produce energy. The design of the engine is based on fluid dynamics
13	<u>Human body:</u> • The flow of blood in the blood vessels • Blood pressure • Cardiovascular fluid dynamics • Efficient drug delivery (e.g. optimising nasal spray parameters) <u>Energy production:</u> • Burning of coal for electricity generation • Burning of aviation fuel for airplane flight • Design of rockets and missiles • Energy generation from renewable energy sources such as wind, solar, tidal <u>The study of:</u> • Swimming patterns of fish, divers and athletes • Flight of birds and insects • Underground water motion, rivers <u>Astrophysical fluid dynamics</u> <u>Painting and ink-jet printing</u>
14	a) images 2,4,5 b) images 1,3,5,6 c) images 1, 4,6 T could provide more information about a, b and c after the exercise
15	Reflection phase. Opportunity for classroom discussion.