Title: Hydrogen potential

Author of the teaching scenario: Helena Ivanac-Perutka
Subject title: Renewable Energy Sources
Grade: 3rd or 4th grade
Level of performance complexity: medium

Teaching method: Collaborative learning strategy

Collaborative learning strategy is used when the goal of teaching is to strengthen interaction among students. Groups of students work together to solve problems, create a task, or create a product. Collaborative learning is based on the premise that learning is a social act.

Key words:
EU green plan, renewable energy sources, economy, energy markets, hydrogen technology

Correlations, interdisciplinarity and cross-curricular topics (CCT):
Power Electronics, Power Engineering, Thermodynamics, CCT: Learning to Learn, Personal and Social Development, Use of ICT and Sustainable Development

Learning outcomes:
- recognize the potential of hydrogen (A, B)
- understand the importance of hydrogen as an energy carrier (B, D)
- determine the benefits of the hydrogen-based economy (C, D)
- process the data obtained by the collaborative learning strategy (B)

Cross-Curricular topics expectations:

Learn how to learn:
- Information management; The student independently seeks new information from various sources, transforms it into new knowledge and successfully applies it in solving problems.

- Precisely defines the problem and all its elements, 2. Applies and tests different strategies and selects those that will effectively lead to a quality solution, 3. Critically analyses the problem-solving process and identifies opportunities to use newly acquired knowledge and skills in other situations.
- Planning; The student independently determines the learning goals, chooses the approach to learning and plans the learning.
- Self-evaluation / self-assessment; The student self-evaluates the learning process and its results, assesses the progress made and plans future learning based on that.

Personal and social development:
- He manages his educational and professional path.
- Collaborative learns and works in a team.
- Collaborates, organizes, performs its task, sets hypotheses, develops its role in the team, makes decisions.

Use of ICT:
- The student analytically decides on the selection of the appropriate digital technology.
- The student takes responsibility for their own security in the digital environment and the construction of a digital identity.
- The student independently conducts complex research with the help of ICT.
- The student independently and responsibly manages the collected information.
- The student independently or in collaboration with colleagues presents, creates and shares new ones.
- The student independently or in collaboration with others creates new content and ideas or reshapes existing digital solutions by applying different ways to encourage creativity.
- The student presents, creates and shares ideas and works on a complex topic with the help of ICT.

Sustainable development:
- It critically reflects on the impact of our actions on Earth and humanity

Evaluations:

For learning:
- during the lesson the professor encourages constructive discussion between the student and the student - teacher, encourages teamwork, presentation of facts and opinions (A, B, C)

As learning:
- evaluation and self-evaluation is achieved through homework (D)
- teacher will analyse the information gathered by the student with the students in the next lesson
- students will critically look at information given to them and encourage discussion (A, B, C)

Learned:
- the knowledge will be obtained through the activities of students in class and from homework (A, B, C, D)

Activity description:

A EU green deal

EU Green Plan referring to Renewable Energy Sources, economy and energy markets. Through conversation, teacher encourages and directs students to think logically, in order to application of what has been learned so far come to a conclusion (without CO_2 and fossil fuels).

Link: https://www.youtube.com/watch?v=dUVPuBXWjD4

Students discover the meaning of the content themselves, and the teacher only directs them. In such learning, it is necessary to use as much as possible the independent work of students on problems related to the content to be mastered.

Teacher asks the following questions:
Is hydrogen one of the possible solutions?

Students talk to each other about the question accepting other people's ideas, critical and creative thinking, presenting one's own ideas. The teacher begins a discussion with students about the benefits of renewable energy.

B What do we know about hydrogen?

At the beginning of the activity, students are divided into groups. All together they will fill out K-W-L Chart about hydrogen. That's a starting point before research, and at the end they can compare notes.

K-W-L CHART		
What I KNOW	**What I WANT to Know**	**What I LEARNED**

The teacher provides students with the following websites or materials to help with the research:

- https://www.irena.org/publications/2019/Sep/Hydrogen-A-renewable-energy-perspective
- https://abcnews.go.com/Technology/green-hydrogen-renewable-energy-source-watch-2021/story?id=74128340
- https://www.energy.gov/eere/fuelcells/hydrogen-fuel-basics

The teacher asks students: **Is hydrogen a carrier or a source of energy?**

The conversation is conducted in the direction that the students come to a conclusion on their own. Students need to present their observations about hydrogen as the secondary carrier of energy, and how "pure" it is as such.

C Economy

Groups of students is given a text from the internet about hydrogen, where they can analyse the economic aspect and hydrogen energy market.
Link: https://wedocs.unep.org/bitstream/handle/20.500.11822/9024/-The%20Hydrogen%20Economy%20_%20A%20non-technical%20review-2006632.pdf?amp%3BisAllowed=&sequence=3

The teacher initiates a discussion about the price of hydrogen obtained by different technology production, and leads the students to the conclusion that only 4% of the total world hydrogen production is obtained by electrolysis of water, while 96% is obtained by reforming hydrocarbons with steam, the price of which includes 0.5 euros for capture of released CO_2.

After that students discuss Elon Musk's statement on hydrogen technology of Fuel Cells: https://www.youtube.com/watch?v=yFPnT-DCBVs

At the end of the lesson, students fill out K-W-L chart and compare notes they made as a group at the start.

D Independent work at home

As a independent work at home, students need to research and write a paper on fuel cells.

Additional literature, content and links:

Fuel Cells:

- https://www.youtube.com/watch?v=5_lDGna9MBM
- https://www.youtube.com/watch?v=a4pXAmljdUA
- https://www.youtube.com/watch?v=ynSex9p2g4E
- https://www.youtube.com/watch?v=OmVnIIgDA7o

Support procedures

During the lesson, teacher pays special attention to students with disabilities and provides them with additional explanations and help. They are paired up with gifted students to make the adoption of new material easier and more understandable. Gifted students "hone" their communication skills in this way.

At the end of the class, teacher gives students with disabilities additional instructions on how to browse and search for information and video presentations.

Gifted students are given the opportunity to create teaching material on a given topic (mental map, PP, poster, etc.) which they present at the beginning of the next lesson.