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3D STEAM

Project title: ***Accelerating STEAM-related Knowledge and Skills via 3D Modelling and 3D Printing*** *(reg. no. 2023-1-CZ01-KA220-HED-000160664)*

Programme: Erasmus+ KA220-HE - Cooperation partnerships in higher education

MODEL ACTIVITY 2

Helicopter Construction

Available in: English

(2025)

Leading organization: University of Jyväskylä (FIN)

Partner organization: Johannes Kepler University Linz (AT)

University of Ostrava (CZ)

University of Luxembourg (LUX)

Comenius University Bratislava (SK)

OSTRAVSKÁ UNIVERZITA

JOHANNES KEPLER UNIVERSITÄT LINZ

UNIVERSITY OF JYVÄSKYLÄ
FINNISH INSTITUTE FOR EDUCATIONAL RESEARCH

UNIVERSITÉ DU LUXEMBOURG

COMENIUS UNIVERSITY BRATISLAVA

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Lesson Planning Tool – 3D Modeling and 3D Printing (STEAM)

*Template (2 parts: conceptual planning + lesson plan). Replace square brackets with your own content.*3D printing and modeling as tools for the creative development of students' knowledge and skills (original designs, iterations)

PART 1: Conceptual Planning (General Information)

Title of Thematic (STEAM) Block

Helicopter Construction

Authors (Names / School / Country): Martin Droščák, Faculty of Education, Comenius University

SUBJECT	Science
GRADE	9.
NUMBER OF LESSONS	4
DIDACTIC OBJECTIVES	Students will understand the fundamental principles of helicopter construction and movement, and will develop their practical, creative, and technical skills by designing, building, and assembling a helicopter from various materials (plastic bottle, sticks, 3D-printed propeller, and motor). This activity supports logical thinking, problem-solving, experimentation, and teamwork in accordance with STEAM principles.
SPECIFIC OBJECTIVES	Students will understand the basic structure of a helicopter (body, propeller, landing skids, propulsion). Students will learn the principles of movement and rotation (the propeller moves air, and force is generated by a motor). Students will design and create a 3D model of a propeller in Tinkercad. Students will combine various materials (plastic bottle, sticks, and a 3D-printed propeller) into a functional unit. Students will connect a motor and a battery to power the propeller. Students will develop creativity, logical thinking, and curiosity. They learn to collaborate and experiment.

Thematization and Problematization

Students learn through their own experience**,** which supports a deeper understanding of the principles of physics and engineering (rotation, force, motion).

Combines **various STEAM fields**:

- **Science:** motion, aerodynamics, battery energy
- **Technology:** 3D modeling and printing
- **Engineering:** construction and assembly of the helicopter
- **Arts:** design of the propellers and the entire model
- **Mathematics:** measurement, proportions, geometry of the propellers

Problem addressed:

- Students often do not understand how objects work in practice or why they move in a particular way.
- This activity enables the connection of theory and practice, addressing the problem of a lack of meaningful, active, and creative STEAM tasks in pre-primary and primary education.
- It supports critical thinking and experimentation—children explore, test, and refine the construction so that the helicopter operates effectively.

1. **PBL – Problem-Based Learning**
   - Students are given a challenge**:** "Build a helicopter that moves using a motor."
   - Independently or in teams, students seek solutions, test, and fine-tune their constructions.
   - They learn through experimentation and solving real-world problems.
2. **Constructionism**
   - Students learn concepts of physics and engineering by creating their own models (propellers, body, landing skids).
   - The acquired knowledge is reintegrated into their construction solutions – learning through creation.
3. **The EUR Method (E – Exploration / U – Understanding / R – Reflection)**
   - **Exploration:** Examining materials (plastic bottle, sticks, 3D printing of the propeller), and observing the movement of the propeller.
   - **Understanding:** Discussion on the principles of motion, propeller design, and motor function.
   - **Reflection:**Students assess what worked, what needs improvement, and how they would enhance the helicopter.

STUDENT ENTRY-LEVEL SKILLS

☐ Fundamentals of TinkerCAD

☐ Experience with GeoGebra3D

☐ Working with STL/OBJ files

☐ Fundamentals of slicing (PrusaSlicer/Cura/Bambu Studio)

☐ Experience with other software (specify which) ....

☐ 3D printing safety

3D TOOLS AND SOFTWARE

• Modeling software: Tinkercad

• Slicer: PrusaSlicer

• Viewer/AR: -

3D PRINTING

Equipment required for the activity: Yes

Educational objectives related to 3D modeling and 3D printing

Main objective:

- Students will understand the principles of 3D modeling and the production of objects using 3D printing and will be able to independently design and create a functional helicopter rotor blade compatible with other model components.

Secondary objectives:

- Students will be able to navigate the Tinkercad environment and use basic tools to create 3D objects.
- Students are familiar with the basic geometric shapes and dimensions that influence the functionality and stability of the object.
- Students consider the proportions and dimensions of the propellers in relation to the propulsion system and the body of the helicopter.
- Students will be able to connect digital design with real-world production through 3D printing.
- Students will develop creative thinking and aesthetic sensitivity when designing a visually appealing and functional propeller.
- Students understand the basic procedures for safe handling of the 3D printer and the finished component.

STEAM components

STEAM	CHARACTERISTICS OF THE COMPONENT IN THE ACTIVITY

COMPONENT	
SCIENCE	Students observe and investigate the movement of propellers, rotational force, and the influence of various materials on helicopter stability.
TECHNOLOGY	Students design propellers in Tinkercad, print them using a 3D printer, and integrate a motor with a battery to provide propulsion.
ENGINEERING	Students assemble the helicopter, address issues with stability and balance, and optimize the propeller shape for proper functionality.
ART	Students apply creativity in designing the propeller and the entire helicopter model, enhancing visual and spatial awareness.
MATHEMATICS	Students measure the dimensions of the propeller and body, compare proportions, and calculate angles and sizes to ensure optimal rotation and stability.

Syllabus of interconnected subjects within the curriculum

SUBJECTS	EDUCATIONAL AREA	CONTENT STANDARD	PERFORMANCE STANDARD
Science	Human and Nature	Motion. Force.	The student explains how the propeller moves and what force it generates.
Mathematics	Mathematics and Information Processing	Geometry, Measurement, Proportion	The student uses basic geometric shapes and measures lengths and angles. The student determines appropriate dimensions for the propellers and placement of the landing skids to ensure a stable helicopter.
	Mathematics and Information Processing	3D Modeling and Printing	The student demonstrates proficiency with basic tools for creating 3D objects in Tinkercad. The student creates a 3D model of the propeller that is prepared for printing.
Technology	Humans and the World of Work	Construction and Assembly	The student is able to assemble a simple mechanical

			object from multiple materials. The student assembles the helicopter and secures the propeller and motor to ensure proper functioning.
Art		Design and Creative Production	The student applies creativity in the visual design of the object. The student designs an aesthetically appealing propeller and overall helicopter.

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PART 2: Specific Planning – Lesson Plan

Lesson Title: Create Your Own Helicopter – STEAM Project with 3D Printing

Lesson Objectives:

- Students understand the fundamentals of constructing a helicopter (body, propeller, landind skids, propulsion).
- Students understand the principles of motion and rotation (the propeller moves air, and the motor generates force).
- Students will design and create a 3D model of a propeller in Tinkercad.
- Students will combine various materials (plastic bottle, sticks, and a 3D-printed propeller) into a functional unit.
- Students will connect a motor and a battery to power the propeller.

Attitudes:

- Students will develop creativity, logical thinking, and curiosity.
- They learn to collaborate and experiment.

Student outcomes: [list of specific outcomes]

Students can explain how a helicopter propeller functions and the force it generates during rotation.

Students are able to design and create a simple 3D model of a propeller in Tinkercad.

Students can print the prepared 3D model and handle the printed propeller.

Students are able to assemble a helicopter from various materials (plastic bottle, sticks, propeller, motor).

Is able to correctly position the helicopter's landing skids to ensure stability and functionality.

Can connect the motor and battery so that the propeller functions as propulsion.

Demonstrates creativity in designing the propeller and the overall helicopter model.

Is able to measure dimensions, the angular inclination of the propeller, and structural proportions to achieve optimal functionality.

Can analyze problems, experiment with various options, and refine the construction based on observations.

Develops the ability to collaborate within a team, communicate ideas, and solve practical tasks collectively.

Lesson Plan (Phased Description)

Typical phases: Introduction – motivation, objectives, criteria. Student learning – knowledge processing, planning. 3D modeling – CAD. 3D printing – slicing and printing.

Motivation: Presentation of a finished helicopter, demonstration of a functional propeller powered by a motor.

Discussion with students:

“How does the propeller move?” “What do you think we need to assemble a helicopter?”

Lesson objectives:

Explain the principles of rotation and movement of the propeller.

Design and 3D print a propeller.

Assemble a helicopter using various materials.

Success Criteria:

A functional propeller and helicopter.

Accurate dimensions and stable construction.

A creative and aesthetically pleasing appearance.

Student Learning – Knowledge Processing and Planning

Students discuss and plan their procedure:

Task allocation (who will model the propeller, who will prepare the body, who will solve the motor connection).

Exploration of materials (plastic bottle, sticks, motor, 3D-printed propeller).

A sketch or simple construction plan (on paper or as a Tinkercad sketch).

Teacher support:

Assistance in designing the propeller model and explaining the principles of physics (rotation, force, stability).

3D modeling

Introduction to Tinkercad: Basic tools and controls.

Propeller creation:

Students model the propeller according to the planned size and shape.

Discussion on the propeller shape and its influence on function.

Model review:

The teacher verifies whether the model is suitable for printing (size, thickness, proportions).

3D printing – slicing and printing

Preparation for printing:

Export the model to a format suitable for 3D printing (STL).

Slicing setup: layer height, infill density, and print speed.

Printing the propellers: Students observe the printing process and discuss possible errors and solutions.

Safety: Use protective equipment and handle the printer properly.

Helicopter assembly and testing

Assembly of the helicopter:

Attach the 3D printed propeller to the motor.

Connect the motor to the battery.

Attach the landing skids and the propeller to the body made from a plastic bottle.

Functionality Testing:

Students observe whether the propeller operates correctly and adjust its shape or stability.

Reflection and Conclusion

Discussion with students:

What was successful?

What could we improve?

How does the shape of the propeller influence the helicopter's movement?

Evaluation according to criteria for success (functionality, stability, creativity).

Option to document the outcome (photographs, short video, notes).

Assessment – Overview

Reflection/Assessment – Feedback

Students evaluate their own work, identifying successes and areas for improvement.

Assessment of 3D Modeling and 3D Printing (detailed)

1) Does the student understand/know ...? – method: [mind map]

2) Has the student created ...? – method: [product evaluation]

3) Can the student present ...? – method: [presentation, peer review]

4) Does the student implement/improve ...? – method: [prototype revision]

5) Team collaboration ...? – method: [observation, self-assessment]

Additional information (optional)

Notes: [...]

Teaching resources / support materials: [...]

Evaluation resources / materials: [...]

Other resources / materials: [...]