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“MISSION: AIRSHIP” HANDBOOK

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Introduction

The STEAM “Mission: Airship” project is an engaging, hands-on, and interdisciplinary learning activity designed for students in grades 7–9. The project guides learners toward creative problem-solving, scientific thinking, and teamwork by integrating hands-on activities, digital content, and real-life challenges. Students design and refine an imaginary airship while solving diverse tasks related to the fields of science, technology, engineering, arts, and mathematics (STEAM) (Yakman, 2008). All activities are developed in direct alignment with the learning outcomes of the Estonian National Curriculum for grades 7–9 (Vabariigi Valitsus, 2025), enabling teachers to use the project as a meaningful supplement in subject-based lessons or integrated project-based learning.

The strength of the project lies in its structured design and methodology. Each activity supports a contemporary learning approach in which the learner is an active, inquiry-based, and creative constructor of knowledge. Students move between physical experiences and digital environments, experimenting, analyzing, and making decisions independently or in collaboration with others. This evidence-based approach aligns with the values of the Estonian National Curriculum, according to which the learner is an active participant and knowledge is constructed through inquiry, collaboration, and practical experience (Vabariigi Valitsus, 2025). A similar approach is also supported by European education policy, where competence-based learning focuses on the application of knowledge in different contexts and the active engagement of learners in meaningful learning processes (European Commission, 2023).

“Mission: Airship” fits well within contemporary learning environments that emphasize interdisciplinary integration, cross-curricular approaches, and the development of practical and social skills. The project can be implemented flexibly—within a single subject (e.g., physics, technology education) or as part of cross-curricular creative work, project-based learning, or thematic learning days. The teacher’s role is to guide, support, and adapt the game-based learning journey according to the needs of the class and the objectives derived from the curriculum.

General Objectives of the Project

The objectives of the project were:

- To create a VR-based learning environment where students can explore and solve STEAM-related problems through game-based simulations.
- To support inquiry-based, creativity-enhancing, and meaningfully integrated learning.
- To deepen students' understanding of the connections between different subjects and their applications in everyday life.
- To develop 21st-century skills derived from Estonia's long-term strategy "Estonia 2035", which consists of a general framework and an action plan, and emphasizes the development of skills such as collaboration, critical thinking, creativity, and digital competence (Vabariigi Valitsus, 2021).
- To provide a meaningful and engaging environment in which students can perceive how the knowledge they acquire is connected to the real world.

Why Grades 7–9?

At the third stage of basic education, students' abstract thinking deepens and subject-specific knowledge becomes more developed; however, it has been found that students often experience difficulties in applying their knowledge in new and real-life situations.

The airship project is well suited for this age group because:

- the tasks are aligned with the topics and learning outcomes of the national curriculum;
- the activities combine physical, visual, and digital experiences;
- the project supports interdisciplinary integration and helps connect theoretical knowledge with practical situations.

Such an approach helps reduce the gap between knowledge acquisition and its application (Thibaut et al., 2018; Vabariigi Valitsus, 2025).

The Meaning, Impact, and Rationale for Implementing STEAM/MATIK in Education

STEAM (commonly referred to as MATIK in Estonian) represents an integrated learning model in which science, technology, engineering, arts, and mathematics are combined toward a common goal through practical and meaningful tasks. One of the central strengths of this model is its role as a "bridge" between theory and real-world application: learners observe phenomena, formulate problems, design solutions, build prototypes, test them, analyse data, and communicate their results (Yakman, 2008).

The Estonian equivalent "MATIK" emerged through a deliberate terminology development process. A press release from the School of Educational Sciences at Tallinn University (9 September 2019) announced a word competition (sõnause) to find an Estonian equivalent for the English acronym STEAM; the same press release defines STEAM as a practice-oriented approach that integrates science, technology, engineering, arts, and mathematics (Tallinn University, 2019a). In the results announcement (31 October 2019), Tallinn University reported that over 200 proposals were submitted, and the winning term "MATIK" was defined as an integrated practical learning approach combining mathematics, science, technology, engineering, and the arts (Tallinn University, 2019b).

STEAM/MATIK is not simply "five separate subjects taught together," but rather a problem-centered learning experience in which (a) different disciplines contribute distinct types of knowledge to the solution and (b) integration is intentional (shared goals, shared terminology, and shared assessment); otherwise, it becomes merely a parallel sequence of activities. This principle aligns with descriptions of integrated STEM education, which emphasize problem-based, inquiry-driven, design-oriented, and collaborative learning as core components of implementation (Thibaut et al., 2018).

Empirical evidence supports the effectiveness of integrated STEM/STEAM approaches: meta-analyses generally report positive effects on learning outcomes and, in many cases, also on attitudes and higher-order thinking skills. However, these effects depend significantly on the quality of implementation (e.g., authenticity of the problem, instructional support, organisation of collaboration, time allocation, and alignment of assessment with objectives) (Becker & Park, 2011; Jeong et al., 2023; Thibaut et al., 2018;

Zhang & Ma, 2023; Zhou et al., 2025). Zhou et al. (2025) demonstrate that the impact depends on the type of integration and pedagogical approach: contextual integration > content integration > "tool-based" integration, and inquiry-based learning tends to yield stronger effects than problem-, design-, or project-based approaches on average. Effective outcomes do not arise simply from adding a "hands-on" component; they emerge when students make relationships explicit (data → decision → improvement) and when teachers guide integration so that disciplines do not remain superficial additions (Thibaut et al., 2018; Zhou et al., 2025).

The Estonian Education Strategy emphasises increasing the share of practical learning (problem- and project-based learning) to develop the ability to solve challenges creatively, collaboratively, and innovatively (Vabariigi Valitsus, 2021). The same document highlights the importance of practical teaching in science, technology, and mathematics, as well as the integration of these fields with creative subjects to foster creativity, problem-solving, and critical thinking (Vabariigi Valitsus, 2021). The present learning game aligns with this framework, as it is not merely a quiz but a structured problem-solving process. Students engage in a short design cycle (evidence → decision → justification) and use digital tools purposefully and meaningfully.

"Estonia 2035" is the country's long-term development strategy, providing a unified direction and serving as the basis for sectoral development plans and funding decisions; its action plan is updated regularly (Riigikogu, 2021; Vabariigi Valitsus, 2024). In this context, the aim of STEAM/MATIK education is to develop learners who can apply knowledge in new situations and make well-reasoned decisions. Even short, well-structured learning games can effectively support the development of these skills (Thibaut et al., 2018).

Alignment with the Curriculum

The Estonian National Curriculum for Basic Schools (PRÕK) defines digital competence as the ability to find and evaluate information, create digital content, and use digital tools for problem-solving and collaboration, while also ensuring the protection of privacy and identity (Vabariigi Valitsus, 2025). The curriculum emphasises cross-curricular themes as a means of integration and outlines their modes of implementation (e.g., project-based learning, creative work, and the design of the learning environment), including the cross-curricular theme "technology and innovation" (Vabariigi Valitsus, 2025). In addition, "general teaching" (üldõpetus) is supported—meaning theme-based instruction without strict subject boundaries—which enables the implementation of integrated STEAM/MATIK learning activities (Vabariigi Valitsus, 2025).

"Mission: Airship" is a STEAM/MATIK-based learning game designed to support the application, consolidation, and integrated use of students' previously acquired knowledge in a practical learning environment. The structure of the game is based on the principle that each hands-on activity leads to a subject-related question requiring the use of prior knowledge. This approach aligns with the learning concept described in the national curriculum, according to which knowledge and skills are applied in real-life situations, learning is connected to everyday life, and active learning methods are used, including field trips and museum-based learning (§ 5(4), clauses 4 and 6) (Vabariigi Valitsus, 2025).

During the game, students develop the learning competence described in § 4(4), as they are required to "apply what they have learned in different situations and in solving problems and to relate newly acquired knowledge to prior learning" (Vabariigi Valitsus, 2025). For example, in Challenge A – Appearance, students identify three-dimensional shapes and associate them with their correct names, after which they answer questions related to the aerodynamic properties of shapes ("Rank the shapes from the most aerodynamic to the least aerodynamic"). This requires not only recognition of shapes but also an understanding of their properties and the ability to apply them in a new context. A similar process occurs in Challenge E – Tools, where students identify materials through tactile exploration and then evaluate their suitability for constructing an airship ("Rank the materials from most suitable to least suitable"), linking material properties to their practical use.

Learning takes place collaboratively, which supports the development of communication competence as described in § 4(5). Students express their ideas, listen to others, and work towards a shared solution. For example, in Challenge B – Steering, they must collaboratively determine how to control an object, while in Challenge C – Space they discuss measurement results and their meaning. Questions such as "Which fuels are suitable for flight?" or "Which weight distribution ensures stability?" require students to present and justify their reasoning, which is central to communication competence (Vabariigi Valitsus, 2025). In addition, the arts are directly connected to communication competence, as visual design is a form of communication—students "present and justify their ideas," in this case through a visual solution. This also supports entrepreneurial competence (§ 4(7), as designing a logo requires creative thinking, innovation, and decision-making under uncertainty (Vabariigi Valitsus, 2025).

The mathematical, scientific, and technological competence described in § 4(6) is at the core of the game. Students use mathematical, scientific, and technological knowledge to understand phenomena and make decisions. For example, in Challenge C – Space, they measure pressure and use the obtained values, while in Challenge D – Engine they experiment with the functioning of mechanical systems. Questions such as "Match the physical quantity with its unit" or "What affects the lift of an airship?" require the application of knowledge rather than simple recall. Such activities support the ability to describe the surrounding world using scientific models and to make evidence-based decisions, as required by the curriculum.

The problem-solving and open-ended nature of the game also supports entrepreneurial competence (§ 4(7). Students must respond to changing situations, test different solutions, and make decisions under time constraints. For example, in Challenge D – Engine there is no single correct solution; students must find a working mechanism through experimentation. Similarly, tasks such as "Which materials are environmentally friendly?" or "Which configuration ensures stability?" require decision-making under uncertainty, fostering the ability to take reasonable risks and act creatively (Vabariigi Valitsus, 2025).

Digital competence (§ 4(8) is expressed through the purposeful use of digital tools. Students use QR codes, access information in digital environments, and input answers to progress in the game. Digital technology is not an end in itself but a tool that supports learning, in line with the curriculum's requirement to use digital tools for problem-solving and collaboration (Vabariigi Valitsus, 2025).

In addition, the game supports the general learning outcomes of the third stage of basic education (§ 6). Students "are able to solve everyday problems in different domains," using logical and spatial reasoning (p 7), for example when analysing measurement results or comparing different solutions. They "are able to cope in the technological world" (p 10) by applying knowledge of mechanisms, materials, and energy, and they "think systematically, creatively, and critically" (p 14), as each task requires analysis and justification (Vabariigi Valitsus, 2025).

From the perspective of the learning concept, the game is a comprehensive example of the implementation of § 5(5), according to which learning activities are structured as a coherent whole through integration. Each task connects multiple subject areas: for example, evaluating materials integrates science and technology, experimenting with mechanisms combines physics and technology, and designing a logo integrates the arts and engineering. Thus, subjects are not treated separately but as part of a unified problem-solving process.

The overall logic of the learning game does not end with hands-on activities and related questions but culminates in the application of solutions in a virtual environment. After students have developed their airship based on knowledge acquired through different challenges (e.g., selecting materials, evaluating weight distribution, and testing mechanisms), the activity moves into a virtual reality (VR) environment where they can test their solution. This environment allows students to observe how their decisions affect the functioning of the airship, such as its stability, movement, or lift. In this way, learning moves from abstract discussion and decision-making to simulated application, enabling students to directly experience the consequences of their decisions. This approach supports the curriculum principle of applying knowledge in real or simulated real-life situations and drawing conclusions from experience (§ 5(4), clause 4) (Vabariigi Valitsus, 2025).

Furthermore, the VR phase strengthens digital competence (§ 4(8), as students use digital technologies not only to access information or input data but also to understand complex systems and analyse the outcomes of problem-solving. At the same time, it reinforces mathematical, scientific, and technological competence (§ 4(6), as students connect their prior decisions (e.g., material selection or structural design) with observable outcomes in the virtual environment.

Thus, the learning game forms a coherent learning cycle in which hands-on activity, analysis, answering questions, and virtual testing together create a unified process that supports the application of knowledge, informed decision-making, and understanding of consequences. Although "Mission: Airship" clearly supports the development of general competencies defined in the national curriculum, its pedagogical value is not limited to general skills but is also directly grounded in subject-specific learning outcomes and curricula (Vabariigi Valitsus, 2025).

For example, in Challenge E – Tools, students identify different materials based on their properties through tactile exploration and comparison. In subsequent questions, they evaluate the suitability of materials for a specific purpose, such as constructing an airship hull ("Rank the materials from most suitable to least suitable"). This task is based on the learning outcomes of science and technology education, where students compare material properties and evaluate their suitability for different applications (PRÕK Appendix 4; Appendix 7) (Vabariigi Valitsus, 2025).

Similarly, tasks related to mechanisms and movement are linked to the learning outcomes of technology education and physics, where students understand the functioning of technical systems and explain the purpose of simple mechanisms (PRÕK Appendix 4; Appendix 7) (Vabariigi Valitsus, 2025). The arts are represented in the game through visual communication and design, such as in the logo creation task, which aligns with the objectives of the arts curriculum (PRÕK Appendix 3) (Vabariigi Valitsus, 2025).

Such a structure, where each activity and question is based on specific subject learning outcomes, is consistent with § 5(5) of the national curriculum, according to which integration supports the development of both general and subject-specific competencies (Vabariigi Valitsus, 2025). Therefore, it is justified to view "Mission: Airship" not only as a tool for developing general competencies but also as an environment for the purposeful application of subject-specific learning outcomes.

The following chapter provides a more detailed overview of the learning game narrative and explains how each challenge and question is connected to specific curriculum learning outcomes and what knowledge and skills they develop in students.

Narrative, Challenges, and Rationale of the STEAM Approach in the Learning Game

The narrative of the “Mission: Airship” learning game is built around three different characters, each representing distinct engineering and design problems. The characters are not merely elements of the story but function as a didactic tool that helps students understand that technical solutions depend on their intended purpose and that the same system (the airship) can be designed to meet different needs.

Each character presents a different challenge that guides students to make decisions, consider trade-offs, and apply their knowledge within a specific context. During the game, two performance indicators are distinguished: score and credit.

Score points are earned by answering questions, and the maximum number of points is linked to the accuracy of the solution—answering correctly on the first attempt allows students to receive the maximum score (200 points), while each additional attempt or the use of hints reduces the number of points earned. Credit, on the other hand, remains a fixed resource throughout the game and does not directly depend on the results of answering questions.

Such a system encourages students to carefully consider their responses, avoid random guessing, and value accuracy and strategic thinking. This supports the STEAM/MATIK approach, in which problem-solving is goal-oriented and requires the integration of knowledge from multiple disciplines.

Characters

Jessy Jet – Speed and Efficiency

Jessy Jet represents the context of racing and speed, where the primary goal of the airship is to move as quickly and efficiently as possible. Her mission directs students to focus on properties such as speed, aerodynamics, weight, and manoeuvrability.

Pedagogically, this means that students must:

- understand how shape affects movement in the air;
- consider the impact of mass and materials;
- make decisions that increase efficiency but may reduce stability.

This approach primarily develops competencies in physics (motion, forces, air resistance), mathematics (comparison, optimisation), and engineering (design decisions). Jessy Jet helps students understand that a technical solution is not neutral but depends on its intended purpose—in this case, achieving maximum speed.

Victor Strand – Comfort and User Experience

Victor Strand represents the context of tourism and passenger services, where the goal of the airship is not maximum speed but a comfortable, safe, and visually appealing travel experience. His mission directs students to consider factors such as stability, noise level, visual design, and passenger capacity.

Pedagogically, this means that students:

- analyse what makes movement comfortable (e.g., smoothness, balance);
- understand that technical solutions influence user experience;
- connect visual design (e.g., logo and appearance) with functionality.

This character particularly supports the integration of arts (visual communication), physics (stability, balance), and technology education (the suitability of solutions for users). Victor Strand helps students understand that engineering is not only about functionality but also about considering user needs.

Dr. Laura Cassidy – Durability and Environmental Context

Dr. Laura Cassidy represents a work- and environment-oriented mission, where the airship is used for practical tasks such as transportation or clean-up operations. The focus of this mission is on load capacity, durability, and stability.

Pedagogically, this directs students to:

- analyse the properties of materials and their suitability;
- understand the relationship between weight distribution and stability;
- consider environmental impact and practical use.

This character primarily supports learning outcomes in science (materials, environment), technology education (structures), and physics (balance, centre of gravity). Dr. Goodyear helps students understand that technical solutions must be durable and purpose-driven, and that compromises often need to be made between speed, functionality, and aesthetics.

Description of Challenges and Educational Rationale

During the game, players move between five different physical locations within a museum environment. Visual cues are used to guide them to the next location—players are shown a photo of a specific place, which they must recognise and locate in the physical space. This approach encourages students to actively observe their surroundings, compare visual information with the real environment, and draw conclusions in order to identify the correct location.

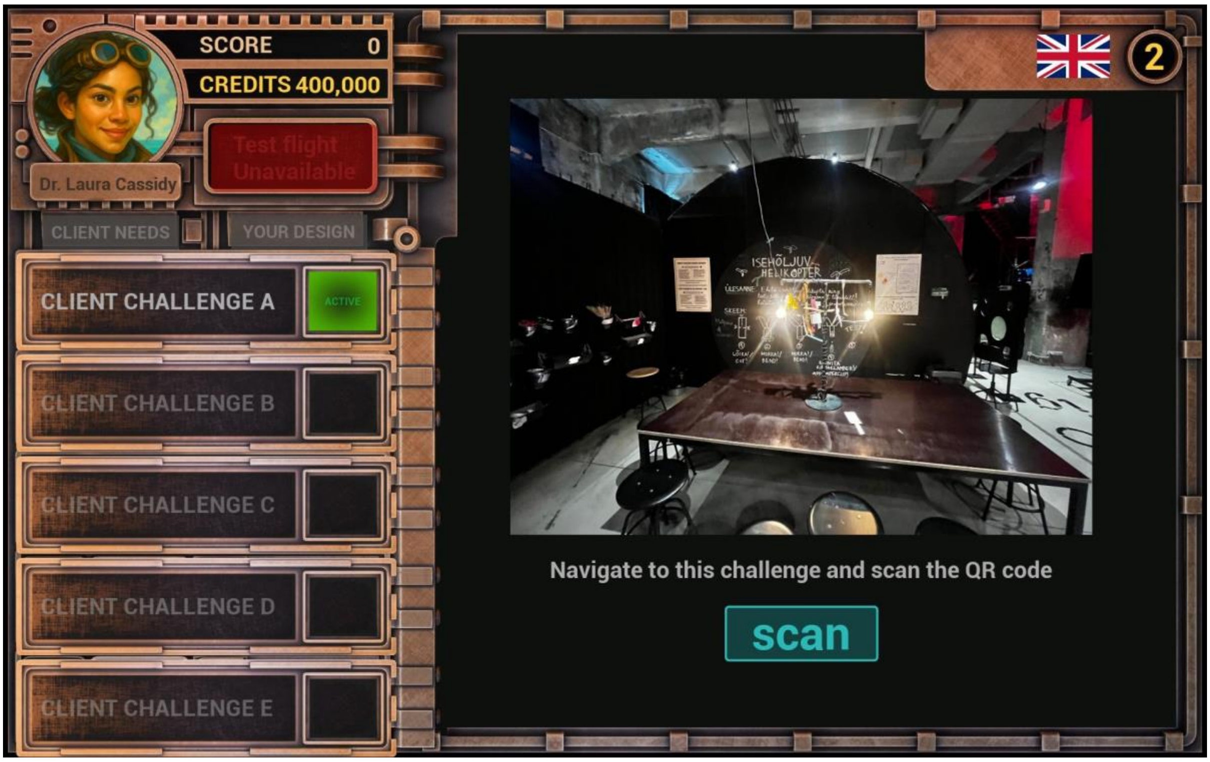
Once players reach the correct location, they confirm their presence by scanning a QR code. This unlocks a corresponding challenge, in which they must complete a hands-on task and find the correct code. After entering the code, four questions appear on the tablet, directly related to the completed activity and based on the learning outcomes of the third stage of the national curriculum. These questions guide students to analyse their actions, reflect on them, and connect them with theoretical knowledge.

Such a structure creates a clear learning cycle, in which students move from activity to analysis and then to the application of knowledge. Learning begins with a concrete experience—movement and hands-on activity—followed by reflection and analysis through answering questions. Students then connect their actions with theoretical concepts and apply the acquired knowledge in subsequent tasks or in a virtual environment.

This learning logic is also described by a cyclical approach, where learning occurs through experience, analysis, conceptualisation, and application (Kolb, 1984). In this learning game, knowledge is not presented in a ready-made form but is constructed through activity, enabling learners to actively participate in the creation of knowledge.

Such an approach is particularly important in the context of STEAM/MATIK education, as it enables the integration of knowledge from different subject areas through practical experience and supports the active role of the learner in knowledge construction (Thibaut et al., 2018).

Challenge A - Visual & durable design



Description

Students work with a physical task where different three-dimensional shapes (e.g., cylinder, cube, prism, pyramid, sphere) are placed on a table, each assigned a number (1–5). Their task is to identify the shapes and match them with the correct names, using both visual perception and prior knowledge. After identifying the shapes, students must find the corresponding number for each shape and enter them in the given order to form the correct passcode. The task requires attention, logical thinking, and the ability to connect a physical object with an abstract concept.

Once the code has been successfully entered, students move on to the next stage, where they create a logo for their airship based on given instructions. In designing the logo, they consider both visual and symbolic elements, taking into account the purpose and characteristics of their airship. The completed logo is photographed using a tablet and is automatically applied to their airship image, allowing students to see their created solution as part of a complete design.

pyramid (3) → cylinder (1) → prism (4) → sphere (5) → cube (2)

Code: 31452

Learning Objectives

The challenge supports the integrated development of multiple STEAM/MATIK domains and is based on the learning outcomes of the third stage of the Estonian National Curriculum for Basic Schools (Vabariigi Valitsus, 2025):

Mathematics (M): the student describes and compares the properties of three-dimensional shapes and applies them in solving problems (PRÕK Appendix 5, Geometry, Stage III).

Arts (A): the student plans and creates a visual solution (logo), considering the meaning of form and colour as well as the purpose of the design (PRÕK Appendix 3, Arts, Stage III).

In addition, the activity supports the development of general competencies:

- **learning competence (§ 4(4) p 4):** the student applies knowledge in different situations and relates new knowledge to prior learning;
- **mathematical, scientific and technological competence (§ 4(4) p 6):** the student uses mathematical and scientific knowledge to solve problems and make informed decisions;
- **communication competence (§ 4(4) p 5):** the student presents and justifies their ideas and collaborates with others;
- **digital competence (§ 4(4) p 8):** the student uses digital technology purposefully for learning and problem-solving, including finding and using information and creating digital solutions (e.g., using QR codes, working with a tablet, and operating in a virtual environment).

Why this activity?

The challenge combines physical experience with abstract concepts, supporting deeper learning. Observing and handling shapes helps students activate prior knowledge and create connections between a visual object and a mathematical concept.

The code system makes the task purposeful and game-like—students are not solving the task merely to check their knowledge, but to progress further. This increases motivation and reduces random guessing, encouraging students to think more deliberately.

The logo creation stage adds a creative dimension to the task, where technical knowledge is connected with visual expression. This supports the STEAM approach, in which knowledge is not treated as separate, but functions together in creating a coherent solution.

Follow-up Questions

1. *Rank the materials from most suitable to least suitable for constructing an airship envelope.*

Correct order (Most suitable → Least suitable):

C) Coated fabric → B) Rubber → D) Plain cloth → A) Paper

2. *Match each colour with its common meaning.*

Colour	**Meaning**
Blue	Calmness and reliability
Red	Passion and energy
Yellow	Joy and optimism
Green	Nature and growth

3. Which of the following materials are best for the environment?

A) Bamboo – grows quickly, renewable, biodegradable ✅

B) Single-use plastic – made from fossil fuels, pollutes the environment ❌

C) Recycled aluminum – saves energy compared to producing new metal ✅

D) Styrofoam – takes hundreds of years to decompose ❌

E) Organic cotton – grown without harmful chemicals, biodegradable ✅

Challenge B - Speed, propulsion & range

Description

Students are required to guide a wooden disc through a hole-filled labyrinth using strings. To control the movement, the strings must be pulled in a coordinated manner in order to direct the disc into the correct target hole. The task requires precision, cooperation, and control of movement.

When the disc reaches the correct hole, students hear an audio riddle, the solution of which provides them with a code for progressing further.

Code: SUNDAY

Learning Objectives

The challenge primarily supports the integrated development of engineering, science, and technology (Vabariigi Valitsus, 2025):

Science / Physics (S): the student explains the relationship between force and motion and understands how force affects the movement of an object (PRÕK Appendix 4, Physics – mechanics).

Technology (T): the student uses technological tools and simple systems purposefully and understands their principles of operation (PRÕK Appendix 7, Technology domain, Stage III).

Engineering (E): the activity also involves engineering-related problem-solving, where students test different solutions and adjust their actions based on the results.

In addition, the activity supports the development of general competencies:

- **learning competence (§ 4(4) p 4):** the student "applies what has been learned … in solving problems" and relates new knowledge to prior learning;
- **social and civic competence (§ 4(4) p 2):** the student cooperates with others and follows agreed rules in group activities;
- **communication competence (§ 4(4) p 5):** the student presents, discusses, and "expresses and justifies" their ideas in group decision-making;
- **mathematical, scientific, and technological competence (§ 4(4) p 6):** the student uses modelling and measurement logic and makes "evidence-based decisions" (and uses technology purposefully);
- **digital competence (§ 4(4) p 8):** the student uses digital tools (e.g., entering a code on a tablet) as part of problem-solving and follows the principles of safe digital behaviour.

Why this activity?

The challenge focuses on cooperation and the control of movement, creating a strong connection between physical experience and scientific concepts. Students do not learn the relationship between force and motion theoretically, but experience it directly through action.

The task requires teamwork—no student can solve it alone—thereby naturally developing communication and collaboration skills. In addition, students must test different strategies, learn from mistakes, and adapt their actions, which supports problem-solving and entrepreneurial competence.

The game-based elements (target, sound, code) help maintain high motivation and guide students to focus on precise and well-considered actions.

Follow-up Questions

1. *Rank the shapes from the most aerodynamic to the least aerodynamic.*

Correct order (Best → Worst):

C) Teardrop → B) Sphere → D) Flat plate → A) Box

2. *Fill in the sentence with the correct words:*

   A more powerful engine increases [speed], but also uses more [fuel].

Drag the correct answers:

✅ speed

✅ fuel

❌ balloon

❌ wind

❌ wheels

❌ fabric

3. *You need to choose a fuel for an airship or aircraft. Below is a list of different fuels. Select all that could be suitable for flying.*

Fuel Options:

- Gasoline ✅
- Diesel ✅
- Hydrogen ✅
- Coal ❌

- Wood ❌

4. Match the Unit with What It Measures

Drag or draw lines between each unit (abbreviation) and what it measures.

A) Mass → kg

B) Speed → km/h

C) Volume → L

D) Force → N (Newton)

E) Energy → J (Joule)

F) Power → W (Watt)

G) Length or Distance → m

H) Time → s

I) Pressure → Pa (Pascal)

Challenge C - Passenger & cargo space

Description

Students use an interactive device equipped with a pressure gauge. A green zone is marked on the gauge scale, indicating the system's safe operating range.

The task for the students is to determine at which pressure level the green zone begins and at which level it ends. To do this, they must read the corresponding values from the measuring device and add them together in order to obtain the correct code for further progression.

Code: 39.5

Learning Objectives

The challenge primarily supports the integrated development of science, mathematics, and technology.

Science / Physics (S): the student understands the concept of pressure and its role in the functioning of a system and relates measured values to real-world phenomena (PRÕK Appendix 4, Physics – mechanics).

Mathematics (M): the student reads numerical values from a measuring device, uses them to solve a problem, and performs calculations (addition) to obtain the result (PRÕK Appendix 5, Stage III).

Technology (T): the student uses a technological device purposefully and understands its operating principles (PRÕK Appendix 7, Technology domain).

In addition, the activity supports the development of general competencies:

- **learning competence (§ 4(4) p 4):** the student applies acquired knowledge in new situations and relates it to prior learning;
- **mathematical, scientific, and technological competence (§ 4(4) p 6):** the student uses measurement and draws conclusions based on numerical data;
- **digital competence (§ 4(4) p 8):** the student uses digital tools (e.g., entering a code on a tablet) to continue the task.

Why this activity?

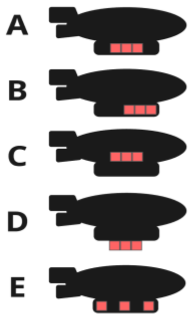
The challenge develops the ability to interpret visual and measured information and to connect it with numerical values. Students must read data from a measuring device, understand its meaning, and use mathematical operations to reach a solution.

Such an activity helps students understand how measurement and calculation function in real-life situations and how physical quantities influence the functioning of a system.

The game-based context (finding the correct operating range and obtaining a code) creates a clear goal and increases motivation, guiding students toward precise and well-considered actions.

Follow-up Questions

1. *Look at the following cargo layouts. Rank the layouts from most stable to least stable.*



Correct

D > E > A > C > B

2. *Volume Fit Challenge*

You are loading cargo into an airship. Each cargo box has a volume of **0.5 cubic meters (m^3)**. The airship's cargo bay can hold a total of **3 cubic meters (m^3)**. **How many full cargo boxes can you fit inside?**

Options:

A) 3

B) 6 ✅

C) 9

D) 12

3. *Air Pressure Matching Task*

Some things can change the **air pressure inside an airship**, and some do not.

Match each situation to how it affects the internal air pressure.

A) Passenger breathing > Adds carbon dioxide (CO_2), but doesn't change pressure much ✅

B) Cargo shape > Has no effect on air pressure ✅

C) Flying to higher altitude > External pressure drops, air inside expands ✅

D) Tear in the airship > Pressure drops inside due to escaping gas ✅

4. *Passenger Comfort Priorities – Ranking Task*

Rank the following features **from most important to least important** for general **passenger comfort** during an airship flight. Use numbers **1 (most important)** to **4 (least important)**.

- Stability - Smooth and stable flight
- Silence - Quiet environment
- Chair - Comfortable seating
- View - From windows

Research shows the most common priority is:

Stability → Silence → Chair → View ✅

Challenge D - Lifting capacity & maneuverability

Description

Students use a gear system designed to transfer motion from an input gear to an output gear. Their task is to position the gears correctly so that the system functions and the movement is transmitted effectively.

The system includes hidden magnets and sensors that indicate when the correct connections have been achieved. When the gears are positioned correctly and the connection functions as intended, the system is activated and students receive a secret code to proceed further.

Code: 1895

Learning Objectives

The challenge primarily supports the integrated development of science and technology.

Science / Physics (S): the student explains the transfer of motion and understands how force and movement are transmitted through mechanical systems (PRÕK Appendix 4, Physics – mechanics).

Technology (T): the student uses technological systems purposefully and understands their operating principles (PRÕK Appendix 7, Technology domain, Stage III).

Engineering-related problem-solving (E): the student tests different solutions and adapts their actions based on the results in order to achieve a functioning system.

In addition, the activity supports the development of general competencies:

- **learning competence (§ 4(4) p 4):** the student applies prior knowledge in solving a new problem;
- **mathematical, scientific, and technological competence (§ 4(4) p 6):** the student understands how systems function and draws conclusions based on experimentation;
- **communication competence (§ 4(4) p 5):** the student discusses and justifies their solutions in group work;
- **digital competence (§ 4(4) p 8):** the student uses digital tools (e.g., entering a code on a tablet) to continue the task.

Why this activity?

The challenge is based on experimentation and understanding systems. Students are not given a ready-made solution but must test different gear configurations and observe how movement changes within the system. This approach develops logical thinking, problem-solving skills, and an understanding of how technical systems function. Students directly experience how a single component affects the operation of the entire system.

The game-based element (finding the correct connection and obtaining a code) maintains high motivation and guides students toward consistent and systematic action.

Follow-up Questions

1. *Gas Lift Match – Molar Mass & Lift Ability*

Match each gas name to its correct **molar mass**, along with its lift ability description.

Match the following:

1. Helium (He) > A) (4 g/mol) – very light, ideal for lift ✅
2. Nitrogen (N_2) > B) (28 g/mol) – slightly lighter than air ✅
3. Oxygen (O_2) > C) (32 g/mol) – slightly heavier than air ✅
4. Carbon dioxide (CO_2) > D) (44 g/mol) – much heavier, does not lift ✅

2. Physics & Airships – Drag the Words Into the Blanks

Instructions: Drag the correct word into each sentence.

Word bank: mass, lift, pressure, volume, weight, gravity

1. An airship needs more __**lift**_____ to rise when it carries more mass.
2. The force that pulls the airship down is called __**gravity**_____.
3. The gas inside the airship builds up __**pressure**_____, which helps it stay afloat.
4. When the cargo increases, the total ___**weight**____ of the airship goes up.
5. The space that the lifting gas takes up is called its ___**volume**____.
6. The ___**mass**____ of an object influences Earth's pull on that object.

3. Which of the following factors affect how much an airship can lift?

(Choose all that apply)

✅A) The type of lifting gas used

✅B) The volume of the gas chamber

❌ C) The color of the airship

✅D) The total weight of the airship and its load

❌ E) The shape of the tail fin

4. What could help improve maneuverability of an airship?

(Select all that apply)

✅A) Adjustable rudders and fins

✅B) Balanced weight distribution

✖C) Using heavier lifting gas

✅D) Lowering the airship’s center of gravity

Challenge E – Tools

Description

The challenge consists of two stages.

In the first stage, students must identify different materials using only their sense of touch. The materials are placed in closed boxes or a barrel, and each material is assigned a number. Students feel the materials, attempt to recognise their properties (e.g., softness, elasticity, texture), and match them with images displayed on a tablet. When the matching is correct, a code is formed, which allows them to proceed to the next stage.

Code: 53241

In the second stage, students use air pressure to affect balloons of different weights. The balloons contain hidden weights, and the students' task is to observe which balloons move more easily and which require greater force. Based on their observations, they rank the balloons from lightest to heaviest, and this sequence forms a new code.

Code: 32514

Learning Objectives

The challenge primarily supports the integrated development of science, technology, and mathematics.

Science (S): the student describes the properties of materials and relates them to their possible applications; additionally, the student understands the effect of force and mass on movement (PRÕK Appendix 4).

Technology (T): the student uses various tools and systems purposefully and evaluates their suitability for solving a specific task (PRÕK Appendix 7).

Mathematics (M): the student compares quantities, creates sequences, and uses logical thinking to solve problems (PRÕK Appendix 5, Stage III).

In addition, the activity supports the development of general competencies:

- **learning competence (§ 4(4) p 4):** the student applies knowledge gained through experience and relates it to prior learning;
- **mathematical, scientific, and technological competence (§ 4(4) p 6):** the student draws conclusions based on experimentation and comparison;
- **digital competence (§ 4(4) p 8):** the student uses a tablet to input answers and verify the solution.

Why this activity?

The challenge combines sensory experience with analytical thinking. Identifying materials through touch develops attention, perception, and the ability to describe properties without visual support. This creates a strong connection between experience and scientific concepts.

The second stage (the balloon experiment) develops an understanding of the relationships between force, mass, and motion. Students are not given the answers but must experiment and compare the results themselves.

The game-based structure (obtaining codes in two stages) maintains high motivation and guides students toward precise and systematic action.

Follow-up Questions

1. *What gear best fits the client needs?*

   (Match the gear with the correct client need)

Client	Client A	Client B	Client C	Client D
Need	Guard the skies from pirates	Show tourists beautiful landscapes	Break air-race speed record	Hauling cargo around
Gear	Searchlight	Binoculars	Booster engine	Hoisting crane

2. *Which tools allow you to navigate with your airship?*
   - ☑ Radar
   - ☑ Compass
   - ☑ Map/GPS
   - ✗ Radio
   - ✗ Sonar
   - ✗ Calculator

3. *What design decisions match the goal?*

What airship components have the most impact on meeting the client need?

Client	Client A	Client B	Client C	Client D
Need	I need more speed	I need more lifting power	I need more agility	I need more passenger capacity
Gear	Add more propellers	Increase the blimp size	Add more steering wings	Increase gondola size

4. *Your airship hull is damaged, lifting gas is leaking, what tools do you use to repair?*

- ✗ A blowtorch
- ✗ A hammer with wood
- ✅ Tape
- ✅ Glue with fabric
- ✗ Spraypaint
- ✗ A band-aid plaster

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