ERASMUS+ KA220-VET
Strategic Partnerships for Vocational Education and Training

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WASTE MANAGEMENT IN AVIATION

TOOLKIT

A Comprehensive Resource for Aviation Educators and Students

Project partners:

Aviation Academy, Belgrade, Serbia (Lead Partner)
Education Support Association InterEdu, Serbia
Aksu Ucak Bakim Teknolojisi MTAL, Antalya, Turkey
Istituto Tecnico Trasporti e Logistica "Francesco De Pinedo", Rome, Italy

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1. About the project

AviWaste – At a Glance

AviWaste is an Erasmus+ KA220-VET Strategic Partnership project bringing together four institutions from Serbia, Turkey, and Italy active in VET education. The project develops innovative learning resources to embed waste management and environmental sustainability into vocational aviation education, in alignment with the European Green Deal.

1.1. Background and rationale

Environmental protection in aviation is one of the most pressing challenges facing the industry today. Air transport, while essential to global connectivity and economic development, generates significant quantities of waste across its operations - from aircraft maintenance and repair to ground handling and in-flight services. Proper disposal and management of this waste is critical to preventing pollution of air, water, and land.

Despite the scale of this challenge, waste management has historically received less attention in vocational aviation education than technical flight and maintenance skills. Aviation schools across Europe have a unique opportunity - and responsibility - to change this. By integrating sustainability and waste management into their curricula, these institutions can prepare the next generation of aviation professionals to be not only technically competent, but environmentally responsible.

The AviWaste project was born from this recognition. The four consortium partners came together to develop a more environmentally friendly and innovative approach to waste management education in aviation. Their collective expertise, spanning aircraft maintenance, air traffic management, logistics, and non-formal education, creates a rich foundation for developing materials that are practical, current, and internationally relevant.



1.2. Alignment with European priorities

AviWaste is directly aligned with the European Green Deal, the EU's flagship strategy for achieving climate neutrality and environmental sustainability by 2050. Specifically, the project contributes to:

- Reducing the environmental footprint of the aviation sector through education and awareness
- Developing green skills among VET learners and teachers across Europe
- Promoting circular economy principles in vocational training contexts
- Strengthening international cooperation in vocational education and training
- Supporting the digitalization of learning through VR and online course development

The project also responds to Erasmus+ priorities for VET, including innovation in teaching and learning, mobility of learners and staff, and the development of transferable qualifications and skills.

1.3. Project vision and objectives

The overarching vision of AviWaste is to equip aviation students and teachers with the knowledge, skills, and attitudes needed to contribute meaningfully to environmental sustainability in their future professional roles.

The specific objectives of the project are:

- To develop learning and teaching resources about waste management in aviation that will innovate school curricula and bring environmental sustainability to the forefront of VET education.
- To incorporate the principles and goals of the European Green Deal into vocational aviation curricula across partner countries.
- To contribute to innovation in VET through a training curriculum covering waste management in the aviation sector for the purpose of environmental protection.
- To create awareness for environmental protection in the aviation sector, supported by needs analysis and research at national and international level.
- To improve the digital skills of teachers by training them to create digital teaching and learning materials, specifically VR-based activities.

To prepare students for work-based learning environments by enabling them to acquire skills and knowledge in the classroom through VR activities before undertaking practical training in real aviation companies.

2. Project descriptions

2.1. Project summary

AviWaste provides students with hands-on experience in waste management practices through three interconnected outputs: a Toolkit, an Online Course (MOOC), and Virtual Reality (VR) activities. Together, these resources build a coherent and engaging learning pathway that moves from theoretical understanding to immersive simulation and practical application.

Students who engage with the AviWaste learning materials will develop a deeper understanding of the waste management challenges specific to the aviation sector. They will gain valuable, transferable skills for implementing sustainable solutions as future employees in aviation, whether in aircraft maintenance, ground operations, air traffic services, or logistics.

2.1. Consortium

Aviation Academy - Lead Partner (Belgrade, Serbia)

Aviation Academy is a unique aviation school within the education system of the Ministry of Education, Science and Technological Development of the Republic of Serbia. With more than 800 students and 80 staff members, it is one of the most significant aviation educational institutions in the region.

The school's curriculum covers both civil and military aviation programmes in mechanical engineering and air traffic, developed in accordance with PART-66, PART-147, and PART-FCL international standards.

Education Support Association InterEdu (Serbia)

InterEdu is a non-profit organisation devoted to promoting European educational standards and supporting integration in the educational area across all ages and vulnerable groups. The organisation promotes the best examples of educational practice at national and European level, develops partnership networks, and organises mobilities across Europe.

Established in 2024 by a team of professionals with diverse expertise united by a shared commitment to lifelong learning, InterEdu serves as the coordination and dissemination hub for AviWaste, ensuring effective communication between partners and quality control of project outputs.

Aksu Ucak Bakim Teknolojisi MTAL (Antalya, Turkey)

As Turkey's first thematic and project-based school in aviation, Aksu MTAL operates in Antalya's Aksu district with 300 students and 30 staff. The school began operations in 2016 and features a Boeing 737-400 aircraft on its premises, used for practical training and as a library resource.

The school implements a comprehensive five-year programme with training in two main fields: Aircraft Electronics (Avionics) and Mechanics. Students begin internship programmes in the 11th and 12th grade, attending airport technical units three days per week. The school has nine formal cooperation agreements with national and international airline companies and Antalya Airport Authority, and operates a UAV Research and Innovation Centre with drones, 3D printers, and drone software development equipment.

Istituto Tecnico Trasporti e Logistica "Francesco De Pinedo" (Rome, Italy)

De Pinedo Institute is the only public secondary school in the Lazio region offering a diploma in Transport and Logistics across the areas of Air Vehicle Management, Aircraft Construction, and Logistics. Students aged 14–19 follow a five-year programme oriented toward careers as pilots, air traffic controllers, aircraft maintenance engineers, or logistics specialists.

The school attracts a diverse student population from across Lazio and central-southern Italy, including a high proportion of students from families of foreign origin, making intercultural integration a core institutional value. De Pinedo contributes rich expertise in aviation logistics and the management of goods within airport environments to the AviWaste partnership.

3. Relevance, impact and implementation

3.1. Relevance of the project

The AviWaste project addresses a gap that is both timely and strategically significant: the absence of structured, dedicated waste management education within vocational aviation training programmes across Europe. While the aviation industry operates under increasingly stringent environmental regulations and faces growing public and institutional pressure to reduce its ecological footprint, the vocational schools that train the next generation of aviation technicians, logistics specialists, and ground operations staff have largely lacked the curriculum tools to prepare students for these responsibilities.

The relevance of AviWaste rests on three converging pillars.

Environmental Urgency

Aviation generates waste across every dimension of its operations - from hazardous materials in aircraft maintenance and repair, to catering and packaging waste on flights, to the complex end-of-life challenges of retiring aircraft. Airports can generate tens of thousands of tonnes of waste annually. Improper handling of this waste poses direct risks to soil, groundwater, air quality, and surrounding ecosystems. At the same time, the sector is under regulatory transformation: the EU Emissions Trading System, ICAO's CORSIA programme, EASA environmental requirements, and the overarching European Green Deal are collectively reshaping what it means to operate responsibly in aviation. Future professionals must be equipped to navigate this landscape from day one of their careers.

Educational Need

The European Commission's GreenComp sustainability competence framework calls on all levels of education, including VET, to embed environmental knowledge and green skills into their programmes. Yet prior to AviWaste, no freely accessible, aviation-specific, multilingual learning resource existed to support VET teachers in delivering this content. The needs analysis conducted by consortium partners confirmed this gap across all three partner countries, with teachers reporting limited access to relevant materials and no structured curriculum guidance on aviation waste management.

Sector-Specific Professional Demand

The aviation industry is not waiting for education systems to catch up. Airlines, airports, and MRO organisations across Europe are already implementing environmental management systems, zero-waste-to-landfill commitments, and circular economy programmes. They increasingly expect new employees to arrive with awareness of these systems and a willingness to operate within them. The AviWaste project responds to this demand by creating learning materials grounded in real industry practice, validated by associated partners including airports and aviation companies in Serbia, Turkey, and Italy, and that give students genuine, applicable knowledge before they enter the workplace.

The project is also relevant in its methodological approach. By combining a structured online course with immersive VR activities and a comprehensive teacher toolkit, AviWaste meets learners where they are: in classrooms that vary widely in equipment and resources, with teachers who have varying levels of digital confidence, and in national contexts with different regulatory and industrial environments. The multilingual delivery of all materials ensures that the project's relevance extends beyond the immediate consortium to the broader European VET community.

3.2. Impact on local, national and European level

The impact of AviWaste is designed to radiate outward from individual learners to institutions, sectors, and policy environments across three levels.

Local Impact

Local impact is felt most directly by the students and teachers of the four partner schools. Students at Aviation Academy Belgrade, Aksu MTAL in Antalya, and De Pinedo Institute in Rome gain access to structured, professionally validated learning on a topic directly relevant to their careers. They develop green competences - an increasingly valued category of professional skills - alongside the digital competences built through engagement with VR and online learning platforms. Teachers gain new pedagogical tools and the confidence to deliver environmental content with authority, supported by the lesson plan template, MOOC structure, and VR facilitation guidance developed through the project.

At the level of individual schools, AviWaste has catalysed curriculum modernisation. The integration of waste management content into existing aviation programmes, aligned with EASA standards and European Green Deal priorities, positions partner schools as forward-looking institutions responsive to both industry and policy developments. Student-led initiatives - such as the school-level waste audit undertaken by Aksu MTAL students - demonstrate that the project's impact extends beyond the classroom into school culture and community.

National Impact

National impact flows from the dissemination activities undertaken by each partner in their home country. Each partner school has engaged parents, teaching staff, students, and external stakeholders through newsletters, dissemination panels, and social media. The White Paper produced by InterEdu, grounding the project in a research overview of waste management conditions and challenges in all three partner countries, provides a resource that national educational authorities and sector bodies can draw on when developing their own policies and curriculum frameworks.

In Turkey, the project strengthens the connection between vocational aviation education and the country's rapidly growing aviation sector, including the expanding operations of Antalya Airport. In Italy, it contributes to the environmental education agenda of ENAC and supports the integration of sustainability into the logistics and transport curricula that De Pinedo specialises in. In Serbia, it deepens the already strong relationship between Aviation Academy and its industry partners, adding an environmental dimension to dual education programmes that have until now focused primarily on technical airworthiness skills.

European Impact

European impact is generated through the open availability of all project results. The MOOC, hosted on the Erasmus+ Learning Hub, is freely accessible to any teacher or student across Europe and beyond. The Toolkit, available in English, Serbian, Turkish, and Italian under a Creative Commons open licence, can be adopted and adapted by any aviation VET school on the continent. The VR activities, available both online and offline, remove the hardware barrier that has historically limited the spread of immersive learning tools in under-resourced educational settings.

The project contributes directly to the European Green Deal's education dimension and to the Osnabrück Declaration's call for VET systems to support green transitions. It provides a concrete, replicable model for how vocational schools in any technical sector can integrate sustainability content into existing programmes without displacing existing curriculum - a model transferable to automotive, maritime, rail, and other transport VET contexts. By producing outputs that are open, multilingual, and grounded in real industry validation, AviWaste increases the European VET community's collective capacity to respond to the green transition.

3.3. Project implementation overview

The AviWaste project ran for 22 months, from 1 October 2024 to 31 July 2026, with a total lump sum budget of €120,000 co-funded by the Erasmus+ Programme of the European Union. Implementation was structured across four interconnected work packages: Project Management (WP1), Online Course Development (WP2), Virtual Airport Tour (WP3), and Sustainability and Dissemination (WP4).

Phase 1 - Preparation and Planning

The project launched with TPM1, hosted by Aksu MTAL in Antalya in December 2024. Partners established the project governance framework, distributed tasks, agreed on mobility dates, and made key structural decisions about the three project results. Turkey was assigned responsibility for the course framework template; Aviation Academy Serbia for the evaluation criteria document; and InterEdu for overall compilation and coordination. All decisions were made by consensus, a working principle maintained throughout the project.

Phase 2 - Content Development

Partners undertook research and material selection for the nine MOOC lesson plans, each covering a distinct aspect of aviation waste management. Materials were limited to three pages per topic to ensure accessibility and usability, and all sources were fully referenced. Digital tools for course delivery were researched and selected in parallel. Content was evaluated by both English language teachers and VET subject specialists at each partner school, with associated partners – airports and aviation companies – consulted for professional validation. InterEdu coordinated the final compilation of all submitted materials.

Phase 3 - Capacity Building and VR Development

The Learning, Teaching and Training activity – a five-day Train the Trainer programme – took place in Belgrade. The training was organised and delivered by InterEdu, whose expertise in non-formal education and digital learning tools provided the pedagogical foundation for the programme. Teachers from all partner schools received intensive training in creating and integrating interactive content using Lumi and Moodle – covering the full workflow from content design and H5P activity creation in Lumi, through to uploading, structuring, and managing interactive materials within the Moodle learning environment. Each country brought a draft lesson or activity to the workshop, which were refined collaboratively and integrated into the MOOC platform during the training. This activity was the project's most significant capacity-building investment and directly shaped the quality and consistency of the interactive content developed across all partner schools.

Phase 4 - Finalisation and Quality Review

TPM2 was held at Aviation Academy in Belgrade. Partners confirmed the structure and scope of all three results, agreed assessment and certification arrangements for the MOOC, finalised the piloting plan, set internal deadlines for material uploads and quality review, and confirmed translation requirements. All materials were to be uploaded to Moodle with a cross-partner quality review.

Phase 5 - Piloting

Course piloting ran from 1–15 June 2026, with 20 students per partner institution completing the MOOC and 5 students per partner piloting three VR scenarios developed by their own school. VR scenarios were supervised by teachers with documentary evidence collected. Before-and-after surveys measured changes in students' VR perceptions and course-related knowledge. External stakeholders, including airport representatives, participated in course piloting as part of the project's dissemination and labour market validation strategy.

Phase 6 - Closure and Reporting

TPM3 was hosted by De Pinedo Institute in Rome. Partners reviewed all project results, addressed evaluation recommendations, confirmed dissemination and sustainability commitments, and agreed on final administrative and financial reporting requirements. The Toolkit was delivered as the final project output. Throughout implementation, the partnership maintained a consistent commitment to green practices within its own operations: promoting sustainable transport to meetings, reducing printed materials in favour of digital collaboration, and using reusable materials at all in-person events – modelling the environmental values the project sought to embed in aviation education more broadly.

4. Project timetable

Milestone / Activity	Details & Responsibilities
TPM1 - Antalya, Turkey	Kick-off transnational project meeting hosted by Aksu MTAL. All partners discussed implementation for Year 1, agreed mobility dates, and distributed tasks. Evaluation criteria framework assigned to Aviation Academy Serbia.
Evaluation Criteria Document	Aviation Academy Serbia finalised document with defined evaluation criteria for the online course. Framework template prepared by Turkey partner.
Course Materials Compilation	Each partner prepared PDF materials for assigned topics. Digital tools and apps research completed. Bibliography and sources listed. Materials sent to InterEdu for final compilation. Evaluated by English and VET teachers; associated partners consulted.
TPM2 - Belgrade, Serbia	Second transnational project meeting to review progress on R1, R2, R3; quality assurance review; planning for year 2.
Piloting Phase	Lesson plans and VR activities piloted with students and teachers across partner schools. Feedback collected and integrated into final versions.
TPM3 - Rome, Italy	Third transnational project meeting hosted by De Pinedo Institute. Final review of all outputs; dissemination planning; sustainability strategy.
Translation & Proofreading	Toolkit and course materials translated into Serbian, Turkish, and Italian. English version proofread. Final publication on MOOC platform or in ecological journal.
Project Closure & Dissemination	Final reporting; dissemination events at partner schools; submission of outputs to Erasmus+ result platform.

5. Waste Management in Aviation

5.1. Overview of generation in aviation

The aviation sector generates waste across a wide range of operational areas. Understanding the sources, types, and volumes of this waste is the essential starting point for developing effective management strategies. Waste in aviation can be broadly categorised by its point of generation.

Aircraft Maintenance, Repair, and Overhaul (MRO)

Maintenance operations generate some of the most hazardous waste in aviation. This includes used engine oils and hydraulic fluids, chemical cleaning and degreasing agents, expired or removed aircraft components and parts, paint and coating residues, and contaminated personal protective equipment (PPE). These materials require specialist handling and disposal in accordance with national hazardous waste regulations and EASA environmental requirements.

Airport Ground Operations

Airports are complex environments that generate substantial quantities of operational waste. Sources include ground support equipment maintenance, de-icing fluid application and recovery, fuel servicing, catering and retail operations, passenger terminal services, and construction and renovation projects. Many airports have implemented zero-waste-to-landfill programmes and have achieved significant reductions through source segregation, composting, and recycling partnerships.

In-Flight and Catering Waste

Commercial airlines generate large volumes of cabin waste on each flight, including food and beverage packaging, single-use plastics, catering trays and cups, and blankets and headsets. International regulations (ICAO Annex 14) impose strict requirements on the handling of international catering waste due to biosecurity risks. Airlines such as Finnair, KLM, and British Airways have piloted innovative solutions including compostable packaging and circular economy catering models.

Aircraft End-of-Life

When aircraft reach the end of their operational lives, they contain significant quantities of recoverable materials. Modern aircraft are approximately 85% recyclable by weight, with aluminium alloys, titanium, and composite materials all having established recycling pathways. Specialist aircraft dismantling companies operate across Europe, and the Aviation Industry Chain project (managed by Airbus) has developed protocols for sustainable aircraft retirement.

5.2. Regulatory framework and compliance

Waste management in aviation is governed by a layered framework of international, European, and national regulations. Aviation professionals must be familiar with the requirements applicable to their specific operational context.

- ICAO Annex 14: Sets international standards for aerodrome operations including waste management, particularly for international catering waste.
- EU Waste Framework Directive (2008/98/EC): Establishes the fundamental principles of EU waste law, including the waste hierarchy (prevention, reuse, recycling, recovery, disposal).
- EU Regulation on Persistent Organic Pollutants: Controls certain hazardous substances commonly found in aviation maintenance waste.
- EASA Regulations: EASA Part-145 (maintenance organisations) includes environmental management requirements applicable to MRO operations.
- Basel Convention: International treaty controlling the transboundary movement of hazardous wastes, relevant for airlines operating internationally.
- National Legislation: Each partner country (Serbia, Turkey, Italy) has its own national waste management legislation which applies to aviation operations within that jurisdiction.

The EU European Green Deal, adopted in 2019, sets ambitious targets for waste reduction and circular economy implementation across all sectors, including transport. Aviation companies operating within the EU are increasingly required to report on their environmental performance and demonstrate progress toward sustainability targets.

5.3. Waste minimisation strategies

Effective waste management in aviation follows the internationally recognised waste hierarchy: Prevention → Reduction → Reuse → Recycling → Recovery → Disposal. Best practice organisations seek to move as high up this hierarchy as possible.

Prevention and Reduction

The most effective waste management strategy is to prevent waste from being generated in the first place. In aviation, this can be achieved through: digital documentation replacing paper-based maintenance records; precision inventory management to reduce expired materials; reusable containers and packaging in ground operations; and optimised catering loading to reduce in-flight food waste.

Reuse

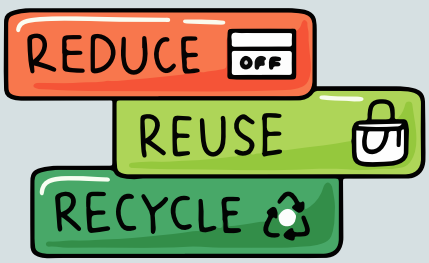
Serviceable aircraft parts removed during scheduled maintenance can often be returned to service on other aircraft or donated to training institutions. Ground support equipment can be refurbished and redeployed rather than replaced. Many airports operate internal reuse schemes for office furniture, equipment, and supplies.

Recycling

Aluminium from aircraft structures, copper from wiring, and plastics from cabin interiors all have established recycling pathways. Engine components containing rare metals such as nickel, cobalt, and titanium are typically returned to the original equipment manufacturer for controlled recycling. Airports partner with specialist recyclers for glass, cardboard, and electronic waste streams.

Waste Segregation

Effective segregation at source is the foundation of all recycling and recovery programmes. Aviation organisations implement colour-coded container systems, clear labelling, and staff training to ensure that waste streams are kept separate. Mixed waste is far more costly to manage and typically results in lower-value recovery outcomes.



5.4. Environmental threats from poor waste management

Improper disposal of aviation waste can have severe environmental consequences. Key risks include:

- Soil and groundwater contamination from hydraulic fluids, de-icing agents, and fuel spills at maintenance facilities and airports.
- Air pollution from open burning or incineration of waste materials, and from volatile organic compounds (VOCs) in solvents and cleaning agents.
- Water pollution from catering waste and grey water improperly discharged at airports or from aircraft.
- Ecosystem damage from hazardous materials entering soil and water systems adjacent to airports.
- Human health risks for maintenance workers exposed to hazardous substances without adequate PPE or waste handling procedures.

Did You Know?
According to industry estimates, a single medium-sized European airport can generate between 10,000 and 30,000 tonnes of waste per year. Effective waste management programmes at airports such as Amsterdam Schiphol and Copenhagen Kastrup have achieved recycling rates of over 60%, demonstrating what is achievable with commitment and investment.

6. Best Practices and case studies

6.1. Best practicies from partners countries

Serbia

Nikola Tesla Airport in Belgrade has implemented a comprehensive waste sorting and recycling programme that covers all terminal and airside operations. JAT Tehnika MRO, one of the partner organisations of Aviation Academy, has developed internal procedures for the safe collection, labelling, and disposal of hazardous maintenance waste in compliance with Serbian environmental law. Aviation Academy itself has introduced environmental education into its practical training programmes, making students aware of waste responsibilities from the earliest stages of their training.

Turkey

Antalya Airport, with which Aksu MTAL has formal cooperation agreements, has invested significantly in waste management infrastructure in recent years, driven by the growth of tourist traffic and associated catering and retail waste. The airport operates a food waste composting facility and has partnered with local agricultural businesses to create a circular loop for organic waste. Aksu MTAL students participate in airport technical visits where waste management procedures are observed directly, creating authentic learning opportunities that complement classroom instruction.

Italy

Rome's Fiumicino Airport (Leonardo da Vinci), in the immediate professional context of De Pinedo Institute graduates, has implemented a Waste Management Plan aligned with ENAC (Italian Civil Aviation Authority) environmental requirements. The airport segregates over 15 different waste streams and has achieved significant landfill diversion through partnerships with specialist waste processors. De Pinedo Institute integrates environmental legislation and logistics into its curriculum, ensuring students understand the regulatory environment they will enter as professionals.

6.2. International good practice example

Changi Airport, Singapore

Changi Airport operates a centralised waste management centre that processes all airport waste streams. Food waste is converted to biogas through anaerobic digestion, providing energy back to the airport. The airport publishes an annual sustainability report documenting waste generation and diversion metrics, setting a benchmark for transparency in airport environmental performance.

Heathrow Airport, United Kingdom

Heathrow has committed to sending zero operational waste to landfill and has achieved over 70% recycling and recovery rates across its terminals. The airport's Sustainable Procurement Policy requires all suppliers to demonstrate environmental management systems, creating a cascade effect of improved waste practices throughout the supply chain.

Lufthansa Technik

Lufthansa Technik, one of the world's leading MRO organisations, has developed a certified Hazardous Waste Management System that tracks all hazardous materials from point of generation to final disposal. The system uses digital documentation to eliminate paper records and provide real-time visibility of waste streams. Lufthansa Technik's practices serve as a reference model for MRO organisations worldwide.

6.3. Innovative approaches

Several emerging innovations are reshaping waste management in aviation:

- Sustainable Aviation Fuel (SAF) from waste: Used cooking oils, agricultural residues, and municipal solid waste are being converted into jet fuel, creating a circular economy solution that addresses both waste and carbon emissions.
- 3D printing from recycled materials: Some MRO organisations are experimenting with 3D printing of non-critical aircraft parts from recycled plastics, reducing both waste and the cost of spare parts.
- Digital twins for waste prediction: Advanced analytics and digital twin technologies are being used to predict maintenance waste generation and optimise procurement, reducing over-ordering and expired materials.
- Blockchain for hazardous waste tracking: Distributed ledger technology is being piloted to create tamper-proof records of hazardous waste transfer chains, improving compliance and accountability.

7. R1 - Online training course (MOOC)

The AviWaste MOOC is a freely accessible Open Educational Resource consisting of nine lesson plans covering the full spectrum of waste management in aviation. The course is designed for use by VET teachers and students and can be completed independently or as part of a structured classroom programme.

The nine lessons cover the following topics:

1. Introduction to Waste Management in Aviation
2. Waste Management Programs at Airports in Our Countries
3. Aircraft Cabin Waste Recycling
4. Recycling of Old and Unused Aircraft: A Sustainable Approach to Aviation Industry
5. Aircraft Recycling: A Treasure Trove with Wings
6. Aircraft Interior recycling
7. Aircraft engines parts and their recycling
8. Sustainable ground handling practices
9. Air travel and climate change

Each lesson plan includes learning objectives, content materials, suggested activities, digital tool recommendations, assessment criteria, and bibliography. Materials were evaluated by both English language teachers and VET subject specialists across the consortium, and associated partners were consulted for expert validation.

Link to MOODLE

8. AVIWASTE LESSON TOPICS CURRICULUM

Lesson topics	Knowledge focus	Skills focus	Language focus	Hands-on activity
1 - Introduction to Waste Management in Aviation *Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on definition of aviation waste, types of waste (municipal solid waste, construction and demolition debris, deplaned waste, biodegradable waste, hazardous and industrial waste...), waste management principles and methods	- Differentiate between solid, liquid, and hazardous waste. - Explore the sources of waste in airports and airlines (e.g., food waste, packaging, chemicals). - Familiarize with local and international regulations (e.g., ICAO, FAA, EU regulations). - Understand the role of environmental management systems (e.g., ISO 14001). - Understand methods for effective sorting and segregation of waste streams at airports. - Examine case studies of successful recycling initiatives in the aviation industry.	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis - Skills for working effectively with local authorities, vendors, and airport staff	- Industry-specific terminology - Listen, Speak, Write and Present Effectively - Report data - Classify and categorize - Develop language skills around waste management terminology (in Serbian, Turkish, and Italian) - Develop vocabulary specific to aviation and environmental management - Terminology; Familiarize with key terms related to waste management (e.g., composting, incineration, landfill, green waste). - Describe materials, processes, and outcomes clearly and concisely.	* Recycling Workshop - Organizing a workshop where participants learn how to properly sort and recycle different types of waste materials commonly found in aviation. * Case Study Analysis - Dividing into groups, analyzing real-life case studies of successful waste management practices implemented by airports or airlines. * Field Trip - Arranging a visit to a local airport or waste management facility, allowing participants to observe waste management practices in action.
2- Waste Management Programs at Airports in Our Countries – Serbia, Turkey, Italy * Case study on the topic of each country participating	- Understand types of waste (municipal, hazardous, e-waste, etc.) and their impact. - Familiarize with local, national, and international waste regulations.(Serbia-Italy-Turkey) - Learn best practices for recycling materials and composting organic waste. - Study sustainable waste management practices including waste reduction, reuse, and biowaste technologies. - Understand the environmental and economic impacts of waste disposal systems and the benefits of effective waste	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis - Digital literacy (using online resources, creating presentations, and sharing findings).	- Industry-specific terminology - Develop Waste management vocabulary in English, Serbian, Italian and Turkey. - Build vocabulary related to environmental management (e.g., recycling, landfill, composting, hazardous waste, waste segregation, circular economy, carbon footprint, biowaste, incineration, green waste). - Read and understand technical documents, regulations, case studies, and policy texts - Develop language skills around waste management terminology (in Serbian, Turkish, and Italian) - Classify and categorize different types of waste, recycling methods, and waste management practices.	* Waste Audit - Conducting waste audits at the airport to measure current waste generation and identify areas for improvement. * Partnerships - Collaborating with local municipalities, NGOs, and environmental organizations to enhance outreach and effectiveness of the waste management program

3- Aircraft Cabin Waste Recycling * Interactive videos/ lessons /branching scenarios/ activities/ games or the immersive web experience on cabin waste composition, collection methods, sustainable aviation agenda of airlines and airports, passenger habits and behavior across cultures	-Understand the various categories of waste (e.g., plastics, food waste, paper, and hazardous materials) generated during flights. - Familiarity with basic principles of recycling, composting, and waste management specific to the aviation industry. - Knowledge of international and local regulations governing waste disposal and recycling in aviation, such as IATA guidelines and EU waste policies -Awareness of the environmental footprint of cabin waste and the benefits of effective waste recycling	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis - Digital literacy through interactive learning tools and immersive technologies. - Environmental awareness and sustainability competence.	- Industry-specific terminology related to aviation, recycling, and environmental sustainability. - Develop vocabulary related to aircraft cabin waste (e.g., cabin waste, catering waste, waste segregation, recyclable materials) - Read and understand airline sustainability policies, waste management procedures, and regulatory documents. - Listen to presentations, interviews, and training materials related to cabin waste management. - Speak confidently in discussions, role plays, and presentations about sustainable aviation practices. - Write summaries, reports, recommendations, and case studies on aircraft cabin waste recycling.	*Interactive Waste Sorting Game - Creating a virtual aircraft cabin with draggable waste items (e.g., plastic bottles, food scraps, newspapers, aluminum cans). Users sort items into labeled bins (e.g., "Recyclables," "Compost," "General Waste"). * Virtual Reality Cabin Walkthrough - Developing a 360° VR walkthrough of an aircraft cabin.Users click on highlighted areas (e.g., waste bins, galley, passenger seats) to learn about waste collection points and recycling challenges.
4- Recycling of Old and Unused Aircraft: A Sustainable Approach to Aviation Industry * Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on benefits of recycling old and unused aircraft, ways to recycle old and unused aircraft, aircraft graveyards worldwide	- Learn stages of recycling: dismantling, part harvesting, material recovery, and disposal. -Familiriaze key components of an aircraft (e.g., aluminum, composites, titanium) and their recycling potential - Carbon footprint reduction through material reuse. - Search case studies of aircraft recycling programs (e.g., Boeing, Airbus initiatives). -Learn international regulations and standards for aircraft disposal (e.g., ICAO guidelines).	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis	- Industry-specific terminology - Listen, Speak, Write and Present Effectively - Report data - Classify and categorize - Develop language skills around waste management terminology (in Serbian, Turkish, and Italian) - Develop vocabulary specific to aviation and environmental management - Terminology; Familiarize with key terms related to waste management (e.g., composting, incineration, landfill, green waste). - Describe materials, processes, and outcomes clearly and concisely.	* Aircraft Dismantling Simulation - Virtual simulation or game where users dismantle an aircraft, identifying reusable parts and materials. * Lifecycle Mapping - Creating a flowchart showing an aircraft's lifecycle from manufacturing to recycling. Identify key stages where sustainability can be improved.

5- Aircraft Recycling: A Treasure Trove with Wings *Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on airplane parts that can be recycled, methods of recycling, current trends in airplane recycling, aircraft recycling challenges, best practices and standards in aircraft end-of-life and recycling	- Understand the environmental issues caused by retired aircraft, such as landfill waste, emissions, and resource depletion. - Explore materials commonly used in aircraft (e.g., aluminum, titanium, carbon fiber composites) and their recyclability. - Investigate how recycling aligns with global sustainability goals (e.g., SDGs). -Examine the cost-effectiveness and financial incentives of recycling aircraft parts.	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis	- Industry-specific terminology - Listen, Speak, Write and Present Effectively - Report data - Classify and categorize - Develop language skills around waste management terminology (in Serbian, Turkish, and Italian) - Develop vocabulary specific to aviation and environmental management - Terminology; Familiarize with key terms related to waste management (e.g., composting, incineration, landfill, green waste). - Describe materials, processes, and outcomes clearly and concisely.	* Case Studies - Analyzing real-world examples of aircraft recycling projects (e.g., Airbus or Boeing initiatives). * Field Visits - Touring aviation maintenance or recycling facilities to observe processes in action.
6- Aircraft Interior recycling *Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on aircraft interior parts that can be recycled, methods of recycling, current trends in aircraft interiors recycling	- Understand the components of aircraft interiors, including seats, carpets, panels, overhead bins, and galley equipment. - Explore materials used in aircraft interiors (e.g., plastics, textiles, aluminum, composites) and their recyclability. - Learn methods like mechanical recycling, chemical recycling, and upcycling for interior materials. - Familiarity with aviation standards for recycling interior components (e.g., FAA, EASA, ICAO guidelines). - Overview of how end-of-life interiors are currently disposed of and the challenges involved.	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis - Identification and classification of aircraft interior materials and components. - Evaluation of recycling methods and sustainable design solutions.	- Industry-specific terminology related to aircraft interiors, recycling, and environmental sustainability. -Develop vocabulary related to aircraft interior components and materials (e.g., cabin furnishings, upholstery, sidewall panels, overhead bins, composites, textiles, refurbishment, remanufacturing, material recovery, circular economy). -Read and understand technical documents, recycling standards, aviation regulations, and industry reports. -Listen to presentations, interviews, and training materials on aircraft interior recycling and sustainable cabin design.	* Disassembly Simulation - Simulating the dismantling process of aircraft interiors to assess recyclable parts. * Prototype Design - Building models of sustainable interior components using recyclable materials. * Group Discussions - Engaging in role-play activities to simulate stakeholders working on recycling programs (airlines, manufacturers, recyclers, policymakers).

7- Aircraft engines parts and their recycling *Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on aircraft engines parts that can be recycled, methods of recycling, current trends in aircraft engines recycling	- Understand the main parts of an aircraft engine (e.g., turbine blades, compressors, casings, and nozzles) and their functions. - Explore the materials used in engine parts (e.g., titanium alloys, nickel-based superalloys, ceramics) and their recyclability. - Learn about specific recycling techniques such as metal recovery, remanufacturing, and reprocessing of composite materials. - Understand the environmental implications of disposing of engine parts versus recycling them. - Familiarity with aviation standards and regulations for recycling engine parts (e.g., FAA, EASA, ICAO).	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Interpreting images - Critical analysis	- Industry-specific terminology - Listen, Speak, Write and Present Effectively - Report data - Classify and categorize - Develop language skills around waste management terminology (in Serbian, Turkish, and Italian) - Develop vocabulary specific to aviation and environmental management - Terminology; Familiarize with key terms related to waste management (e.g., composting, incineration, landfill, green waste). - Describe materials, processes, and outcomes clearly and concisely.	* Disassembly Workshops - Practicing the disassembly of engine components (using models or real discarded parts) to identify recyclable materials. *Upcycling Projects - Designing new products or tools from recycled engine components, like furniture or industrial equipment.
8- Sustainable Ground Handling Practices * Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on ground handling services, ground handling services waste management, best GH sustainability practices	- Understand the roles and responsibilities involved in ground handling, including baggage handling, fueling, catering, and aircraft servicing. - Examine how traditional ground handling practices affect the environment, such as CO2 emissions, noise pollution, and waste generation - Learn about green technologies and strategies such as electric ground support equipment (GSE), alternative fuels, renewable energy sources, and waste reduction methods. - Explore ways to optimize energy use during ground operations, such as through vehicle electrification and smart logistics. - Familiarity with sustainability guidelines and certifications (e.g., ICAO's environmental policies, IATA's initiatives on carbon neutrality).	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis - Environmental awareness and sustainability competence. - Applying sustainable practices to real-world airport ground operations.	-Industry-specific terminology related to ground handling, airport operations, and environmental sustainability. -Develop vocabulary related to ground support equipment (GSE), baggage handling, aircraft servicing, fueling, catering, energy efficiency, waste management, emissions, renewable energy, and sustainable airport operations. -Read and understand operational manuals, sustainability reports, technical documents, and aviation regulations. -Listen to presentations, interviews, and training materials on sustainable ground handling practices. -Speak confidently in discussions, role plays, and presentations using appropriate technical and professional language.	*Simulation Exercises - Using software or mock setups to simulate ground handling scenarios and test sustainable solutions * Field Visits - Visiting airports or ground handling facilities to observe sustainable practices in action. (Belgrade, Rome and Antalya Airport visits) *Sustainability Plan Development -Working in teams to create comprehensive plans for greening ground handling operations.

9- Air travel and climate change * Interactive videos/ lessons/ branching scenarios/ activities/ games or the immersive web experience on climate aviation facts, aviation emissions, the future of flying, carbon footprint in aviation, sustainability of aviation fuels, waste to fuel conversion	- Understand how air travel contributes to greenhouse gas emissions, including CO2, NOx, and contrails, and their impact on climate change. -Learn how to calculate the carbon footprint of flights and how passenger behavior influences emissions. -Explore alternative fuels such as biofuels, synthetic fuels, and hydrogen, their production processes, benefits, and challenges. - Study advancements in aircraft design, propulsion systems (e.g., electric or hybrid planes), and operational efficiency to reduce emissions. - Understand trends such as urban air mobility, electric aviation, and carbon-neutral airports. - Familiarity with international agreements and initiatives (e.g., ICAO's CORSIA, EU ETS) targeting aviation emissions.	- Critical Thinking - Communication - Collaborative work - Adaptability - Innovative thinking - Problem-Solving - Data Analysis - Identifying the configuration - Critical analysis - Carbon footprint calculation and emissions analysis. - Environmental impact assessment and sustainability evaluation. - Digital literacy through interactive learning tools and immersive technologies. - Environmental awareness and climate literacy.	- Industry-specific terminology related to aviation, climate change, sustainable aviation fuels, and environmental sustainability. -Develop vocabulary related to climate science and aviation (e.g., greenhouse gases, carbon footprint, CO_2 emissions, NOx emissions, contrails, Sustainable Aviation Fuel (SAF), biofuel, hydrogen fuel, synthetic fuel, waste-to-fuel conversion, carbon neutrality, decarbonisation, emissions trading, circular economy). -Read and understand technical articles, sustainability reports, scientific publications, and international aviation policies. -Present research findings, data analyses, and project outcomes clearly and effectively. -Report and interpret data on emissions, carbon footprints, fuel efficiency, and environmental performance. -Classify and categorize aviation emissions, sustainable fuels, and emission reduction strategies.	* Carbon Footprint Calculations - Using online calculators or tools to estimate the carbon emissions of flights and identifying ways to offset them. *Workshops on Policy Development - Developing policies or action plans for aviation sustainability and presenting them to a mock panel. * Fuel Comparison - Comparing the environmental impact of traditional jet fuels versus SAF through a life-cycle analysis.

9. LESSON PLAN



Lesson Title:
Lesson 1 *Introduction to Waste Management in Aviation*

Teacher:
[Name of the teacher]

Target Group:
Aviation VET students 15–18]

Duration:
2 × 40 min

Type of Lesson:
theoretical / practical / mixed

Teaching Mode:
classroom / online / blended / VR-supported / workshop

Abstract/Introduction

This lesson introduces the fundamental principles of waste management in aviation. Students explore why waste management is important for airports and airlines, examine different categories of aviation waste, and learn about the waste hierarchy. The lesson also introduces waste management approaches, recycling practices, and circular economy concepts used in the aviation sector. Through discussions and practical examples, learners develop awareness of environmental, economic, and operational challenges related to aviation waste. The lesson establishes a foundation for further study of sustainable waste management in aviation.

Learning objectives

By the end of the lesson, the teacher will:

- Introduce the concept of waste management in aviation.
- Explain the environmental and economic impacts of aviation waste.
- Explore different categories of waste generated in aviation operations.
- Analyze the waste hierarchy and its application in aviation.
- Explain recycling practices and circular economy principles within the aviation industry.

Learning outcomes

By the end of the lesson, students will be able to:

- Explain the importance of waste management in aviation operations.
- Identify and classify different categories of aviation waste.
- Describe the six levels of the waste hierarchy and their purpose.
- Analyze how recycling and waste management practices reduce environmental impacts.
- Reflect on how circular economy principles can improve sustainability in aviation.

Key competences

Include transversal competences:

- Green competences: Understanding sustainable waste management and environmental responsibility.
- Digital competences: Using digital presentations, online resources, and quizzes.
- Critical thinking: Evaluating waste management strategies and their effectiveness.
- Problem solving: Proposing solutions for reducing aviation waste.
- Language competences: Learning and applying aviation and sustainability terminology.
- Social skills: Collaborating in discussions and group activities.

Teaching methods & tools

Interactive presentation (PowerPoint/Canva)
Guided discussion
Case study analysis
Waste classification activity
Short educational videos
Kahoot/Menti meter quiz
Digital learning platform (Moodle)
VR supported lessons

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Introduce the topic of waste management in aviation.
- Present examples of waste generated at airports and on aircraft
- Ask students why waste management is important in aviation.
- Activate prior knowledge through brainstorming.

Student Activities:

- Participate in discussion.
- Share examples of waste they have observed while travelling.
- Answer introductory questions

Methods & Tools:

- Brainstorming
- Group discussion
- Images and short video
- Interactive questions

Main Part (60 min.)

Teacher Activities:

- Explain the concept of waste management and its significance for environmental protection, public health, and aviation safety.
- Present different categories of aviation waste
- Municipal Solid Waste (MSW
- Construction and Demolition Debris (CDD
- Deplaned Wast
- International Wast
- Compostable and Biodegradable Waste
- Hazardous and Industrial Waste
- Lavatory Waste
- Explain the waste hierarchy:
- Avoidance
- Reduction
- Reuse
- Recycling
- Waste-to-Energy
- Disposal
- Introduce waste management approaches such as waste audits, planning, monitoring, and stakeholder engagement.
- Discuss recycling practices and circular economy concepts in aviation

Student Activities:

- Take notes and ask questions.
- Complete a waste classification exercise.
- Analyze examples of aviation waste.
- Work in groups to match waste categories with appropriate treatment methods.
- Discuss how airports can improve sustainability through waste reduction and recycling.

Methods & Tools:

- Mini lecture
- Case studies
- Group work
- Visual diagrams (Waste Hierarchy and Circular Economy)
- Digital presentation

Conclusion (10 min.)

Teacher Activities:

- Summarize key concepts and terminology.
- Review the waste hierarchy and aviation waste categories.
- Facilitate a short recap discussion.
- Conduct a quick assessment quiz.

Student Activities:

- Complete a short quiz.
- Reflect on the most important lesson takeaway.
- Share one idea for improving waste management at airports.

Methods & Tools:

- Kahoot/Menti meter quiz
- Reflection activity
- Question-and-answer session

Assesment

- Quiz: Kahoot, Moodle, or Google Forms covering waste categories and waste hierarchy.
- Participation: Engagement in discussions and classroom activities.
- Practical Task: Waste classification and hierarchy exercise.
- Reflection: Short written reflection on sustainable waste management in aviation.

Differentiation

Support for Weaker Students

- Simplified worksheets with visual examples.
- Vocabulary support for key terms.
- Additional guidance during activities.

Support for Advanced Learners

- Research task on waste management programs at major airports.
- Additional challenge: compare linear and circular economy models.
- Short presentation on innovative recycling technologies in aviation.

Sustainability/Real-life Connection

- Airports generate significant amounts of waste that must be managed responsibly to protect the environment and public health.
- Waste reduction, recycling, and circular economy approaches help improve resource efficiency and reduce landfill use.
- International organizations such as the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) promote sustainable waste management practices in aviation.
- Real-world airport waste management programs demonstrate how environmental responsibility can create operational and economic benefits.

Note & reflection

For teachers after lesson:

- Which activities engaged students most effectively?
- Did students correctly identify aviation waste categories?
- Were students able to explain the waste hierarchy?
- What concepts required additional clarification?
- How can future lessons include more practical examples?
- Were the learning outcomes successfully achieved?

LESSON PLAN



Lesson Title:
Lesson 2 *Waste Management Programs at Airports in our countries - Serbia, Turkey, Italy*

Teacher:
[Name of the teacher]

Target Group:
VET students 15–18]

Duration:
2 × 45 min

Type of Lesson:
theoretical / practical

Teaching Mode:
classroom / online / blended / VR-supported / workshop

Abstract/Introduction

This lesson introduces students to waste management programs implemented at airports in Serbia, Turkey, and Italy. Students explore how airports apply sustainable waste management practices, recycling systems, and circular economy principles to reduce environmental impact. Through real-life examples, learners compare different approaches to waste management and examine how innovative technologies contribute to more sustainable airport operations.

Learning objectives

- Introduce the concept of waste management in the aviation industry;
- Explain sustainable waste management practices implemented at airports;
- Compare waste management programs in Serbia, Turkey, and Italy;
- Explore innovative technologies that improve airport waste management; and
- Encourage students to evaluate the importance of sustainable waste management in aviation

Learning outcomes

By the end of the lesson, students will be able to:

- Explain the importance of waste management in aviation operations.
- Identify and classify different categories of aviation waste.
- Describe the six levels of the waste hierarchy and their purpose.
- Analyze how recycling and waste management practices reduce environmental impacts.
- Reflect on how circular economy principles can improve sustainability in aviation.

Key competences

Include transversal competences:

- Green competences: Understanding sustainable waste management and environmental responsibility.
- Digital competences: Using digital presentations, online resources, and quizzes.
- Critical thinking: Evaluating waste management strategies and their effectiveness.
- Problem solving: Proposing solutions for reducing aviation waste.
- Language competences: Learning and applying aviation and sustainability terminology.
- Social skills: Collaborating in discussions and group activities.

Teaching methods & tools

Interactive presentation (PowerPoint/Canva)
Guided discussion
Case study analysis
Waste classification activity
Short educational videos
Kahoot/Menti meter quiz
Digital learning platform (Moodle)
VR supported lessons

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Introduce the topic of waste management in aviation.
- Present examples of waste generated at airports and on aircraft
- Ask students why waste management is important in aviation.
- Activate prior knowledge through brainstorming.

Student Activities:

- Participate in discussion.
- Share examples of waste they have observed while travelling.
- Answer introductory questions

Methods & Tools:

- Brainstorming
- Group discussion
- Images and short video
- Interactive questions

Main Part (60 min.)

Teacher Activities:

- Explain the concept of waste management and its significance for environmental protection, public health, and aviation safety.
- Present different categories of aviation waste
- Municipal Solid Waste (MSW
- Construction and Demolition Debris (CDD
- Deplaned Wast
- International Wast
- Compostable and Biodegradable Waste
- Hazardous and Industrial Waste
- Lavatory Waste
- Explain the waste hierarchy:
- Avoidance
- Reduction
- Reuse
- Recycling
- Waste-to-Energy
- Disposal
- Introduce waste management approaches such as waste audits, planning, monitoring, and stakeholder engagement.
- Discuss recycling practices and circular economy concepts in aviation

Student Activities:

- Take notes and ask questions.
- Complete a waste classification exercise.
- Analyze examples of aviation waste.
- Work in groups to match waste categories with appropriate treatment methods.
- Discuss how airports can improve sustainability through waste reduction and recycling.

Methods & Tools:

- Mini lecture
- Case studies
- Group work
- Visual diagrams (Waste Hierarchy and Circular Economy)
- Digital presentation

Conclusion (10 min.)

Teacher Activities:

- Summarize key concepts and terminology.
- Review the waste hierarchy and aviation waste categories.
- Facilitate a short recap discussion.
- Conduct a quick assessment quiz.

Student Activities:

- Complete a short quiz.
- Reflect on the most important lesson takeaway.
- Share one idea for improving waste management at airports.

Methods & Tools:

- Kahoot/Menti meter quiz
- Reflection activity
- Question-and-answer session

Assesment

- Quiz: Kahoot, Moodle, or Google Forms covering waste categories and waste hierarchy.
- Participation: Engagement in discussions and classroom activities.
- Practical Task: Waste classification and hierarchy exercise.
- Reflection: Short written reflection on sustainable waste management in aviation.

Differentiation

Support for Weaker Students

- Simplified worksheets with visual examples.
- Vocabulary support for key terms.
- Additional guidance during activities.

Support for Advanced Learners

- Research task on waste management programs at major airports.
- Additional challenge: compare linear and circular economy models.
- Short presentation on innovative recycling technologies in aviation.

Sustainability/Real-life Connection

- Airports generate significant amounts of waste that must be managed responsibly to protect the environment and public health.
- Waste reduction, recycling, and circular economy approaches help improve resource efficiency and reduce landfill use.
- International organizations such as the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) promote sustainable waste management practices in aviation.
- Real-world airport waste management programs demonstrate how environmental responsibility can create operational and economic benefits.

Note & reflection

For teachers after lesson:

- Which activities engaged students most effectively?
- Did students correctly identify aviation waste categories?
- Were students able to explain the waste hierarchy?
- What concepts required additional clarification?
- How can future lessons include more practical examples?
- Were the learning outcomes successfully achieved?

LESSON PLAN



Lesson Title:
Lesson 3 *Aircraft Cabin Waste Recycling*

Teacher:
[Name of the teacher]

Target Group:
Aviation VET students 15–18]

Duration:
2 × 40 min

Type of Lesson:
theoretical / practical / mixed

Teaching Mode:
classroom / online / blended / VR-supported / workshop

Abstract/Introduction

This lesson introduces the concept of recycling and the most common types of recyclable waste. Students learn how waste materials can be transformed into valuable raw materials and why recycling is important for environmental protection and resource conservation. The lesson provides a foundation for understanding waste management in aviation by connecting general recycling principles to aircraft cabin waste. Learners explore recyclable materials commonly found in everyday life and on-board aircraft. The topic supports sustainability awareness and responsible environmental behavior.

Learning objectives

By the end of the lesson, the teacher will:

- Introduce the concept and purpose of recycling.
- Explain how recycling contributes to waste reduction and resource conservation.
- Explore common recyclable materials and waste categories.
- Analyze the role of recycling in sustainable aviation practices.
- Encourage responsible waste management behavior.

Learning outcomes

By the end of the lesson, students will be able to:

- Describe what recycling is and explain its main purpose.
- Identify common recyclable materials such as plastics, glass, metals, paper, batteries, and electronics.
- Classify different waste items into recyclable and non-recyclable categories.
- Explain how recycling supports environmental sustainability and resource efficiency.
- Demonstrate responsible attitudes toward waste separation and recycling in everyday life and aviation contexts.

Key competences

Include transversal competences:

- Green competences: Environmental awareness and sustainable behavior.
- Digital competences: Use of online quizzes and digital learning materials.
- Critical thinking: Evaluating waste management practices.
- Problem solving: Sorting waste and selecting appropriate recycling methods.
- Language competences: Understanding and using recycling-related terminology.
- Social skills: Collaboration during discussions and group activities.

Teaching methods & tools

Interactive presentation (PowerPoint/Canva)
Guided discussion
Waste-sorting group activity
Image analysis of recycling examples
Kahoot/Menti meter quiz
Digital learning platform (Moodle)

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Welcome students and introduce the topic.
- Show images of waste generated in everyday life and aviation.
- Ask students what happens to waste after it is discarded.
- Activate prior knowledge through brainstorming.

Student Activities:

- Answer introductory questions.
- Share personal experiences with recycling.
- Discuss examples of waste they generate daily.

Methods & Tools:

- Brainstorming
- Group discussion
- Images/photos
- Interactive questions

Main Part (60 min.)

Teacher Activities:

- Explain the definition of recycling as the process of converting waste into raw materials.
- Present common recyclable materials: plastics, glass, metal, aluminum, batteries, electronics, food waste (composting), used oil, tires, paper/cardboard, etc.
- Discuss why these materials should be recycled.
- Connect recycling concepts to aviation waste management and future module topics.
- Facilitate a waste-sorting activity.

Students Activity:

- Take notes and ask questions.
- Analyze examples of recyclable materials.
- Work in small groups to classify waste items.
- Present group findings.
- Reflect on how recycling could be improved in airports and aircraft cabins.

Methods & Tools:

- Mini lecture
- Group work
- Waste classification exercise
- Digital presentation
- Case examples from aviation

Conclusion (10 min.)

Teacher Activities:

- Summarize key concepts.
- Review recyclable waste categories.
- Clarify misconceptions.
- Conduct a short knowledge check.

Student Activities:

- Complete a short quiz.
- Reflect on one new thing learned.
- Share ideas for improving recycling behavior.

Methods & Tools:

- Kahoot/Menti meter quiz
- Reflection activity
- Question-and-answer session

Assesment

- Quiz: Kahoot, Moodle, or Google Forms covering waste categories and waste hierarchy.
- Participation: Engagement in discussions and classroom activities.
- Practical Task: Waste classification and hierarchy exercise.
- Reflection: Short written reflection on sustainable waste management in aviation.

Differentiation

Support for Weaker Students

- Simplified worksheets with visual aids.
- Pre-prepared examples of recyclable materials.
- Additional teacher guidance during activities.

Support for Advanced Learners

- Research task on innovative recycling technologies.
- Additional challenge: identify recyclable materials commonly found in aircraft cabins.
- Short presentation on recycling improvements in aviation.

Sustainability/Real-life Connection

- Recycling reduces waste and conserves natural resources.
- Many materials found in aircraft cabins (plastic bottles, aluminum cans, paper products) can potentially be recycled.
- Effective recycling supports sustainable aviation and helps reduce the environmental impact of air transport.
- The lesson prepares students for later topics on aircraft waste management and aircraft cabin waste.

Note & reflection

For teachers after lesson:

- What worked well?
- Which activities generated the highest student engagement?
- Were learning outcomes achieved?
- Did students correctly identify recyclable materials?
- What improvements should be made for future lessons?
- Were the time allocations appropriate?

LESSON PLAN



Lesson Title:
Lesson 4 *Recycling Old and Unused Aircraft*

Teacher:
[Name of the teacher]

Target Group:
VET students 15–18]

Duration:
2 × 45 min

Type of Lesson:
theoretical / practical

Teaching Mode:
classroom / online / blended / VR-supported / workshop

Abstract/Introduction

This lesson introduces students to the recycling of old and unused aircraft and its importance for sustainable aviation. Students explore the aircraft decommissioning and dismantling process, identify recyclable aircraft components and materials, and learn how valuable resources can be recovered and reused. The lesson also highlights the environmental, economic, and technological aspects of aircraft recycling while promoting circular economy principles within the aviation industry.

Learning objectives

- Introduce the concept and importance of aircraft recycling;
- Explain the main stages of aircraft decommissioning and recycling;
- Analyze the environmental and economic benefits of recycling retired aircraft;
- Explore innovative recycling technologies and sustainable aviation practices; and
- Encourage students to evaluate the role of aircraft recycling in supporting a circular economy.

Learning outcomes

By the end of the lesson, students will be able to:

- Describe the purpose and importance of aircraft recycling;
- Explain the six main stages of the aircraft recycling process;
- Identify aircraft components and materials that can be reused, refurbished, or recycled;
- Explain the environmental and economic benefits of recycling old aircraft;
- Propose simple ways in which aircraft components can be reused, refurbished, recycled, or upcycled.

Key competences

Include transversal competences:

- Green competences: Understanding the importance of recycling and protecting the environment.
- Digital competences: Using digital learning materials and VR technology.
- Critical thinking: Evaluating aircraft recycling practices and their environmental impact.
- Problem-solving: Identifying suitable recycling solutions for aircraft materials.
- Language competences: Using aviation and sustainability terminology appropriately.
- Social skills: Cooperation during discussions and group activities. Teamwork.

Teaching methods & tools

The lesson will be delivered through an interactive presentation, guided discussion, and group work. Students will analyze real-life case studies, images, and videos related to aircraft recycling and participate in a VR-based learning activity using VR headsets. The lesson will conclude with a quiz to review key concepts, while Moodle or another digital learning platform may be used to provide additional learning materials and support.

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Welcome students and introduce the lesson topic;
- Display images of retired aircraft and aircraft recycling facilities;
- Ask students what the lifecycle of an aircraft is;
- Ask students what happens to aircraft after retirement; and
- Introduce the concept of aircraft sustainable aircraft recycling.

Student Activities:

- Share ideas and previous knowledge;
- Answer introductory questions; and
- Discuss why recycling is important for aviation.

Methods & Tools:

- PowerPoint presentation;
- Brainstorming;
- Group discussion;
- Images and photographs;
- Interactive questioning; and
- Short video

Main Part (65-70 min.)

Teacher Activities:

- Explain why aircraft recycling is important;
- Present the six stages of aircraft recycling;
- Explain how aircraft components are removed, sorted, recycled, or reused;
- Introduce companies and organizations involved in aircraft recycling (e.g., AFRA, Airbus, TARMAC Aerosave);
- Explain the challenges of recycling composite materials;
- Demonstrate real examples of aircraft upcycling and circular economy; and
- Guide students through a VR activity exploring aircraft components.

Students Activity:

- Take notes and ask questions;
- Analyze the stages of aircraft recycling;
- Work in groups to classify aircraft components according to their recycling potential;
- Explore aircraft recyclable components using VR headsets;

- Discuss the environmental and economic benefits of recycling retired aircraft; and
- Present group findings - Work in groups as aircraft recycling consultants and propose three possible reuse, recycling, or upcycling solutions for selected aircraft components, justifying their choices from an environmental and economic perspective.

Methods & Tools:

- Interactive PowerPoint presentation;
- MOOC course;
- Guided discussion;
- Image and video analysis;
- Group work; and.
- VR experience using VR headsets to explore parts of an aircraft.

Conclusion (10 min)

Teacher Activities:

- Summarize key concepts;
- Review the stages of aircraft recycling;
- Check students' understanding and provide further explanations if necessary; and
- Conduct a short knowledge check.

Student Activities:

- Complete a short quiz;
- Use VR headsets to identify recyclable aircraft components;
- Reflect on one new thing learned during this lesson; and
- Participate in a short class discussion.

Methods & Tools:

- Short quiz;
- VR activity;
- Reflection activity; and
- Question-and-answer session.

Assesment

- Quiz: Kahoot, Moodle or Google Forms;
- Participation: Contribution to discussions and teamwork;
- Practical task: Classification of selected aircraft components according to their reuse, refurbishment, recycling, or upcycling potential, with short justification;
- Reflection: Oral reflection on the importance of aircraft recycling for sustainable aviation; and
- Peer evaluation: Students give constructive feedback on their classmates' ideas for aircraft recycling and sustainability.

Differentiation

Support for Weaker Students

- Simplified worksheets with visual aids.
- Pre-prepared examples of recyclable materials.
- Additional teacher guidance during activities.

Support for Advanced Learners

- Research task on innovative recycling technologies.
- Additional challenge: identify recyclable materials commonly found in aircraft cabins.
- Short presentation on recycling improvements in aviation.

Sustainability/Real-life Connection

- Sustainability/Real-life Connection
- Recycling reduces waste and conserves natural resources.
- Many materials found in aircraft cabins (plastic bottles, aluminum cans, paper products) can potentially be recycled.
- Effective recycling supports sustainable aviation and helps reduce the environmental impact of air transport.
- The lesson prepares students for later topics on aircraft waste management and aircraft cabin waste.

Note & reflection

For teachers after lesson:

- Note & reflection
- For teachers after lesson:
- What worked well?
- Which activities generated the highest student engagement?
- Were learning outcomes achieved?
- Did students correctly identify recyclable materials?
- What improvements should be made for future lessons?
- Were the time allocations appropriate?

LESSON PLAN



Lesson Title:
Lesson 5 *Aircraft Recycling: A Treasure Trove with Wings*

Teacher:
[Name of the teacher]

Target Group:
VET students 15–18]

Duration:
2 × 45 min

Type of Lesson:
theoretical / practical

Teaching Mode:
classroom / online / blended / VR-supported / workshop

Abstract/Introduction

This lesson introduces students to the concept of aircraft recycling and demonstrates how end-of-life aircraft can become a valuable source of reusable materials and components. Students explore the aircraft dismantling process, identify recyclable aircraft parts and materials, and examine innovative examples of upcycling in aviation. The lesson highlights environmental, economic, and sustainability benefits of aircraft recycling while encouraging students (learners) to consider circular economy principles within the aviation industry.

Learning objectives

- Introduce the concept of aircraft recycling and circular economy in aviation;
- Explain the aircraft dismantling and recycling process;
- Analyze which aircraft components and materials can be reused or recycled and how;
- Explore innovative examples of aircraft upcycling and sustainable practices; and
- Encourage evaluation of the environmental and economic importance of aircraft recycling.

Learning outcomes

By the end of the lesson, students will be able to:

- Describe the purpose and importance of aircraft recycling;
- Explain the basic stages of aircraft dismantling before recycling;
- Identify major aircraft components that can be reused, refurbished, or recycled;
- Evaluate the environmental and economic benefits of aircraft recycling for the aviation industry;
- Propose innovative reuse or upcycling solutions for selected aircraft components based on circular economy principles.

Key competences

Include transversal competences:

- Green competences: Understanding the importance of recycling and protecting the environment.
- Digital competences: Using digital presentations, videos, and online learning platforms.
- Critical thinking: Evaluating advantages and challenges of aircraft recycling.
- Problem-solving: Identifying suitable recycling and reuse solutions for aircraft components.
- Language competences: Using aviation and environmental terminology appropriately.
- Social skills: Cooperation during discussions and group activities. Teamwork.

Teaching methods & tools

The lesson will be delivered through an interactive PowerPoint presentation combined with guided discussion and image analysis. Students will examine real-life case studies of aircraft recycling, participate in group work, explore recyclable aircraft components through a VR activity, and watch a short educational video related to sustainable aviation practices. Moodle or another digital learning platform may be used to provide additional learning materials and support.

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Welcome students and introduce the lesson topic;
- Display images of retired aircraft stored in aircraft graveyards and parts of disassembled aircraft;
- Ask students what the lifecycle of an aircraft is;
- Ask students what happens to aircraft after they are permanently withdrawn from service; and
- Introduce the concept of aircraft recycling through brainstorming.

Student Activities:

- Share ideas and previous knowledge;
- Answer introductory questions; and
- Discuss possible ways old aircraft could be reused or recycled.

Methods & Tools:

- PowerPoint presentation;
- Brainstorming;
- Group discussion;
- Images and photographs;
- Interactive questioning; and
- Short video

Main Part (65-70 min.)

Teacher Activities:

- Explain why aircraft recycling is becoming increasingly important;
- Present the aircraft dismantling process, including fluid removal and safe disassembly;
- Explain how different parts of aircraft, for example engines, landing gear, avionics, fuselage materials, composites, and tires are recycled or reused;
- Introduce valuable recyclable materials such as aluminum, titanium, copper, and carbon-fiber composites;
- Present examples of aircraft upcycling, including furniture, hotels, decorative items, and architectural applications;
- Facilitate a group activity where students classify aircraft components according to their recycling potential; and
- Lead a discussion about the environmental and economic benefits of recycling.

Student Activities:

- Explain why aircraft recycling is becoming increasingly important;
- Present the aircraft dismantling process, including fluid removal and safe disassembly;
- Explain how different parts of aircraft, for example engines, landing gear, avionics, fuselage materials, composites, and tires are recycled or reused;
- Introduce valuable recyclable materials such as aluminum, titanium, copper, and carbon-fiber composites;
- Present examples of aircraft upcycling, including furniture, hotels, decorative items, and architectural applications;
- Facilitate a group activity where students classify aircraft components according to their recycling potential; and
- Lead a discussion about the environmental and economic benefits of recycling.

Methods & Tools:

- Interactive PowerPoint presentation;
- MOOC course;
- Guided discussion;
- Image and video analysis;
- Group work; and.
- VR experience using VR headsets to explore parts of an aircraft.

Conclusion (10 min.)

Teacher Activities:

- Summarize key concepts;
- Review the main recyclable aircraft components;
- Address any remaining questions; and
- Conduct a short knowledge check.

Student Activities:

- Complete a short quiz;
- Use VR headsets to explore parts of an aircraft;
- Reflect on one new thing learned during this lesson; and
- Share ideas for improving sustainability in aviation.

Methods & Tools:

- Short quiz;
- Reflection activity; and
- Question-and-answer session.

Assesment

- Quiz: Kahoot, Moodle or Google Forms;
- Participation: Contribution to discussions and teamwork;
- Practical task: Design a reuse, refurbishment, recycling, or upcycling plan for selected aircraft components and justify the proposed solution;
- Reflection: Oral reflection on the importance of aircraft recycling for sustainable aviation; and
- Peer evaluation: Students give constructive feedback on their classmates' ideas for aircraft recycling and sustainability.

Differentiation

Support for Weaker Students

- Clear step-by-step instructions for each activity;
- Visual examples of recyclable aircraft components;
- Additional guidance and encouragement during individual and group activities; and
- Opportunities to ask additional questions and receive individual feedback.

Support for Advanced Learners

- Research innovative aircraft recycling technologies;
- Investigate companies specializing in aircraft dismantling (e.g., TARMAC Aerosave);
- Evaluate the environmental and economic benefits of different recycling methods; and
- Prepare a short presentation on future recycling challenges related to composite aircraft materials.

Sustainability/Real-life Connection

- Aircraft recycling significantly reduces waste and conserves valuable raw materials;
- Reusing aircraft components decreases the need for new resource extraction and lowers environmental impact;
- Upcycling aircraft parts into furniture, buildings, and everyday products demonstrates circular economy principles; and
- Sustainable aircraft recycling supports greener aviation and contributes to reducing the industry's environmental footprint.
- Aircraft recycling demonstrates how circular economy principles can reduce waste while creating new economic opportunities in the aviation sector.

Note & reflection

For teachers after lesson:

- Note & reflection
- For teachers after lesson:
- What worked well?
- Which activities generated the highest student engagement?
- Were learning outcomes achieved?
- Did students correctly identify recyclable materials?
- What improvements should be made for future lessons?
- Were the time allocations appropriate?

LESSON PLAN



Lesson Title:
Lesson 6 *Aircraft Interior Recycling*

Teacher:
[Name of the teacher]

Target Group:
VET students 15–18]

Duration:
2 × 45 min

Type of Lesson:
theoretical / practical / VR

Teaching Mode:
classroom /blended / VR-supported

Abstract/Introduction

This lesson explores how aircraft interiors are dismantled, recycled, upcycled, or repurposed at the end of an aircraft's life. Students learn why interior components—such as seats, panels, galleys, carpets, and avionics - can be reused thanks to strict maintenance standards, and how recycling companies ensure proper certification and environmental compliance. The topic is essential for understanding circular economy principles in aviation, eco-design, and sustainable waste management.

Learning objectives

The lesson aims to:

- Introduce the concept of aircraft interior recycling and its role in sustainability.
- Explain how interiors are dismantled, sorted, and certified.
- Analyze recycling, upcycling, and repurposing processes.
- Explore the role of eco-design and materials mapping.
- Discuss real-world companies and practices (AIRA, AELS, MotoArt).

Learning outcomes

By the end of the lesson, students will be able to:

- Describe how aircraft interiors are dismantled and processed.
- Explain the difference between recycling, upcycling, and repurposing.
- Analyze which interior components can be reused and why.
- Evaluate the environmental benefits of circular economy in aviation.
- Identify real-life examples of creative reuse and industry practices.

Key competences

- Green competences: sustainability, circular economy, waste reduction.
- Digital competences: use of videos, diagrams, online tools.
- Critical thinking: evaluating recycling vs. landfill decisions.
- Problem solving: proposing reuse solutions for interior components.
- Language competences: technical vocabulary (EoL, Part 145, upcycling).
- Social skills: teamwork, discussion, collaborative tasks.

Teaching methods & tools

Interactive presentation, Case studies (AIRA, AELS, MotoArt), Video on aircraft dismantling, Group analysis of recycling tables, Brainstorming and creative design tasks, Digital quiz (Kahoot / Google Forms)

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:
- Show images of dismantled aircraft interiors.
- Introduce the concept of aircraft EoL and circular economy.
- Activate prior knowledge: “What do you think happens to aircraft seats, panels, or galleys?”

Student Activities:
- Observe and describe images.
- Share ideas about reuse and recycling.

Methods & Tools:
- Discussion, images, short introductory video.

Main Part (65-70 min.)

1. Why Aircraft Interiors Are Recycled
Teacher: explains decommissioning, eco-design, and regulatory context (EASA Part 145). Students: identify reasons why interiors retain value (strict maintenance, certification). Tools: diagram of aircraft lifecycle (document citation: “The blue section represents the aerospace business…”).

2. What Can Be Recycled
Teacher: presents the table of components and their possible fates (e.g., seats, wiring, CFRP, galleys). Students: group task: match components with recycling options. Tools: printed table, worksheet.

3. Recycling, Upcycling, Repurposing
Teacher: explains differences (document citation: “Upcycling is when products… are reworked and upgraded”). Students: propose creative reuse ideas for selected components. Tools: brainstorming board, examples (MotoArt, Rush Faster).

4. Companies & Real-World Practices
Teacher: presents AIRA, AELS, SustainAir, MotoArt. Students: analyze services offered (logistics, certification, storage, dismantling). Tools: case study sheets, website screenshots.

5. Creative Reuse & Design
Teacher: shows examples: furniture, offices, libraries, bars, hotels. Students: design a repurposed interior object (group mini-project). Tools: paper, digital drawing tools.

Conclusion (10 min.)

Teacher Activities:

- Summarize key concepts: dismantling, recycling, upcycling, repurposing.
- Highlight sustainability impact.

Student Activities:

- Reflect on circular economy in aviation.
- Complete a quick quiz or exit ticket.

Methods & Tools:

- Kahoot / Mentimeter
- Reflection prompt: “Which interior component has the most reuse potential?”

Assesment

- Digital quiz (Kahoot / Google Forms)
- Participation in group tasks
- Short written reflection on creative reuse
- Practical task: propose a repurposed interior component
- Peer evaluation during group design activity

Differentiation

- Weaker students: simplified vocabulary list, guided worksheets, visual aids.
- Advanced learners: deeper research on eco-design, regulatory aspects, or material science.
- Mixed groups: peer tutoring, differentiated tasks.

Sustainability/Real-life Connection

- Shows how recycling reduces waste and saves resources.
- Connects to real aviation practices (AIRA, AELS, SustainAir).
- Highlights creative reuse in design, architecture, and industry.
- Discusses eco-design and materials mapping for future aircraft.

Note & reflection

For teachers after lesson:

- Which activities engaged students most?
- Was the creative design task effective?
- Did students understand the difference between recycling, upcycling, repurposing?
- What should be improved next time?

LESSON PLAN



Lesson Title:
Lesson 7 *Aircraft Engines: Parts, Maintenance & Recycling*

Teacher:
[Name of the teacher]

Target Group:
VET students 15–18]

Duration:

Type of Lesson:
theoretical

Teaching Mode:
classroom /blended / VR-supported

Abstract/Introduction

This lesson introduces students to the lifecycle of aircraft engines, from operation to maintenance, dismantling, and recycling. It highlights how engines work, why maintenance is essential for safety, and how end-of-life engines are responsibly processed. The topic is crucial for understanding aviation sustainability, as up to 95% of an Airbus A320 can be recovered (document citation). Students explore how recycling reduces waste, conserves resources, and supports the aviation aftermarket.

Learning objectives

By the end of the lesson, the teacher will have:

- Introduced the lifecycle of aircraft engines and their components.
- Explained how turbine engines work and why maintenance is essential.
- Analyzed key maintenance processes such as TBO, HSI, and overhaul.
- Explored dismantling, part-out, and recycling procedures.
- Discussed sustainability challenges and innovations in engine materials.

Learning outcomes

Students will be able to:

- Describe how aircraft engines function and identify their main components.
- Explain the purpose of maintenance processes (TBO, HSI, overhaul).
- Analyze how engines are dismantled and recycled at end of life.
- Evaluate the environmental benefits of recycling engine parts.
- Apply knowledge to real aviation cases (AMARG, Finnair, AFRA).

Key competences

- Green competences: environmental awareness, sustainable aviation practices.
- Digital competences: use of videos, diagrams, online quizzes.
- Critical thinking: evaluating maintenance decisions and recycling processes.
- Problem solving: identifying safe and efficient end-of-life solutions.
- Language competences: technical aviation vocabulary.
- Social skills: group work, discussion, peer collaboration.

Teaching methods & tools

Interactive presentation, Case study analysis (AMARG, Finnair), Short video on engine teardown, Group discussion and problem-solving tasks, Digital quiz (Kahoot / Google Forms), Visual diagrams of engine components

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Warm-up: show a photo of a dismantled aircraft engine, Activate prior knowledge: ask students what they know about engine lifespan, Introduce lesson goals and sustainability focus

Student Activities:

- Observe and describe images, Share ideas about aircraft ageing and recycling.

Methods & Tools:

- Discussion, images, short introductory video

Main Part (65-70 min.)

1.How Aircraft Engines Work
Teacher: explains fan → compressor → combustion → turbine → nozzle sequence. Students: label engine diagram; identify components. Tools: diagram, short animation.

2. Maintenance Processes
Teacher: explains TBO, HSI, overhaul (citing document: “The Hot Section Inspection focuses on components subjected to extreme heat and pressure…”). Students: compare maintenance types; analyze why failures occur. Tools: case examples, maintenance logs.

3. Dismantling & Recycling
Teacher: presents part-out process, AMARG, Air Salvage International, Finnair case. Students: group task: map the recycling steps (teardown → sorting → recycling → mutilation). Tools: infographic, group worksheet.

4. Sustainability & New Materials
Teacher: explains new ceramic coatings extending engine life (document citation: “A new coating could extend the life of engine parts by up to 200 times”). Students: discuss how innovation reduces waste. Tools: article excerpt, discussion.

Conclusion (15-20 min.)

Teacher Activities:

- Summarize key points: engine lifecycle, maintenance, recycling, Clarify misconceptions.

Student Activities:

- Reflect on sustainability in aviation, Complete a quick digital quiz.

Methods & Tools:

- Kahoot / Mentimeter poll, Exit ticket: “One thing I learned / one question I still have”

Assesment

Include at least 2 methods:

- Digital quiz (Kahoot / Google Forms) aligned with learning outcomes
- Participation in group tasks and discussions.
- Short written reflection on sustainability in engine recycling.
- Practical task: label engine components or map recycling steps.

Align with learning outcomes.

Differentiation

- For weaker students: simplified diagrams, vocabulary list, guided worksheets.
- For advanced learners: deeper analysis of regulatory aspects (EASA Part 145), research on new materials, extended case studies.
- Mixed groups: peer tutoring during tasks.

Sustainability/Real-life Connection

- Highlights how recycling reduces waste and conserves materials.
- Connects to real aviation practices: AMARG, AFRA, Finnair dismantling program.
- Shows how up to 95% of an A320 can be recovered (document citation).
- Discusses environmental impact of engine materials and innovations.

Note & reflection

For teachers after lesson:

- What worked well?
- Which activities engaged students most?
- Were the diagrams and case studies effective?
- What should be improved next time?
- How well did students grasp sustainability concepts?

LESSON PLAN



Lesson Title:
Lesson 8 *Sustainable Ground Handling*

Teacher:
[Name of the teacher]

Target Group:
Aviation VET students 15–18]

Duration:
2 × 40 min

Type of Lesson:
theoretical / practical / mixed

Teaching Mode:
classroom / online / blended / VR-supported / workshop

Abstract/Introduction

This lesson introduces students to the concept of sustainable ground handling through the use of Green Ground Support Equipment (GSE). Learners explore how conventional ground support vehicles contribute to emissions, noise pollution, and operational costs, and how electric, hybrid, and alternative-fuel equipment can reduce environmental impacts. The lesson examines the benefits of green GSE, including lower emissions, improved working conditions, and increased operational efficiency. Students also learn about best practices for implementing sustainable equipment at airports and ground handling organizations.

Learning objectives

By the end of the lesson, the teacher will:

- Introduce the concept of Green Ground Support Equipment (GSE).
- Explain the environmental impacts of conventional ground handling equipment.
- Explore different types of sustainable GSE technologies.
- Analyze the environmental and economic benefits of green GSE.
- Demonstrate best practices for implementing electric and low-emission equipment in airport operations.

Learning outcomes

By the end of the lesson, students will be able to:

- Explain the environmental impact of traditional ground support equipment.
- Identify different types of Green Ground Support Equipment, including electric, hybrid, and alternative-fuel GSE.
- Describe the benefits of green GSE for sustainability and airport operations.
- Explain how green GSE contributes to emission reduction and improved workplace conditions.
- Discuss practical considerations for implementing electric GSE fleets at airports.

Key competences

Include transversal competences:

- Green competences: Understanding sustainable technologies and environmental protection.
- Digital competences: Using online resources and digital learning materials.
- Critical thinking: Evaluating sustainable solutions for airport operations.
- Problem solving: Identifying ways to reduce emissions and operational impacts.
- Language competences: Learning industry-specific sustainability terminology.
- Social skills: Participating in discussions and collaborative activities.

Teaching methods & tools

Interactive presentation (PowerPoint/Canva)
Guided discussion
Case-study analysis
Airport operations scenarios
Educational videos on electric GSE
Kahoot/Menti meter quiz
VR supported lessons

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:

- Introduce sustainability challenges in aviation ground handling.
- Show images or videos of conventional and electric GSE.
- Ask students how airport vehicles affect the environment.
- Facilitate a brainstorming activity about sustainability in airports.

Student Activities:

- Participate in discussion.
- Share ideas about environmental issues at airports.
- Observe and compare different types of GSE.

Methods & Tools:

- Brainstorming
- Group discussion
- Images and short video
- Interactive questions

Main Part (65-70 min.)

Teacher Activities:

- Explain the role of ground support equipment in airport operations.
- Introduce Green GSE and its purpose in reducing emissions, noise, and operational costs.
- Present examples of Green GSE:
- Electric baggage tractors & belt loaders
- Pushback tugs
- Hybrid vehicles
- Alternative-fuel vehicles using HVO, bio-CNG, or hydrogen
- Electric Ground Power Units (GPUs) and PCA units
- Discuss key benefits:
- Zero local emissions
- Lower noise levels
- Reduced fuel and maintenance costs
- Improved reliability
- Easier regulatory compliance
- Explain implementation best practices:
- Fleet assessment
- Phased electrification
- Charging infrastructure planning
- Renewable energy integration
- Staff training

Student Activities:

- Take notes and ask questions.
- Analyze examples of airport ground support equipment.
- Compare conventional and electric GSE.
- Work in groups to identify sustainability advantages and challenges.
- Present recommendations for introducing Green GSE at an airport.

Methods & Tools:

- Mini lecture
- Case studies
- Group work
- Visual diagrams (Waste Hierarchy and Circular Economy)
- Digital presentation

Conclusion (10 min.)

Teacher Activities:

- Summarize the concept and benefits of Green GSE.
- Review key sustainability impacts and technologies.
- Facilitate a short recap discussion.
- Conduct a quick knowledge-check quiz.

Student Activities:

- Complete a short quiz.
- Reflect on the most important lesson takeaway.
- Share one idea for improving sustainability in airport ground operations.

Methods & Tools:

- Kahoot/Mentimeter quiz
- Reflection activity
- Question-and-answer session

Assesment

- Quiz: Knowledge of Green GSE concepts and sustainability benefits.
- Participation: Engagement during discussions and activities.
- Group Activity: Analysis of conventional versus electric GSE.
- Reflection: Short written reflection on sustainable airport operations.

Differentiation

Support for Weaker Students

- Visual aids and simplified diagrams.
- Guided worksheets with key vocabulary.
- Additional teacher support during discussions.

Support for Advanced Learners

- Research task on airport electrification projects.
- Analysis of alternative fuels such as hydrogen and bio-CNG.
- Short presentation on sustainable airport ground operations.

Sustainability/Real-life Connection

- Ground handling activities contribute to airport emissions and noise pollution. Green GSE helps reduce these impacts.
- Electric GSE produces zero local emissions and significantly lowers noise levels, improving conditions for airport workers and nearby communities.
- Sustainable ground support equipment supports airport environmental goals and compliance with regulations.
- Many airports worldwide are transitioning to electric and low-emission fleets as part of broader sustainability strategies.

Note & reflection

For teachers after lesson:

- Were students able to distinguish between conventional and Green GSE?
- Did students understand the environmental and economic benefits of electrification?
- Which activities generated the highest engagement?
- Were students able to propose realistic implementation strategies?
- What concepts required additional explanation?
- Were all learning outcomes successfully achieved?

LESSON PLAN



Lesson Title:
Lesson 9 *Aviation and Climate Change*

Teacher:
[Name of the teacher]

Target Group:
VET students 15–18

Duration:
e.g. 2 × 45 min

Type of Lesson:
theoretical

Teaching Mode:
classroom / VR-supported

Abstract/Introduction

This lesson explores the environmental impact of aviation, focusing on CO_2 and non-CO_2 emissions, contrails, radiative forcing, and airport-related pollution. Students learn how aviation compares to other transport modes, why emissions at high altitude have a stronger warming effect, and how global aviation contributes to anthropogenic climate change. The lesson connects scientific data, regulatory frameworks, and sustainability strategies, helping students understand the challenges aviation faces in meeting climate goals such as Net Zero 2050.

Learning objectives

This lesson aims to:

- Introduce the environmental impact of aviation compared to other transport modes.
- Explain CO_2 and non-CO_2 emissions and their effects on climate.
- Analyze contrails, radiative forcing, and high-altitude warming.
- Explore airport-related pollution and noise impacts.
- Discuss international regulations and mitigation strategies.

Learning outcomes

By the end of the lesson, students will be able to:

- Describe how aviation contributes to climate change through CO_2 and non-CO_2 emissions.
- Explain the greenhouse effect and radiative forcing in aviation.
- Analyze the role of contrails and contrail-induced cirrus clouds.
- Evaluate the environmental impact of airports on surrounding communities.
- Identify regulatory measures (ICAO, EASA, UNFCCC) and sustainability strategies.

Key competences

- Green competences: climate awareness, sustainability strategies.
- Digital competences: use of climate data portals (Copernicus, ICAO databases).
- Critical thinking: interpreting scientific data on emissions.
- Problem solving: evaluating mitigation strategies for aviation.
- Language competences: scientific and technical terminology.
- Social skills: group discussion, collaborative analysis.

Teaching methods & tools

Interactive presentation, Scientific data interpretation, Case studies (ICAO, IPCC, EASA), Short videos on contrails and radiative forcing, Group discussion and problem-solving tasks, Digital quiz (Kahoot / Google Forms)

Lesson scenario

Introduction (10–15 min.)

Teacher Activities:
- Show a graph comparing emissions from cars, trains, ships, and planes.
- Introduce the EU Green Deal goal: –90% transport emissions by 2050.
- Ask: “Which transport mode do you think pollutes the most per passenger-km?”

Student Activities:
- Observe and comment on the graph.
- Share initial ideas about aviation’s environmental impact.

Methods & Tools:
- Discussion, infographic, short introductory video.

Main Part (indicate time, e.g. 60 – 90 min.)

Teacher Activities:
- Show a graph comparing emissions from cars, trains, ships, and planes.
- Introduce the EU Green Deal goal: –90% transport emissions by 2050.
- Ask: “Which transport mode do you think pollutes the most per passenger-km?”

Students Activities:
- Observe and comment on the graph.
- Share initial ideas about aviation’s environmental impact.

Methods & Tools:
- Discussion, infographic, short introductory video.

Conclusion (indicate time, e.g.15 – 20 min.)

Teacher Activities:
- Summarize key concepts: CO_2, non-CO_2, contrails, radiative forcing, regulations.
- Highlight aviation’s challenge: balancing mobility and sustainability.

Students Activities:
- Reflect on aviation’s climate responsibility.
- Complete a quick quiz or exit ticket.

Methods & Tools:
- Kahoot / Mentimeter
- Reflection prompt: “Which emission type surprised you the most?”

Assesment

- Digital quiz (Kahoot / Google Forms)
- Participation in discussions
- Short written reflection on aviation's climate impact
- Group task: propose a mitigation strategy
- Peer evaluation during group work

Differentiation

- Weaker students: simplified diagrams, glossary of scientific terms, guided worksheets.
- Advanced learners: deeper analysis of radiative forcing, IPCC reports, ICAO standards.
- Mixed groups: peer tutoring, differentiated tasks.

Sustainability/Real-life Connection

- Connects to EU Green Deal and Net Zero 2050 goals.
- Uses real scientific data (ICCT, IPCC, Copernicus).
- Shows how aviation contributes to global warming beyond CO_2 alone.
- Highlights real mitigation strategies: SAF, engine design, flight planning, regulations.

Note & reflection

For teachers after lesson:

- Which scientific concepts were hardest for students?
- Did students understand the difference between CO_2 and non-CO_2 effects?
- Was the contrail section clear and engaging?
- What should be improved next time?

10. R2 - Virtual Airport Tour (VR Activities)

The Virtual Airport Tour consists of nine interactive VR activities that immerse learners in realistic airport and maintenance environments where waste management decisions must be made. The activities are available in both offline and online versions and are designed to function with or without dedicated VR headsets, maximising accessibility across different school contexts.

The VR activities were developed following intensive training of teachers from all partner schools in VR hardware and software, pedagogical principles of VR integration, and content creation techniques. Teachers from each country contributed one draft lesson or activity to the collaborative development process.

VR Activity Benefits

VR activities allow students to practice waste management procedures in a realistic but risk-free environment before entering real airport or MRO workplaces. This bridges the gap between classroom learning and work-based training, building confidence and competence simultaneously. Research consistently shows that immersive learning environments improve knowledge retention and transfer.





11. META QUEST 3S – OPERATOR & TRAINING MANUAL

FOREWORD

This manual has been prepared within the scope of the Erasmus Project in order to explain the usage, features and basic operation of the META QUEST 3S device.

The purpose of this manual is to support students during training activities by providing a clear understanding of the device and its functions.

This manual is divided into sections:
PART I - INTRODUCTION
PART II - OPERATOR MANUAL
PART III - MAINTENANCE
PART IV - APPENDICES
PART V - META QUEST LINK SOFTWARE

PART I - INTORDUCTION

1. Purpose of this manual

This manual is designed for students and instructors. It explains how to use the META QUEST 3S Mixed Reality (MR) glasses safely and effectively in an educational environment.

The device is used for:

- training
- simulation activities
- technical learning

2. Learning objectives

By using this device, students will learn:

- How MR glasses work
- How to wear and adjust the device
- How to use voice, manual, and gesture controls
- How to take photos and videos
- Basic safety and responsibility rules

3. Device overviews

META QUEST 3S is a hands-free wearable MR device used in industrial and educational environments.

It allows users to:

- View digital information
- Record videos and images
- Use voice commands
- Work hands-free

PART II - OPERATOR MANUAL

4. Technical specifications

Feature	Details
Proccessor	Snapdragon XR2 Gen 2
Memory	8 GB RAM
Operating system	Horizon OS
Camera	Dual RGB Passthrough + Depth Sensor

4.1. Audio

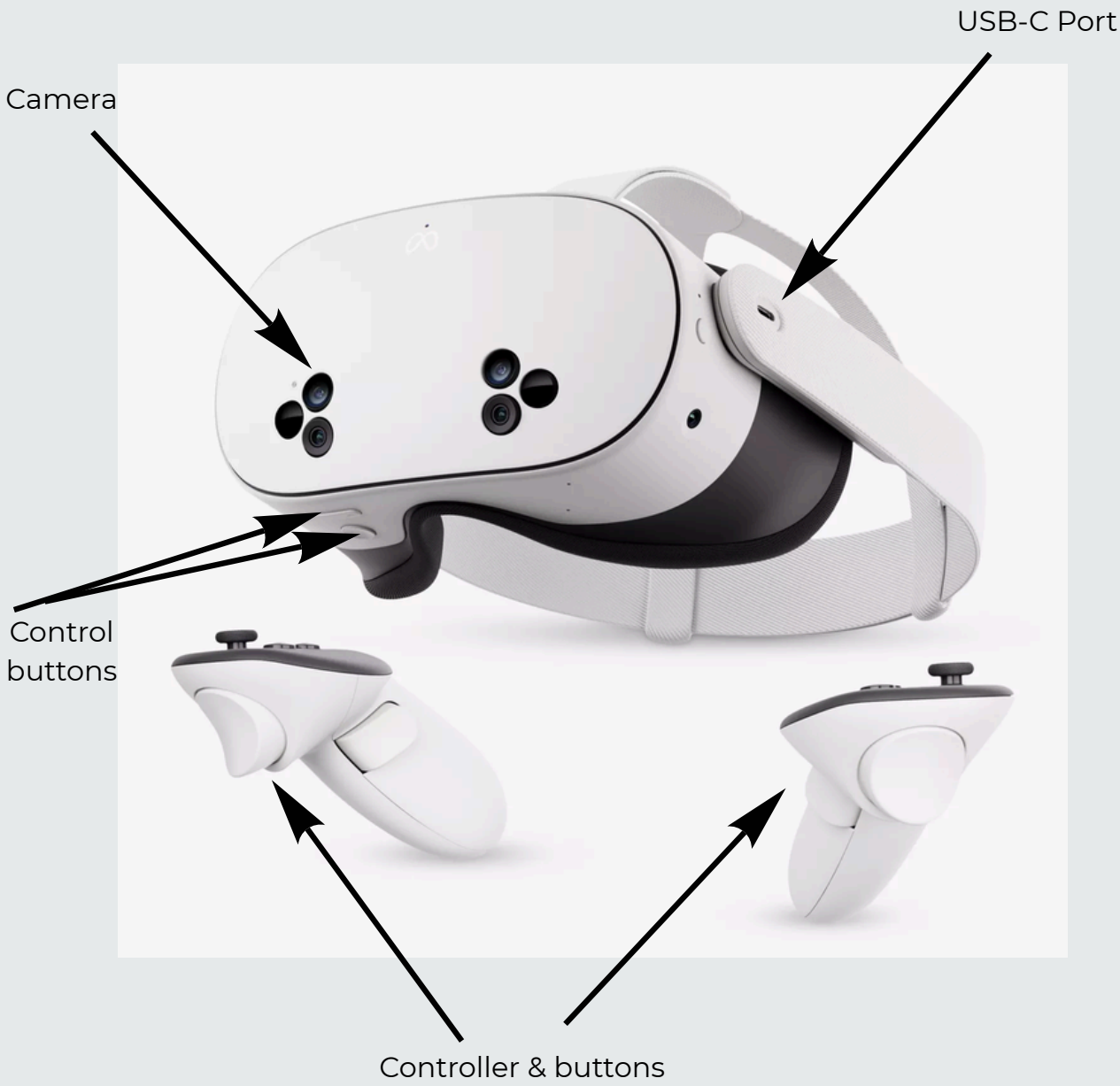
- Digital microphones (noise cancellation)
- Internal speaker

4.2. Display

- Resolution: 1832x1920 per eye (Fresnel Optics)

5. Device components

- Camera
- Display module
- Microphones
- Speaker
- Controllers&buttons
- USB-C port
- Control buttons



6. Wearing the device

6.1. Eye Selection

The device can be used with both eyes simultaneously for stereoscopic vision. Adjust the lens distance according to your comfort.

6.2. Fitting

- Place the device on your head
- Adjust the strap
- Position the display for maximum clarity

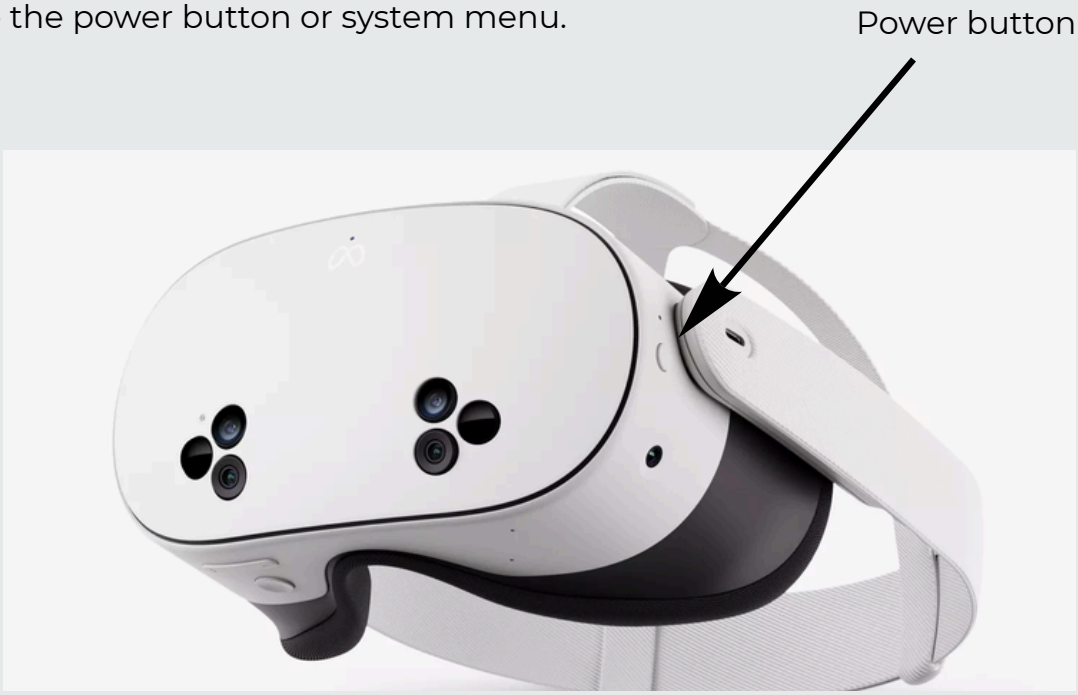
7. Power function

7.1. Power ON

Press and hold the power button for 3 seconds.

7.2. Power OFF

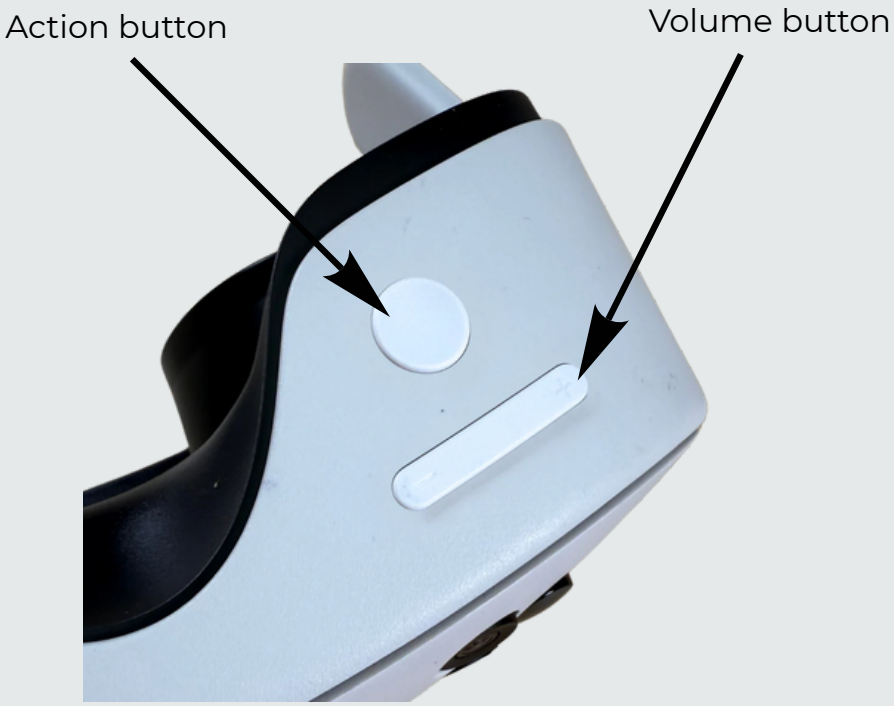
Use the power button or system menu.



8. Device Control

8.1. Buttons

- Power buttons
- Volume buttons
- Action buttons



8.2. Voice Control

The device supports voice commands.
Examples:

- "Hey Meta, take a photo"
- "Hey Meta, record video"

PART III - MAINTENANCE

9. Cleaning
- Use a soft cloth
- Do not use chemicals
- Clean lenses carefully

10. Battery Handling
- Charge using USB-C
- Do not overheat

11. Storage
- Store in dry place
- Avoid extreme temperatures

PART IV - EDUCATIONAL USE

12. Classroom Activities
- Practice device usage
- Simulate inspections
- Record training videos

13. Responsibilities

Instructors supervise usage and ensure safety. Students must follow instructions.

PART V - META QUEST LINK SOFTWARE

1. Introduction

Meta Quest Link is a screen projection software that allows users to display the device screen on a computer. Users can view the screen, control the device, and install applications.

2. Features
- Screen mirroring (device → PC)
- Wireless connection support (Air Link)
- APK installation (drag & drop)
- Navigation buttons (Back, Home, Settings)
- Full screen mode

3. System Requirements

- Windows 10 / 11
- USB connection or same Wi-Fi network

4. Installation

- Download the Meta Quest Link software
- Run the installer

5. Connecting the Device

- Connect via USB or Air Link
- The screen will be mirrored automatically



6. Additional Functions

- Wireless Projection (Air Link)
- Full Screen Mode
- Screenshot Capture

7. APK Installation

Drag the APK file into the program to start installation automatically.

END OF MANUAL

12. CREATING AND INTEGRATING INTERACTIVE CONTENT WITH LUMI AND MOODLE

1. INTRODUCTION

This guide provides step-by-step instructions for creating interactive learning content using Lumi and publishing it within Moodle.
It is designed to support teachers in developing engaging video-based lessons, interactive 360° content, and structured quizzes that can be integrated into online courses.
The document follows a practical approach: from content preparation and creation in Lumi to uploading and managing activities in Moodle.

Purpose of this guide:

- Creating interactive videos with embedded questions
- Designing interactive 360° image activities
- Exporting interactive content in .h5p format
- Uploading and configuring content in Moodle
- Creating and linking quizzes within a course
- Setting up activity completion and tracking student results

This guide focuses on essential features required for building functional and effective interactive lessons. It does not require advanced technical knowledge.

Target audience

This guide is intended for:

- Teachers and instructors who are new to Lumi and Moodle
- Educators who want to create interactive lessons without advanced technical skills
- Course authors responsible for uploading and organizing digital content

No prior experience with H5P content creation is required.

What you will learn

By the end of this guide, you will be able to:

- Create an interactive video in Lumi
- Insert different types of questions into a video timeline
- Create an interactive 360° image with clickable hotspots
- Export interactive content as an .h5p file
- Upload and configure H5P activities in Moodle
- Create quizzes directly in Moodle
- Configure grading and completion tracking
- Connect learning activities into a logical course flow

Required tools and preparation

Before starting, make sure you have the following:

Software Requirements

- Lumi installed on your computer / Desktop version is also solid
- Access to a Moodle course with editing permissions

Content Preparation

- A video file in MP4 format (recommended)
- A 360° image in equirectangular format (2:1 ratio, e.g., 4096x2048) if creating immersive content
- Prepared questions and correct answers
- Optional supporting materials (images, text, links)

Technical Recommendations

- Use compressed video files to reduce upload time
- Test all interactive content before publishing
- Keep file sizes manageable to ensure smooth performance

2. Working in LUMI

Lumi is a desktop application used for creating interactive learning content based on H5P technology. Lumi can work offline too, and does not require advanced technical skills.

It allows teachers to:

- create interactive videos with embedded questions
- design interactive 360° images with clickable hotspots
- build presentations, quizzes, and other interactive activities
- export content as a .h5p file for upload into learning management systems (Moodle for example)
-

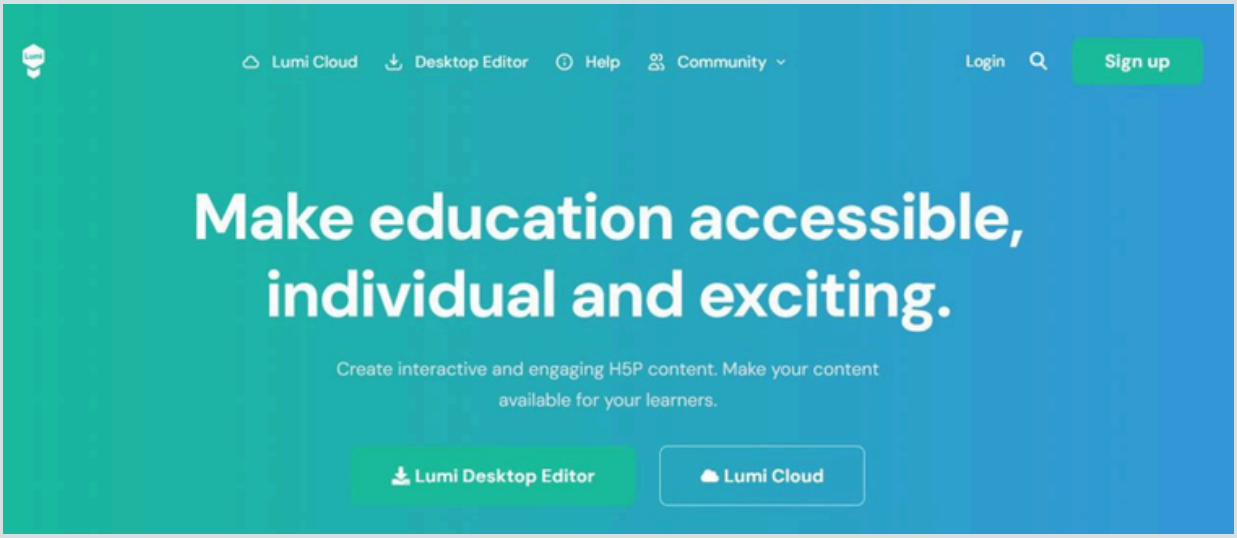
Lumi supports multiple content types. In this guide, we focus on:

- **interactive video** – a video with questions inserted at specific time points
- **360° image** – an immersive image with interactive elements
- **question-based interactions** – multiple choice, true/false, fill in the blank

Key capabilities include:

- timeline-based question placement
- automatic scoring
- feedback messages for students
- exportable and reusable content

LUMI versions
https://lumi.education/en/



Lumi can be used in two ways (option 1 and option 2 shown in the picture above).

Option 1: Online editor (web-based version accessed through a browser, login/sign up is a must)
Option 2: Desktop application (installed on your computer)

Both versions allow you to create and export H5P interactive content. The core editing interface and content types are the same. However, there are some practical differences.

Desktop Version (Installed Application)		**Online Version (Web-Based Editor)**	
Advantages:	**Considerations:**	**Advantages:**	**Considerations:**
Works offline	Requires installation	No installation required	Requires stable internet connection
Files are saved locally on your computer	Content must be manually exported and uploaded to Moodle	Accessible from any device with internet access	Performance depends on browser and connection speed
No dependency on internet speed during editing		Projects may be stored in the cloud (depending on platform setup)	Large video uploads may take longer
More stable for large video files			

Are there functional differences?
In terms of content creation features (interactive video, 360° image, question types), there are no major differences between the desktop and online versions. The main differences relate to file storage location, internet dependency and performance with large media files.
For beginners, the desktop version is often recommended for better stability, especially when working with video content.

Overview of the User Interface

In *Figure 1*, the homepage view is shown when using the desktop version. In *Figure 2*, you can choose OPEN EXISTING H5P or CREATE NEW H5P, depending on what you want to do.

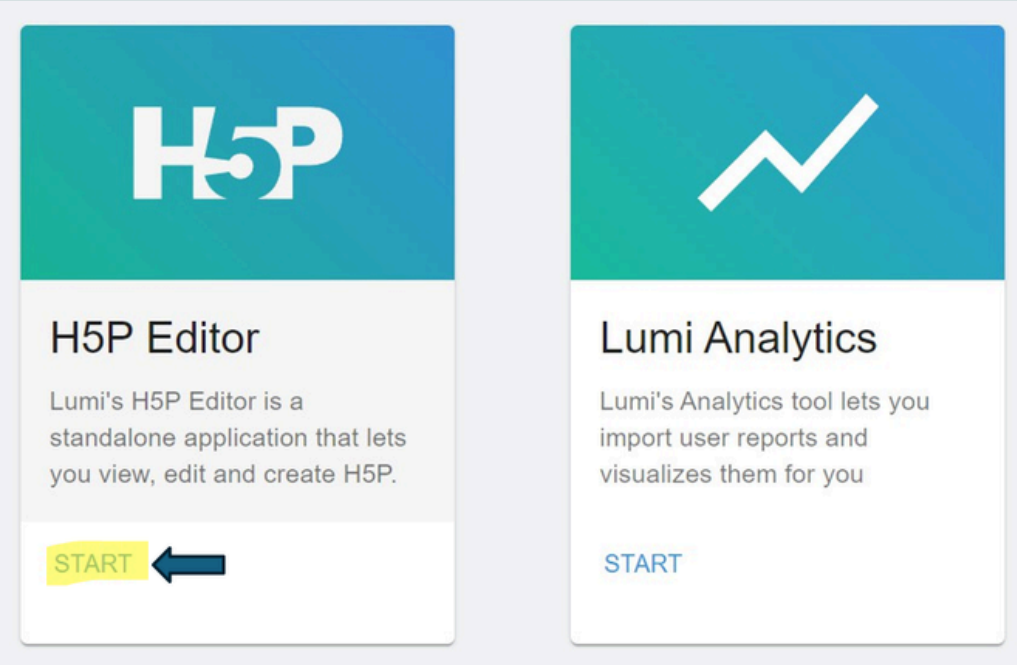


Figure 1

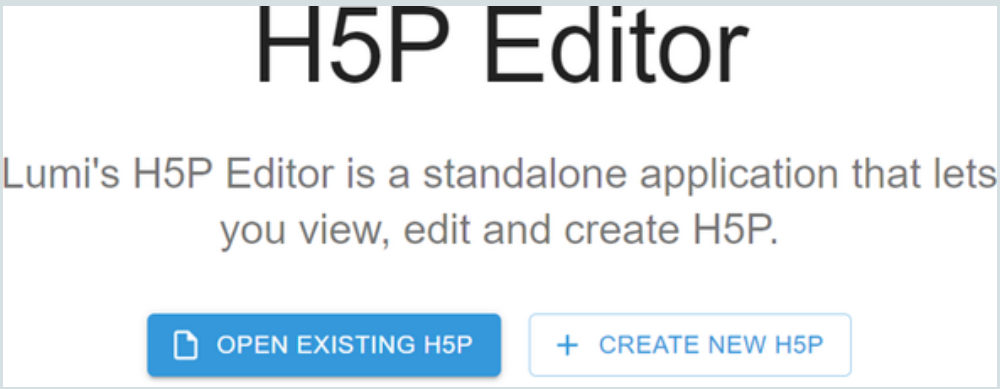


Figure 2

In *Figure 3*, the view is shown when using the online version (for which you need to log in or create an account for the first time). Choose Create Content button. *Figure 4* shows the screen after you have selected Create Content in the online version. Choose New H5P Content.

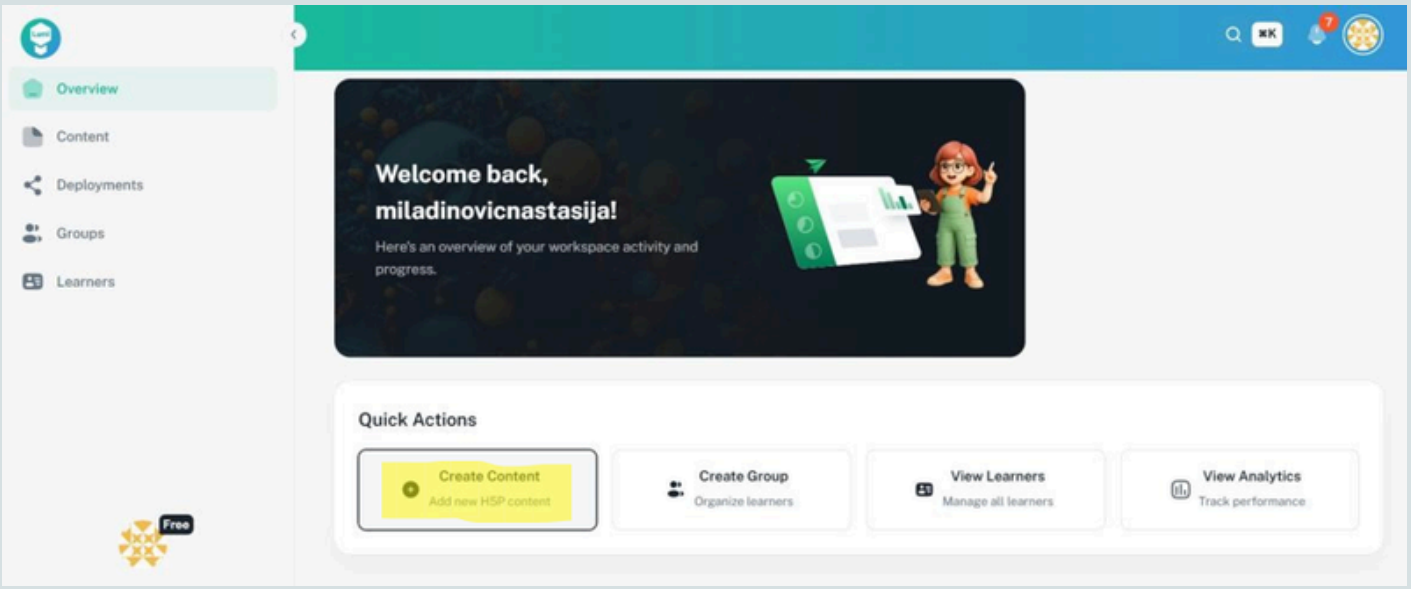


Figure 3

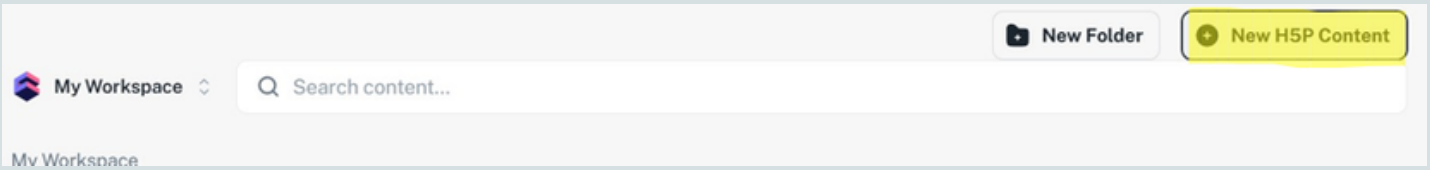


Figure 4

After these steps, the process works the same for both versions – you will see *Figure 5*.

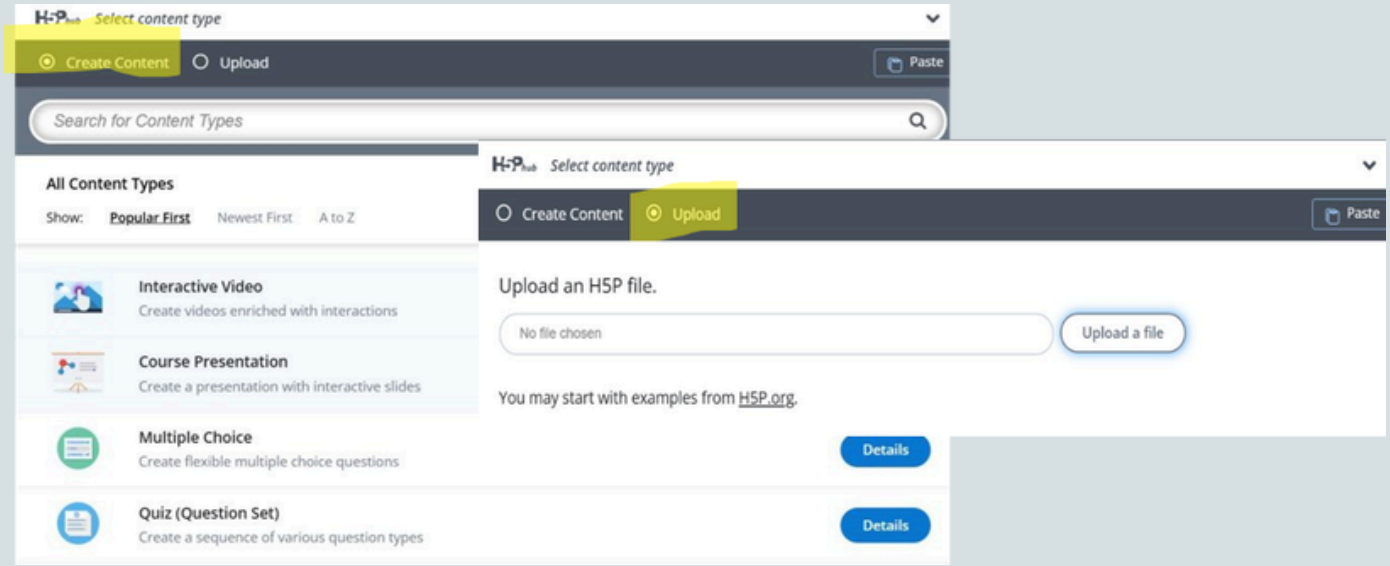


Figure 5

The most important options are:
Create Content - start a new interactive project and choose the content type you want to make, **Upload** - uploadand edit an existing .h5pproject (*Figure 5*)
Save - save your work for future editing, **Share** - generate the final .h5p file for upload (**Figure C* – you will get to that options after making content)

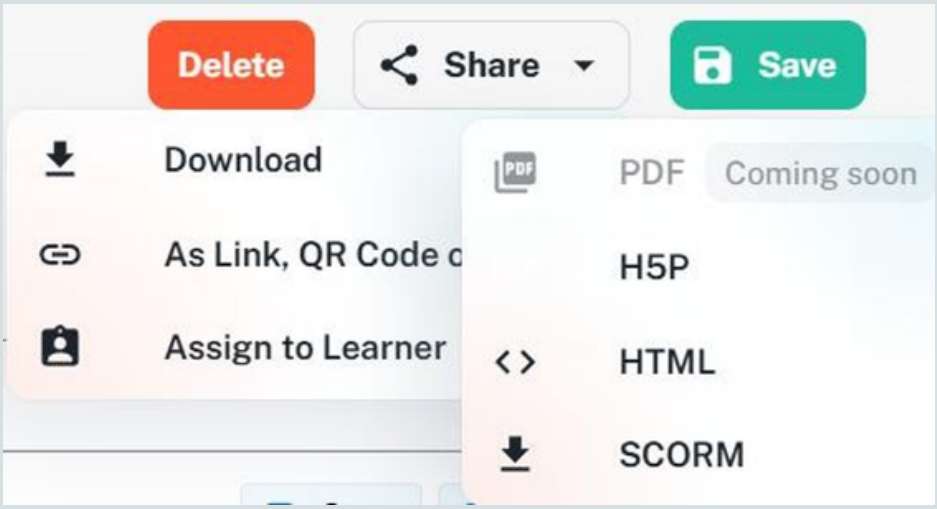


Figure C

Preparing Your Materials

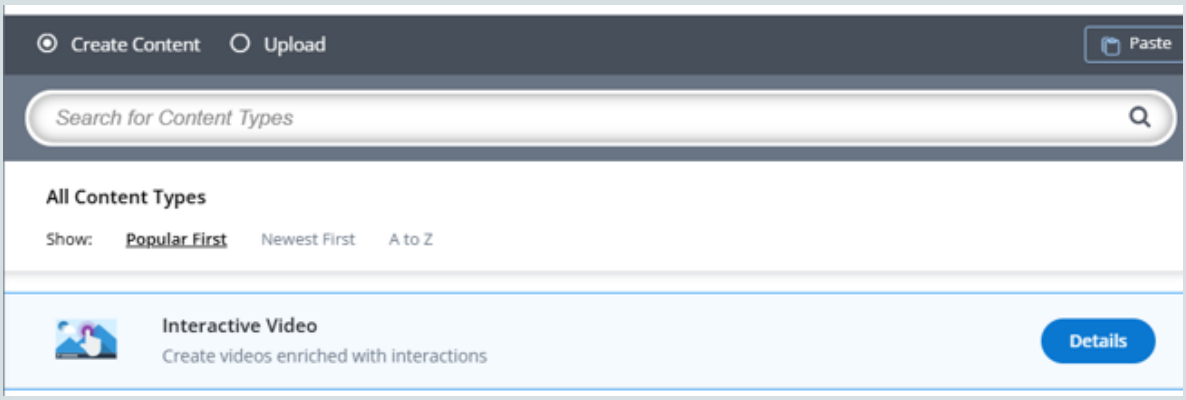
Before creating content, it is important to prepare your materials properly.

- **Preparing a video file**: recommended format is **MP4** (H.264 codec), keep file size reasonable (compressed if possible), avoide xtremely long videos, ensure audio quality is clear. For interactive learning, shorter videos (5–10 minutes) are generally more effective.
- **Preparing a 360° image**: the image must be equirectangular, aspect ratio must be 2:1 (for example: 4096x2048 pixels) incorrect formats will not display properly.
- **Preparing questions and answers:** before starting in Lumi: write all questions in advance, define correct answers, prepare feedback text for correct and incorrect responses, clear and concise questions improve learner engagement.
- **Technical recommendations**: test videos beforeuploading, avoid overly complex question wording, limit the number of questions to avoid cognitive overload, **save your project frequently**

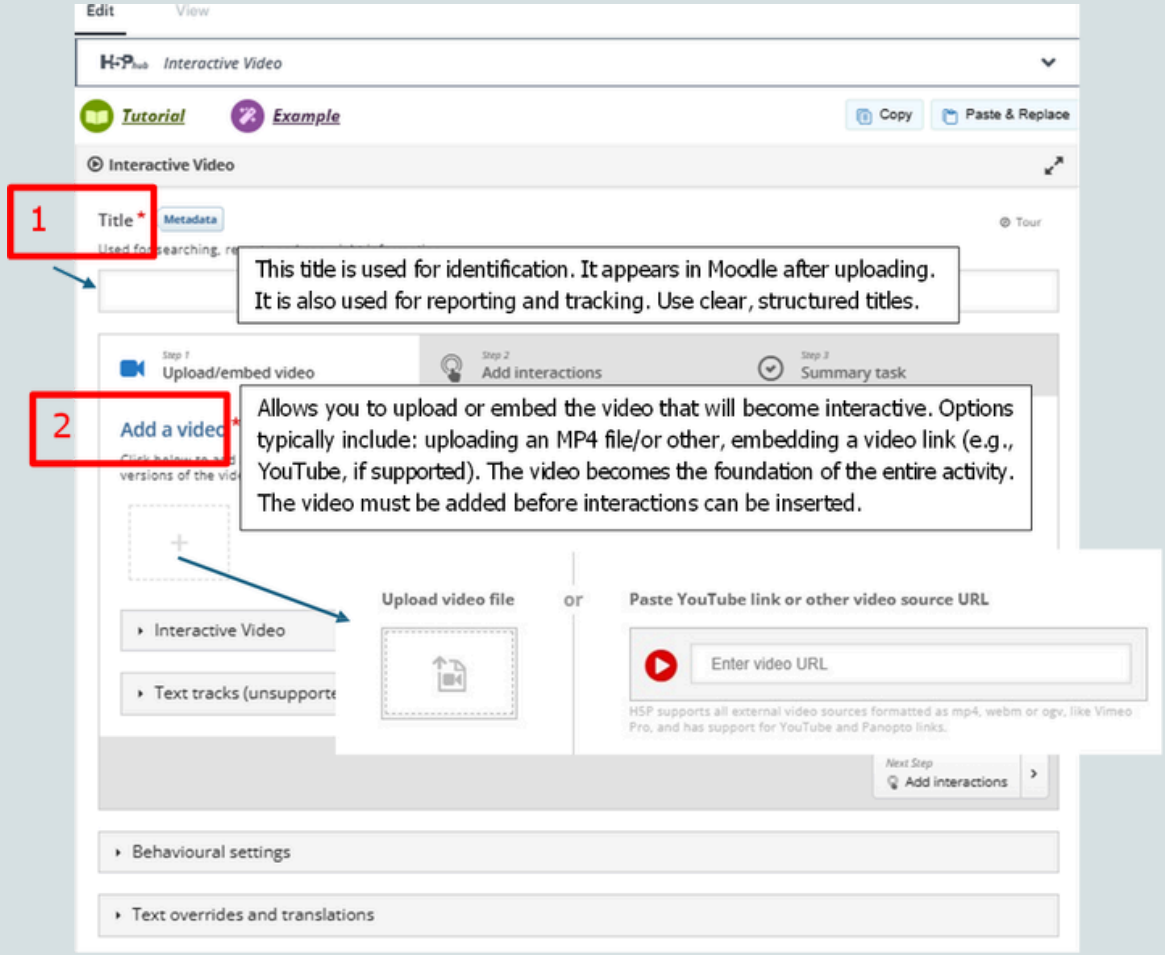
Creating an Interactive Video

Uploading video file

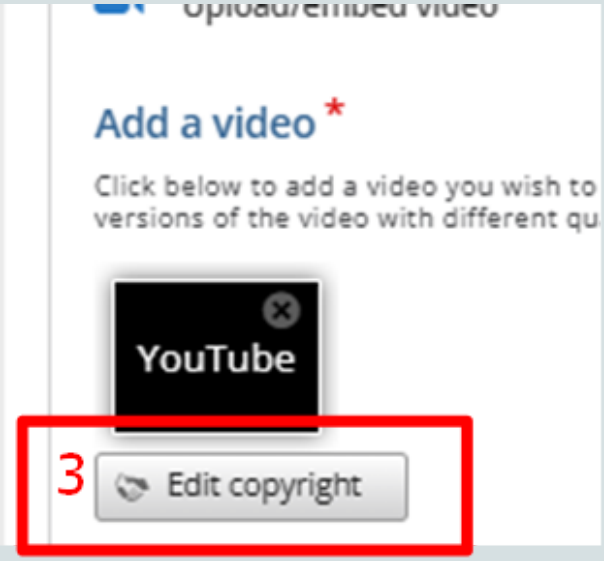
After selecting **Create Content** in either the desktopor online version, choose **Interactive Video** from the list of content types.

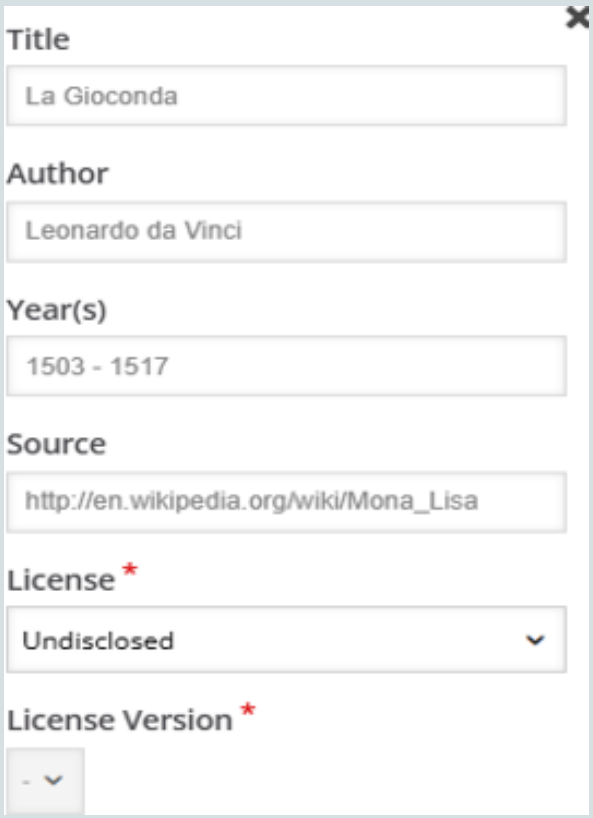


This screen appears after selecting Interactive Video in Lumi. It is divided into structured steps and configuration panels. For the first steps, follow the highlighted boxes in the screenshot.



After adding a video file or embed youtube link, you should **Edit copyright:**





For a detailed overview of copyright types, please refer to the presentation *Classroom and Education Management Strategies for Facilitating VR Experiences*, specifically the section titled *Copyright and Intellectual Property Considerations in VR Environments*.

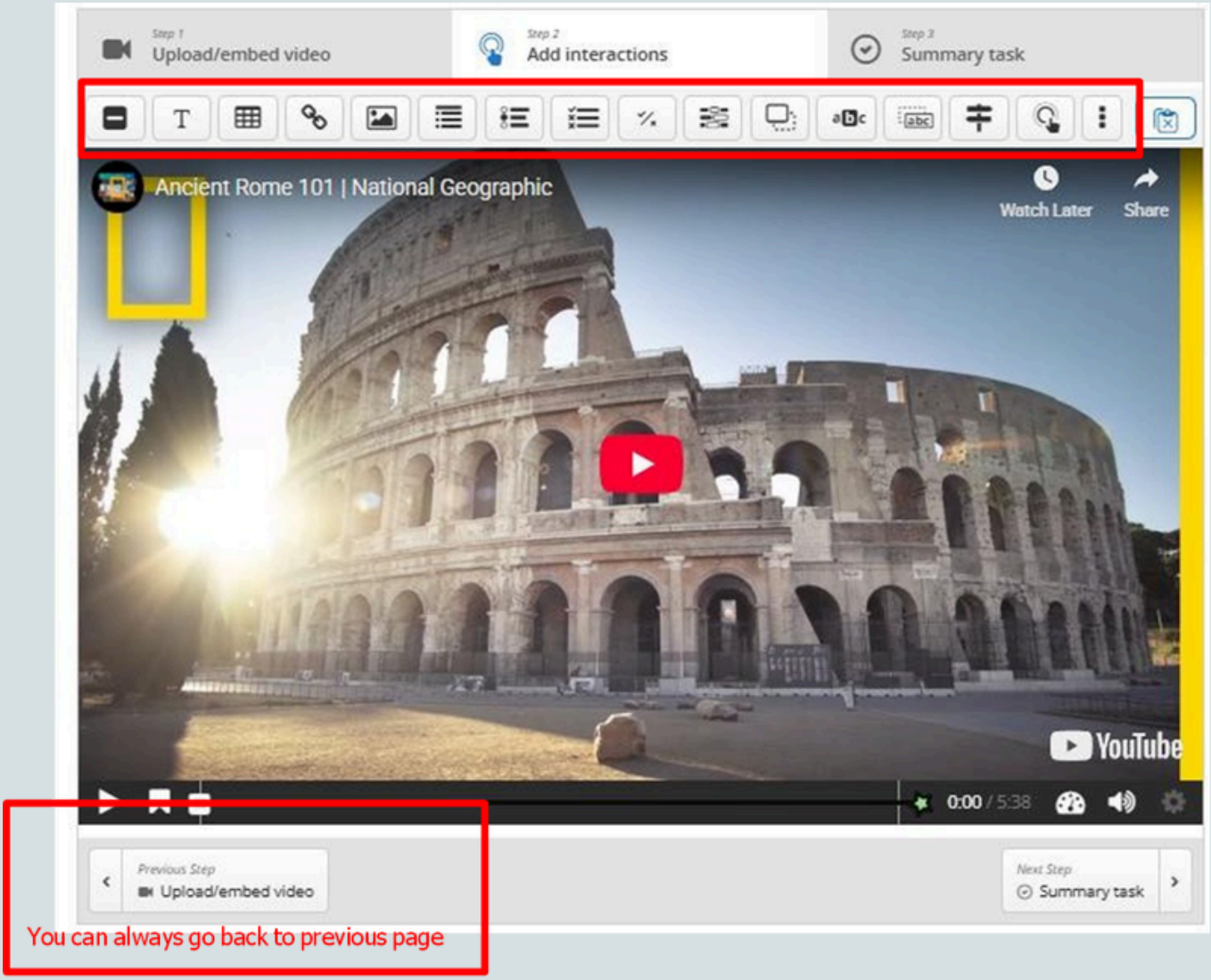
A brief summary of the key points you will need is provided below:

Scenario	Author field	Source field	License selection	License version	When to use
Your own video - All rights reserved	Your name	Optional (website/ platform if published)	Default copyright (All rights reserved)	Not required	When you do not want others to reuse, modify, or distribute your video without permission.
Our own video - Creative Commons license	Your name	Optional (website/ platform if published)	Select chosen CC license (e.g., CC BY, CC BY-SA, CC BY-NC)	Required e.g. 4.0 International	When you want to allow reuse under specific conditions (e.g., attribution required).
Third-party video – Creative Commons licensed	Original author's name	Original source URL	Match the exact CC license specified by the creator	Match original license version	When using a video published under a Creative Commons license. You must follow the original license terms.
Commons licensed	Original author's name	Original source URL	All rights reserved (unless permission granted)	Not required	When using content with explicit permission from the copyright holder.

Adding interactions

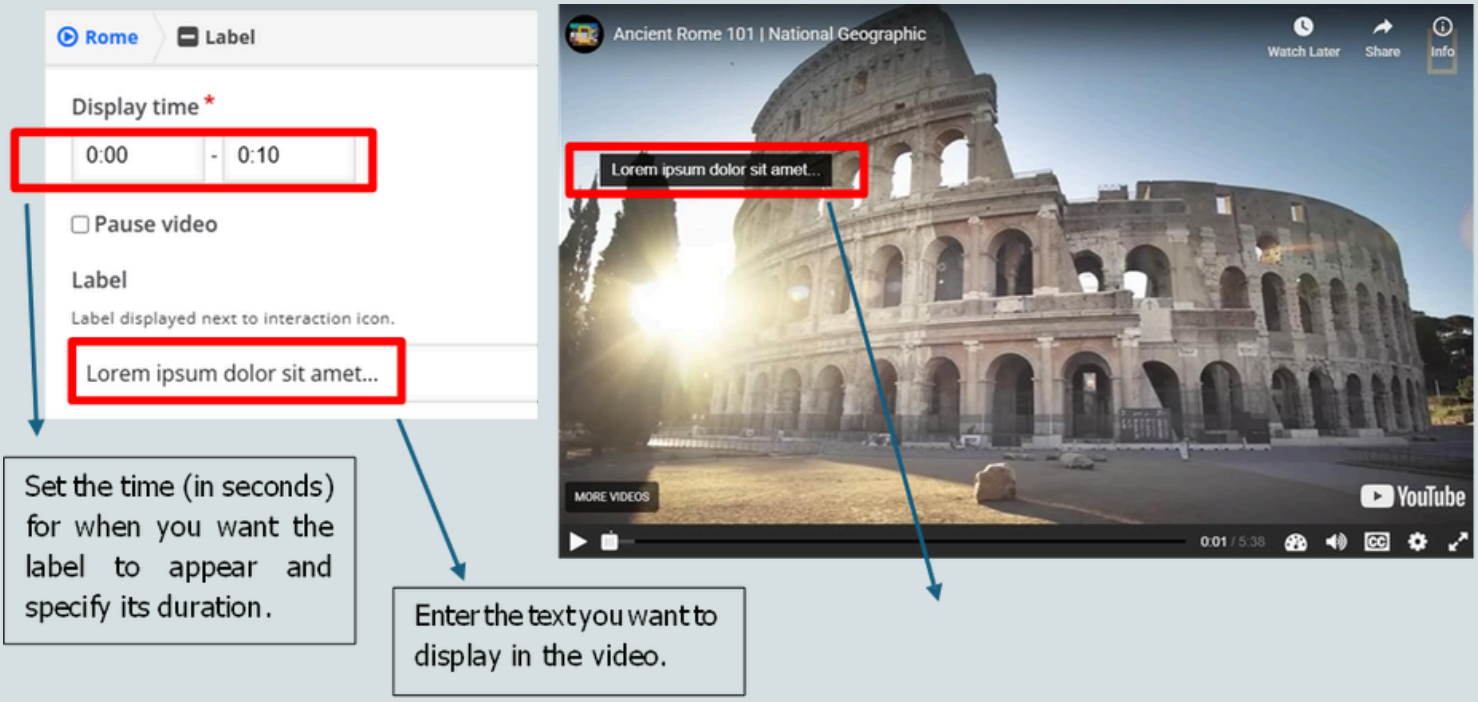
The types of interactions you can add are listed on the track above the video you have embedded or uploaded. Choose the ones you want to include based on your topic summary.

The following text describes features that may be useful to you, and it is up to you to decide if you want to include any additional ones.

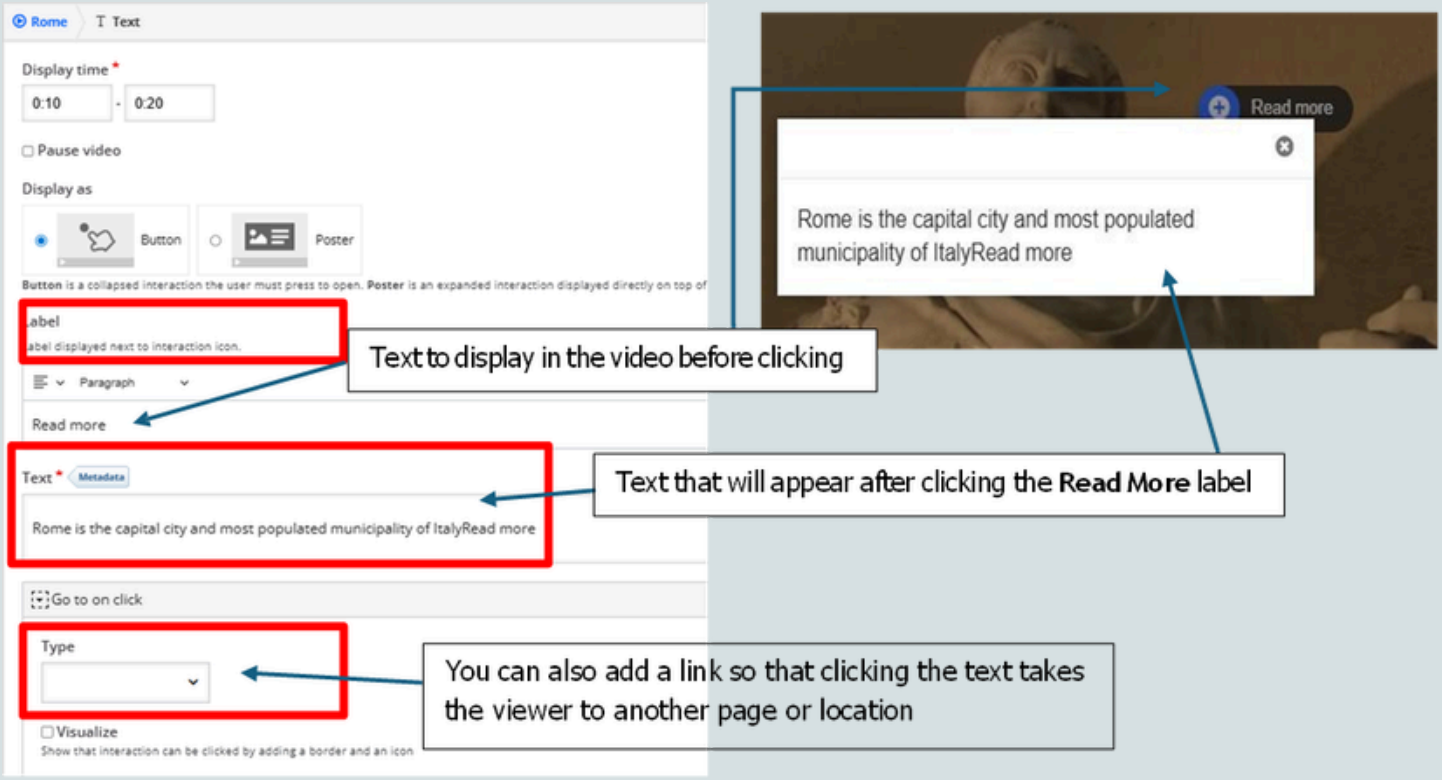


List of interactions:

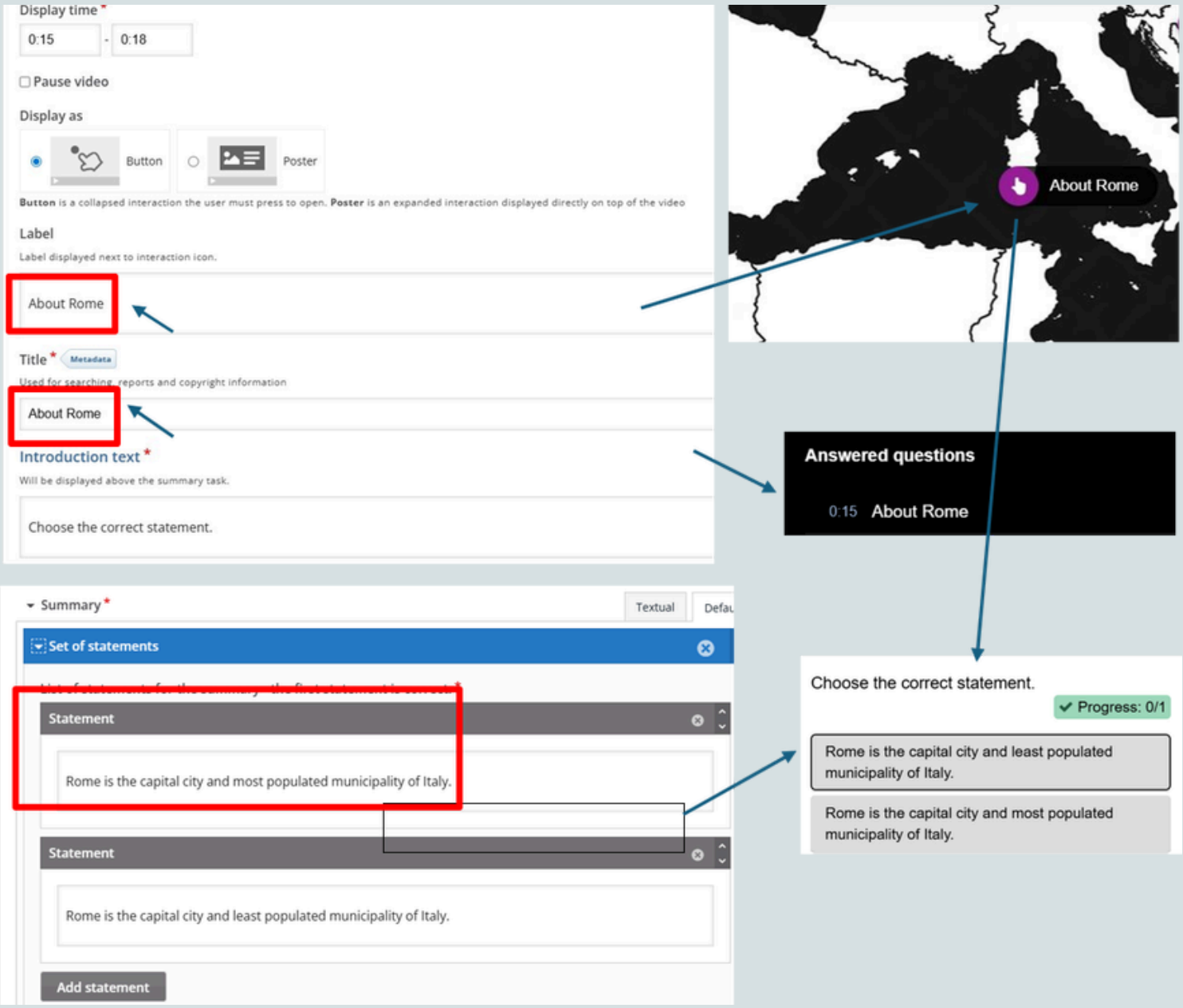
LABEL:

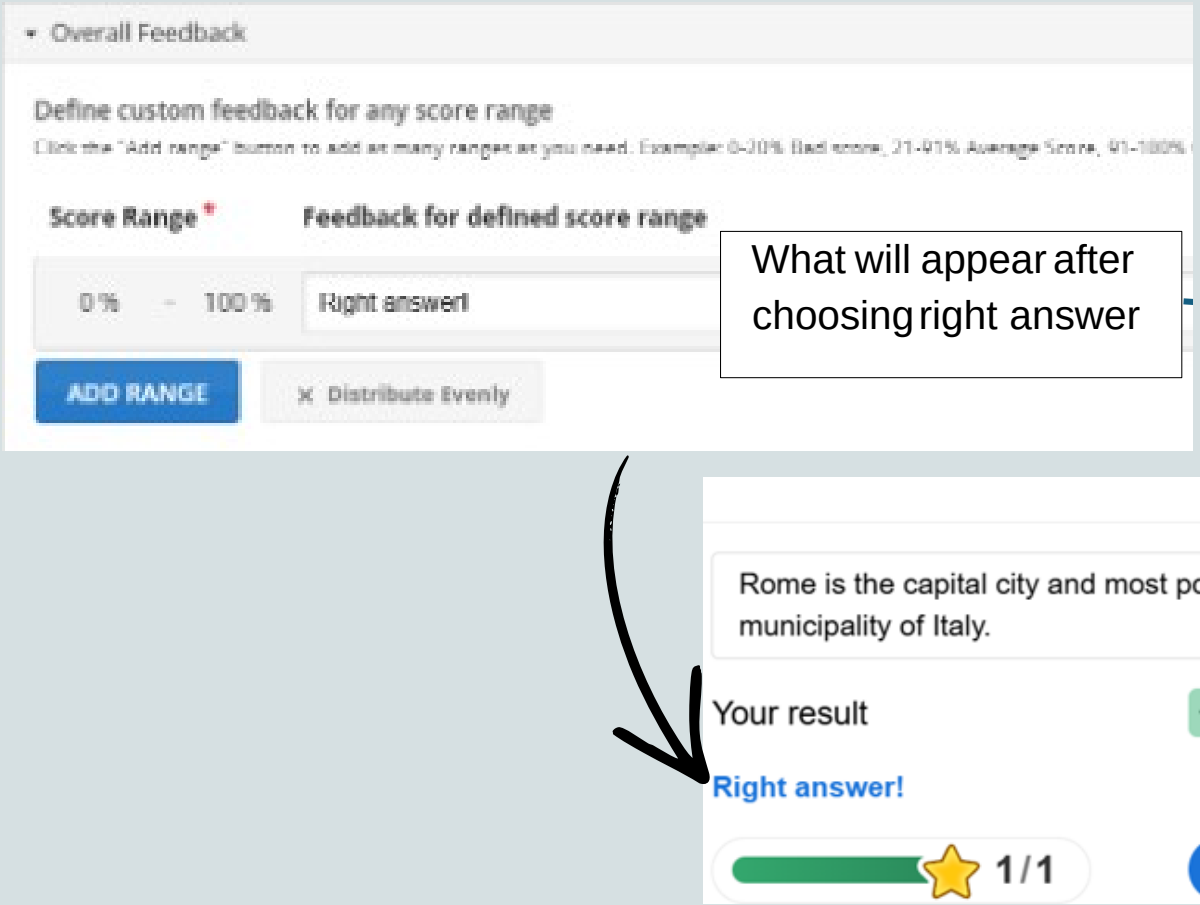


TEXT:

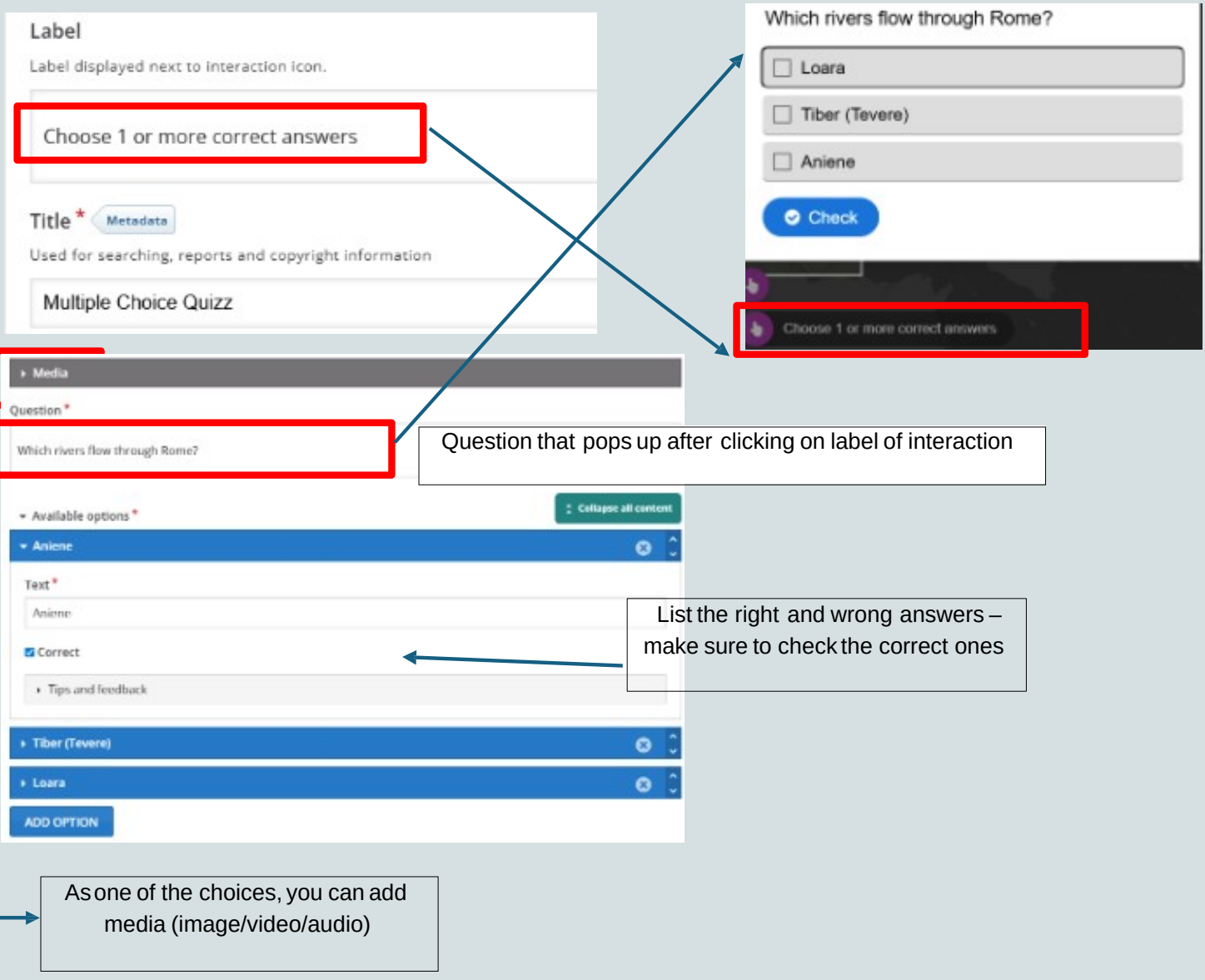


STATEMENTS:


Display time *
0:15
0:18
Pause video
Display as
Button
Poster
Button is a collapsed interaction the user must press to open. Poster is an expanded interaction displayed directly on top of the video
Label
Label displayed next to interaction icon.
About Rome
Title *
Metadata
Used for searching, reports and copyright information
About Rome
Introduction text *
Will be displayed above the summary task.
Choose the correct statement.
About Rome
Answered questions
0:15 About Rome
Summary *
Textual
Set of statements
Statement
Rome is the capital city and most populated municipality of Italy.
Statement
Rome is the capital city and least populated municipality of Italy.
Add statement
Choose the correct statement.
Progress: 0/1
Rome is the capital city and least populated municipality of Italy.
Rome is the capital city and most populated municipality of Italy.


Overall Feedback
Define custom feedback for any score range
Score Range *
Feedback for defined score range
0 %
100 %
Right answer!
ADD RANGE
Distribute Evenly
What will appear after choosing right answer
Rome is the capital city and most populated municipality of Italy.
Your result
Progress: 1/1
Right answer!
1/1
Continue

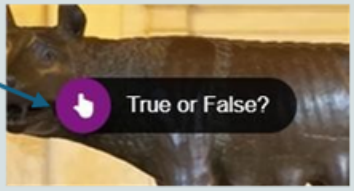
MULTIPLE CHOICE QUIZZ:

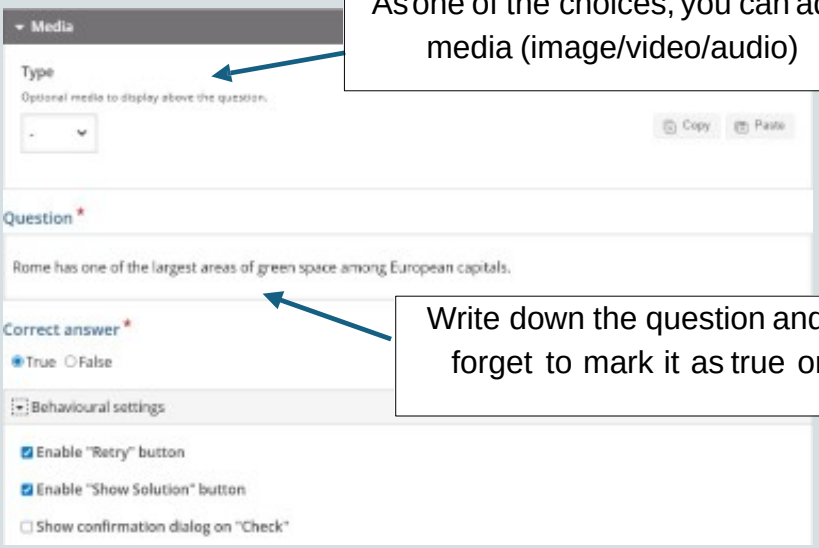


TRUE OF FALSE QUESTIONS:

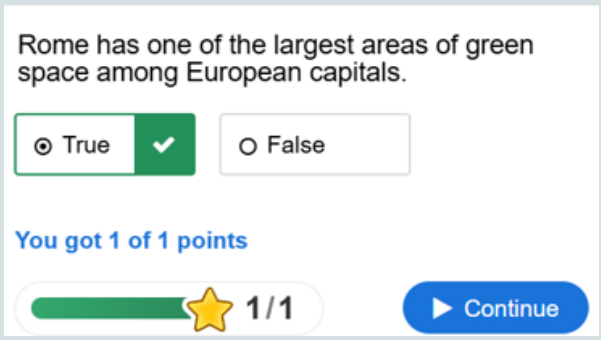


Label text + Title text



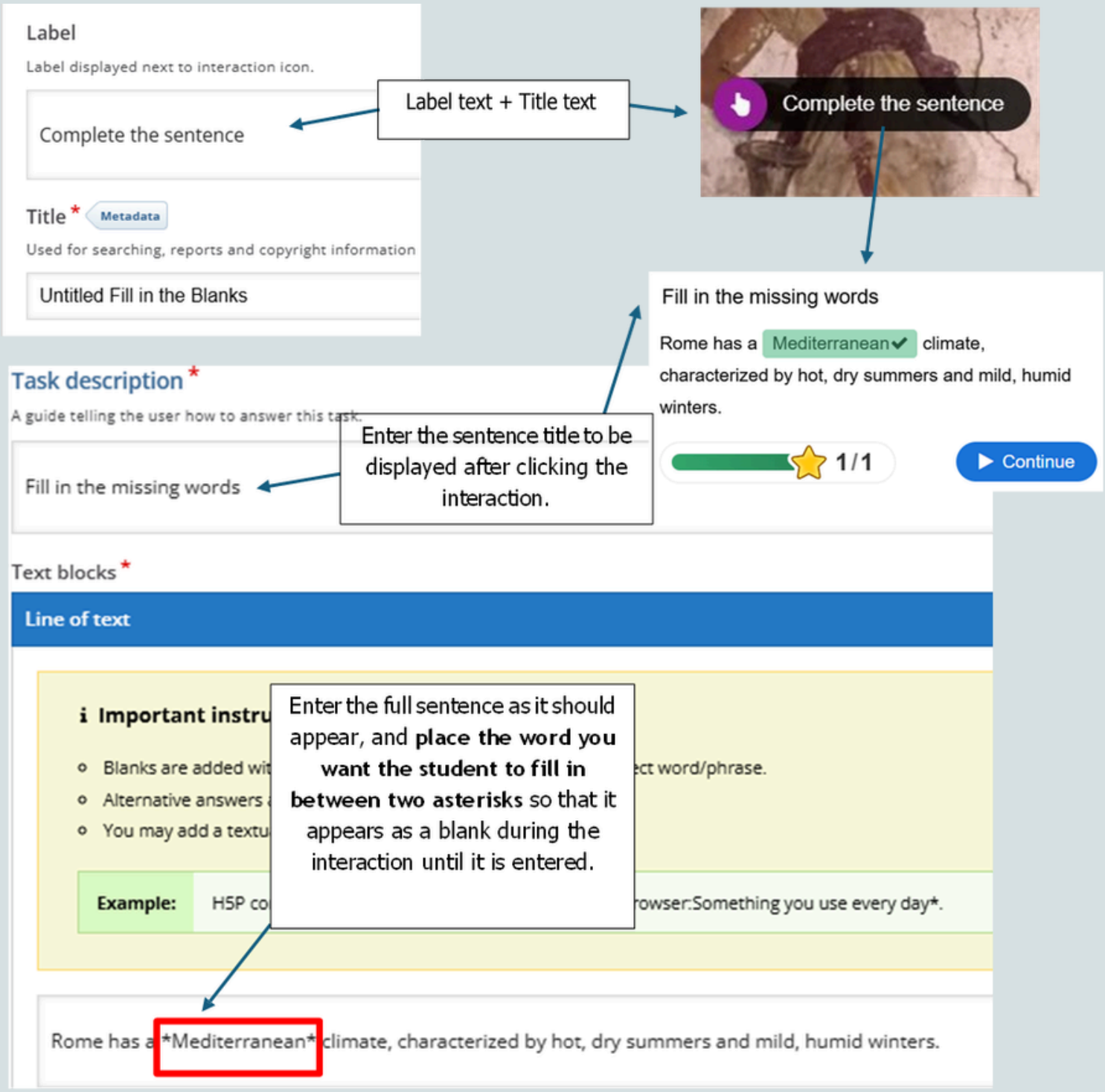


As one of the choices, you can add media (image/video/audio)

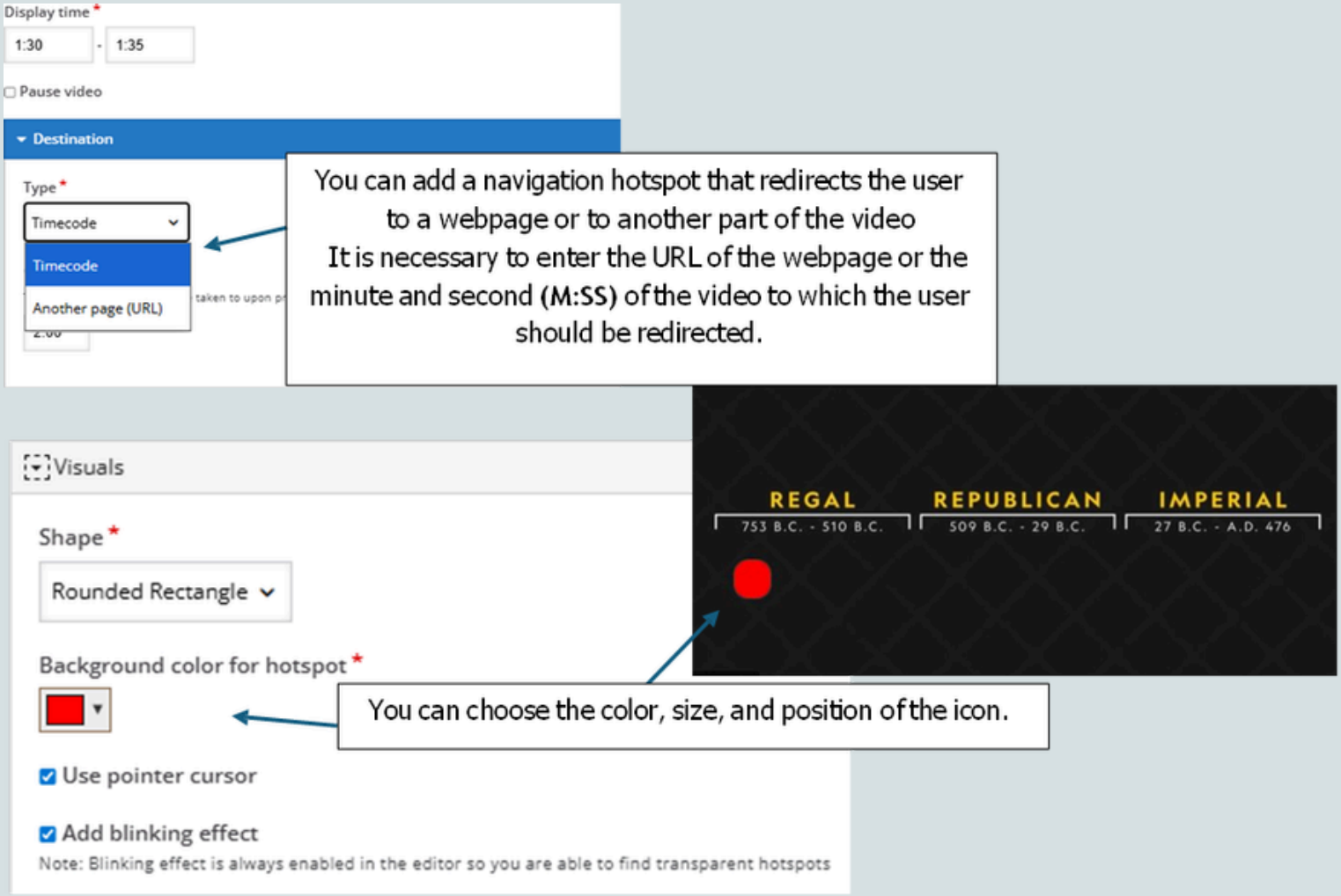


Write down the question and don't forget to mark it as true or false

FILL IN BLANKS:



NAVIGATION HOTSPOT:



Additional interactive elements can be implemented depending on the application version and specific use case. For further clarification regarding functionalities not covered in this document, please contact the author directly.

Creating a Virtual 360° Tour

For a detailed tutorial on creating a virtual tour using 360° images, please refer to this document.

Behavioural settings, Adaptivity and Text overrides and translations

The following two elements are part of every interaction:
Their purpose is explained further in the text; please adjust them according to your specific needs.

BEHAVIOURAL SETTINGS
Purpose: Behavioural settings in Lumio control how learners interact with your activities and how the system responds.
Key uses:

1. Feedback style – Decide if learners see immediate feedback (right/wrong) or only at the end.
2. Attempts – Set how many times learners can try a question or interaction.
3. Navigation – Allow learners to skip ahead, go back, or enforce sequential progression.
4. Scoring s completion – Define whether points are recorded automatically, whether partial credit is allowed, or whether learners must complete all steps to finish the lesson.
5. Hints and guidance – Optionally show hints when learners struggle or prevent skipping until the interaction is completed.

Why it matters: This controls the learning experience and ensures the activity behaves in a way that matches your teaching goals(e.g., practice vs. assessment).

TEXT OVERRIDES AND TRANSLATIONS
Purpose: This feature lets you customize the text labels, messages, or instructions in Lumio activities, including translating them for learnersin different languages.
Key uses:

1. Override default prompts – Change “Correct!” / “Incorrect!” messages to more personalized feedback.
2. Change button labels – Customize labels like “Next,” “Submit,” or “Try Again.”
3. Provide localized versions – Translate the activity into another language without changing the original structure.
4. Accessibility tweaks – Adjust text for clarity, readability, or tone suitable for your audience.

Why it matters: It allows your interactive content to match your audience’s language, tone, or accessibility needs without rebuilding the activity.

ADAPTIVITY
Purpose:
Adaptivity settings control what happens after a learner answers a question, and whether they are allowed to continue the video based on their performance.
These options are typically available inside Interactive Video when you add graded interactions (e.g., Multiple Choice, True/False, Fill in the Blank).

Action on all correct
This setting defines what happens **if the learner answers the question correctly** (i.e., achieves full score for that interaction).
You can configure an automatic action such as:

- Jump to a specific timestamp in the video
- Continue playback normally
- Redirect to another segment

Use case:
You can create branching scenarios. For example, if the learner answers correctly, the video skips remedial explanation and continues forward.

Action on wrong
This defines what happens **if the learner answers incorrectly**. Possible configured actions include:

- Jumping back to an earlier part of the video
- Showing additional explanation
- Allowing retry before continuing

Use case:
This is used for adaptive learning paths – learners who answer incorrectly can be redirected to review content before moving on.

Require full score for task before proceeding
When this option is enabled, the learner must achieve full score on the interaction before continuing the video.

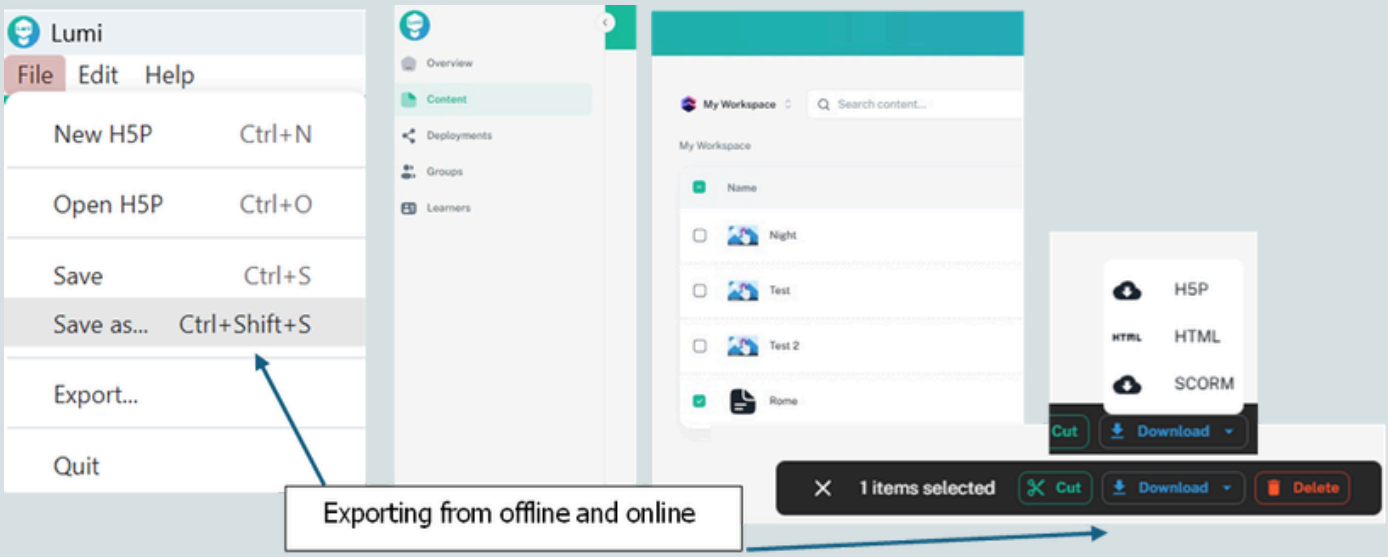
If they answer incorrectly:

- The video will not proceed
- ·They must retry until the correct answer is given (if retries are allowed)

Important technical note:
For this setting to work properly, it should be used together with:
"**Disable navigation forward in a video**" - If forward navigation is not disabled, learners could manually skip ahead using the progress bar, bypassing the required interaction.

Exporting content:

After you finish creating your interactive content in Lumio, you can export it in three formats, depending on your use case:



1. HTML

Purpose: For offline use or embedding in websites.
When to use: You want learners to access the content without an LMS, or inside the Oculus/Meta Quest browser. You want to host the content on your own website
Notes: Learners can interact with the content directly in a browser, but tracking of scores and progress will not be recorded.

2. SCORM
Purpose: For Moodle or other LMS import.

When to use: You want to track learner progress and scores. You want the LMS to handle completion, grading, and reporting
Notes: SCORM packages can include quizzes, interactive videos, and summaries. This is the recommended format for formal courses in Moodle.

3. H5P
Purpose: For direct import into Moodle or other H5P-compatible platforms.
When to use: You want to edit or update the content later inside Moodle. You want native H5P functionality, like branching and adaptive interactions.
Notes: H5P allows reusable content, which can be updated withoutre-uploading a full SCORM package. Tracking and scoring are also supported, similar to SCORM.

3. Working in MOODLE

This section gives you a practical orientation to Moodle: how to get around, find your courses and import H5P contentyou created in Lumi so it worksinside a Moodlecourse.

Moodle is an open-source Learning Management System (LMS) teachers use to host courses online, including lessons, quizzes, files, and interactive content. It provides tools to organizecontent, assess learners, track progress, and communicate with students.
Users log in with their credentials (usually provided by an institution), and once logged in, they land on a dashboard with their enrolledcourses.

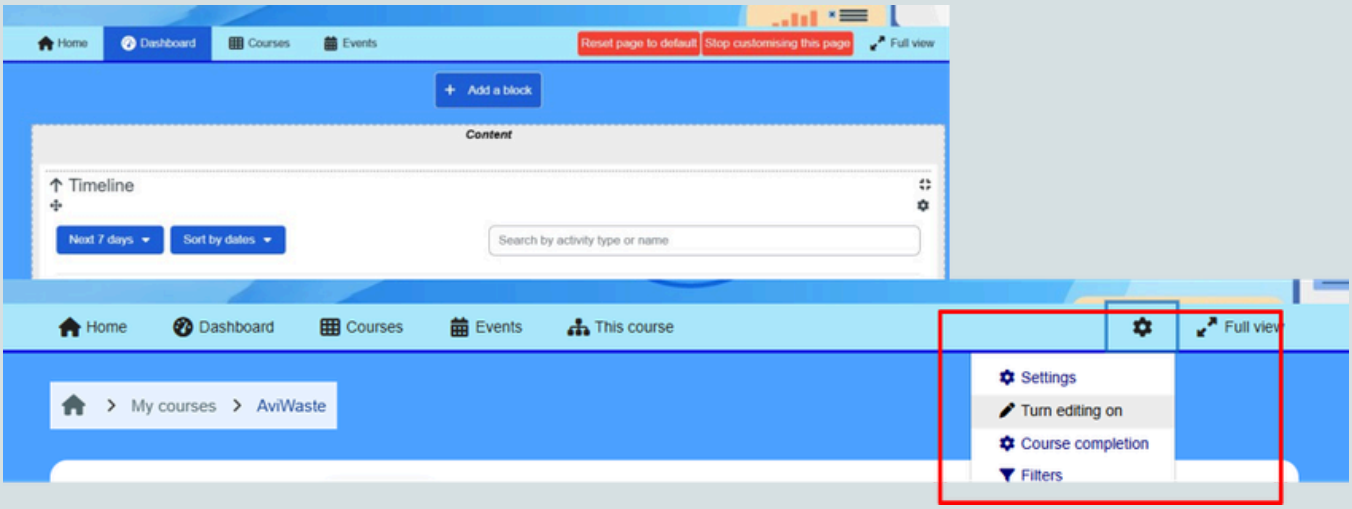
Basic Navigation in Moodle

Link to the platform for which user accounts will be provided to you, if they have not already been created.



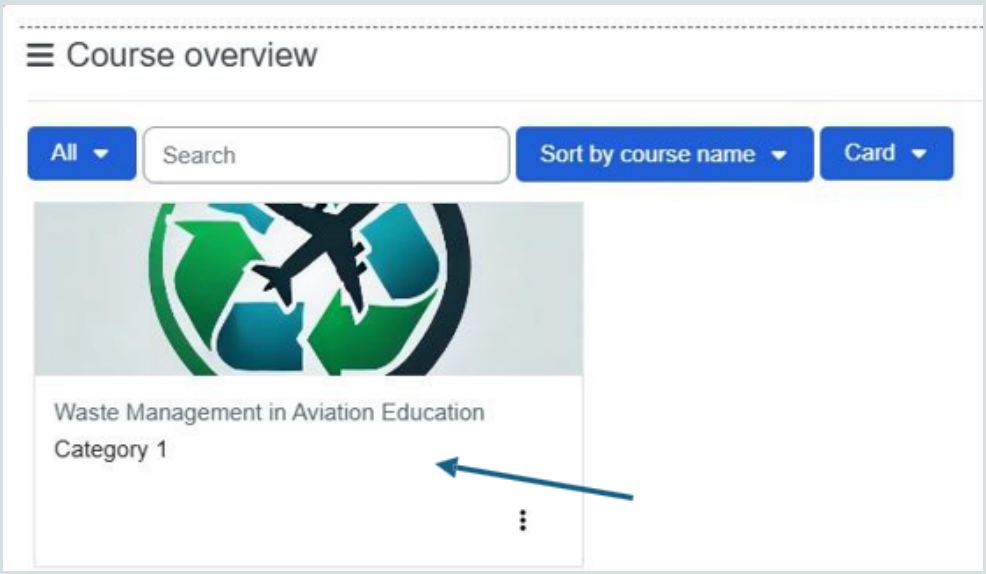
Here's how to find your way around once you've logged in:

Dashboard
Inside a dashboard, the screen is typically organized by sections or topics/weeks. Each section can contain activities or files (pages, assignments, quizzes, etc.). The editing toolbar appearsonce you turn editing ON.

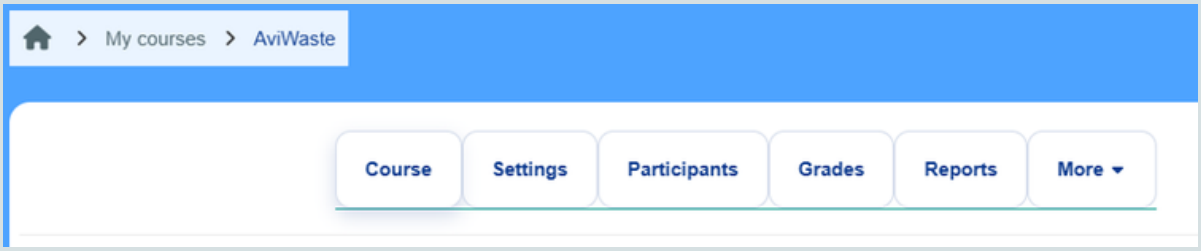


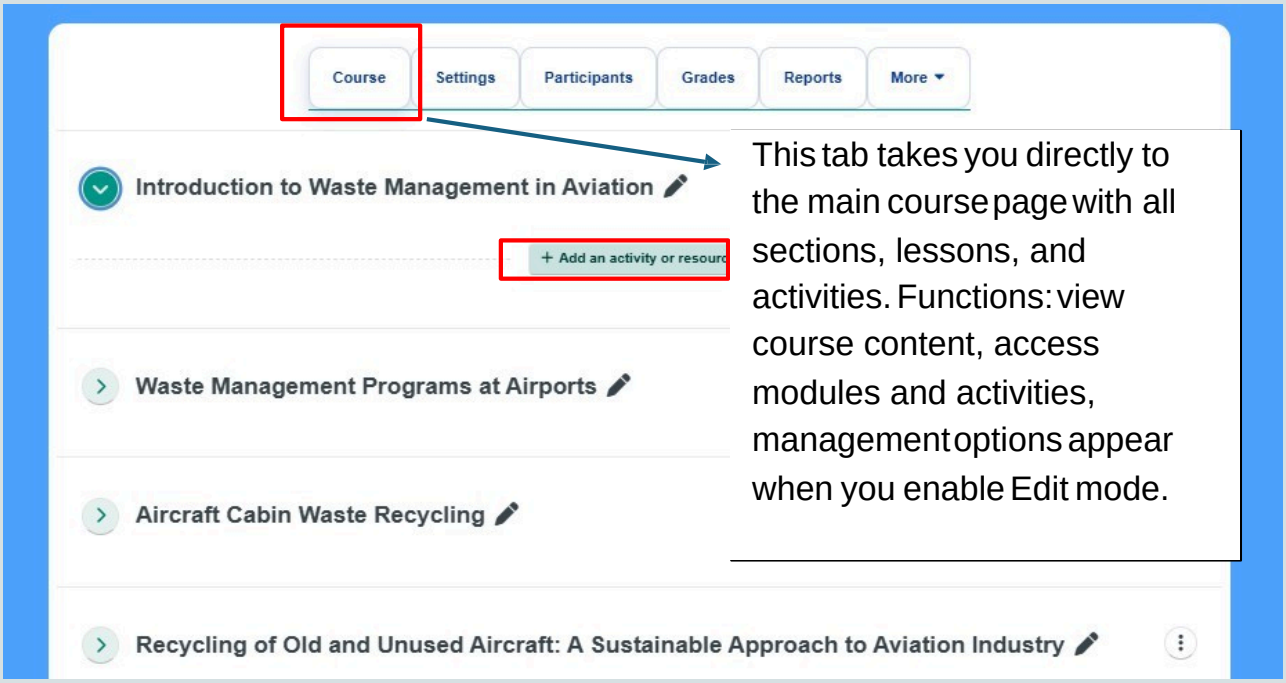
Course page

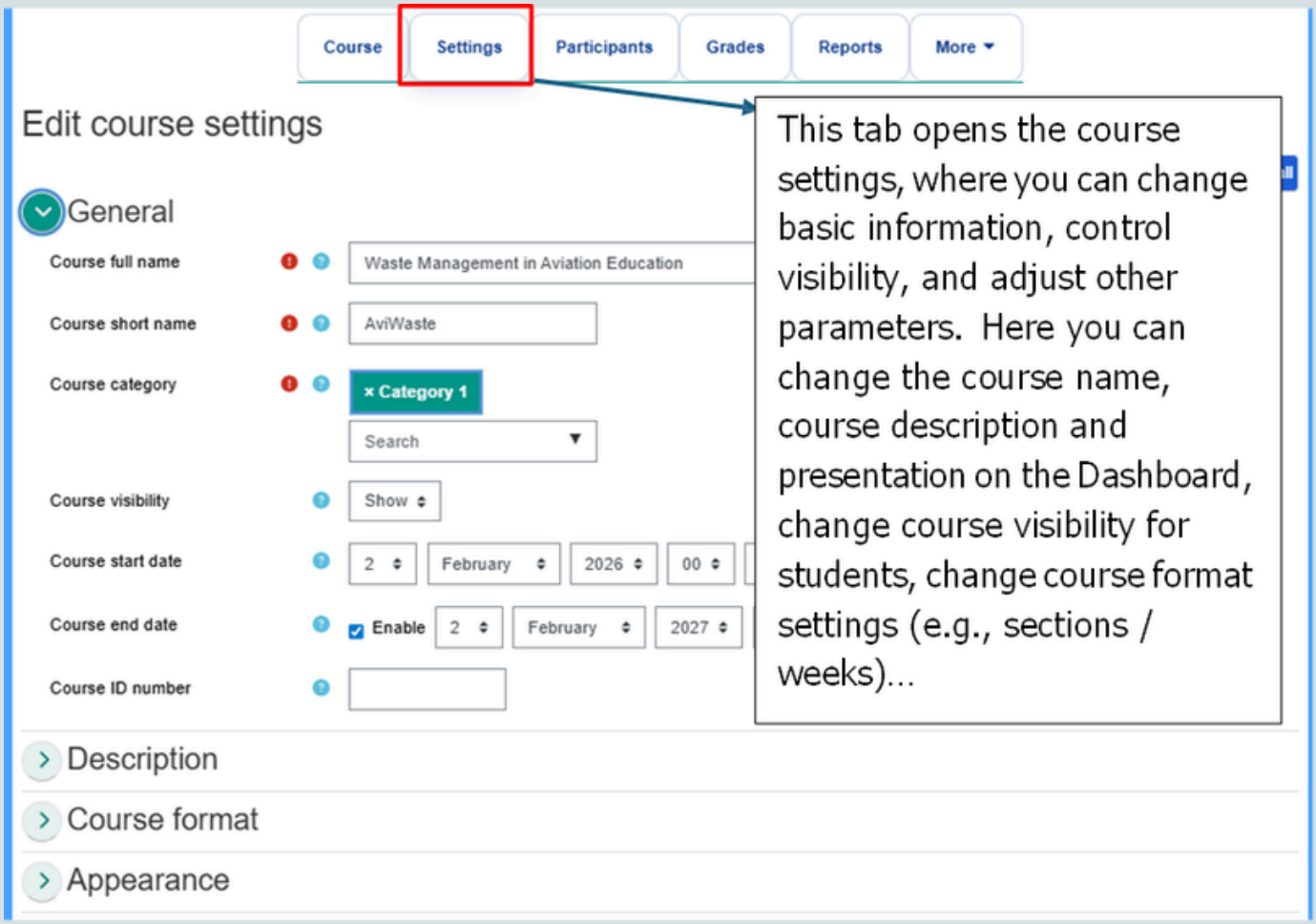
After signing in, you will see your courses - a list of courses you're enrolled in or teaching. From here, click on any course name to enter it.

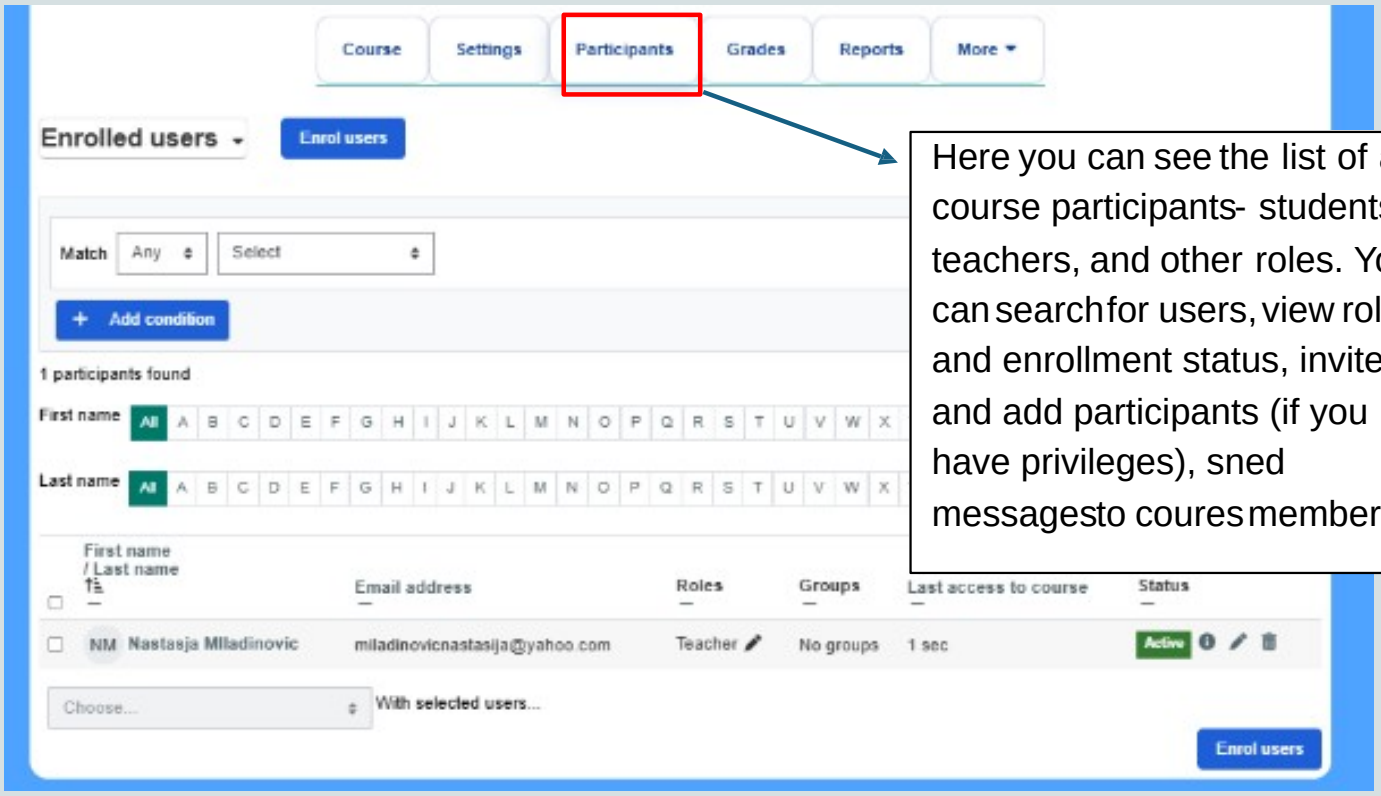


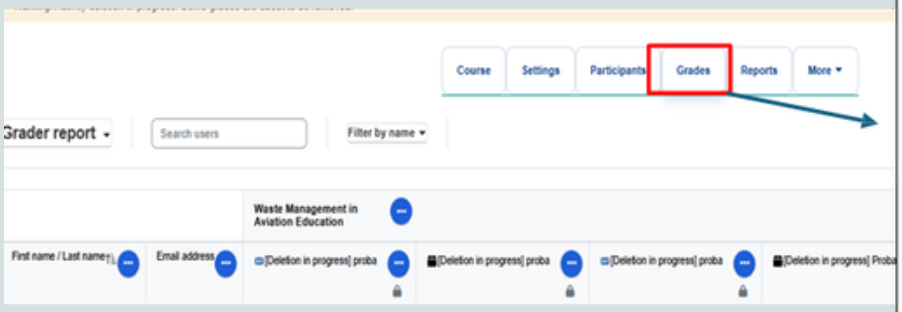
Click on the course of interest and with teacher role you will see the navigation bar shown in the printscreen bellow. The functionalities of each are explained in the further text.



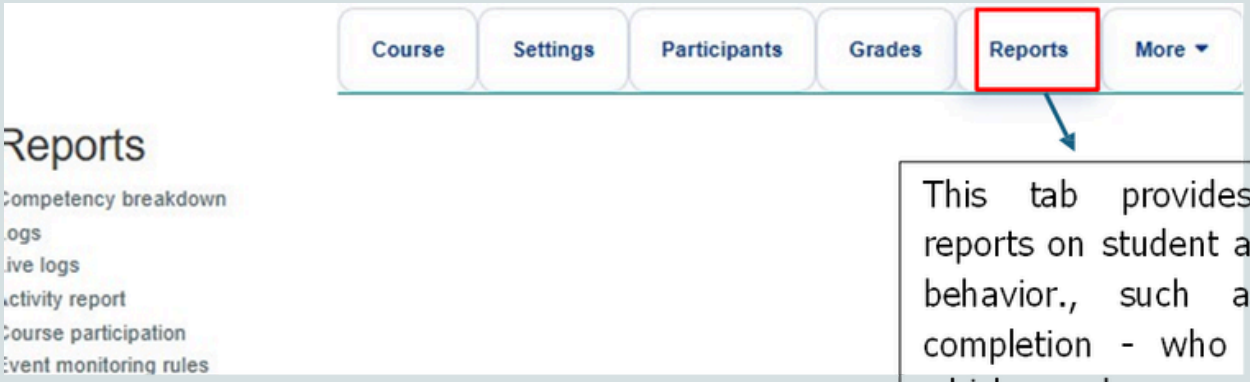



Course
Settings
Participants
Grades
Reports
More
Edit course settings
General
Course full name
Waste Management in Aviation Education
Course short name
AviWaste
Course category
× Category 1
Search
Course visibility
Show
Course start date
2
February
2026
00
Course end date
Enable
2
February
2027
Course ID number
Description
Course format
Appearance
This tab opens the course settings, where you can change basic information, control visibility, and adjust other parameters. Here you can change the course name, course description and presentation on the Dashboard, change course visibility for students, change course format settings (e.g., sections / weeks)...

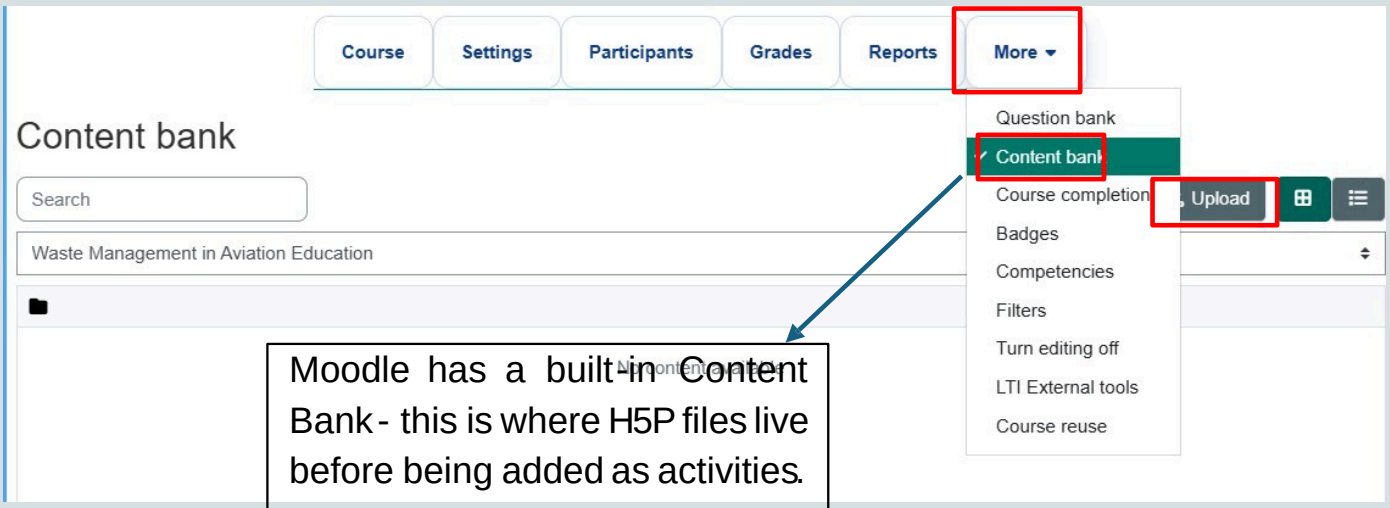

Course
Settings
Participants
Grades
Reports
More
Enrolled users
Enrol users
Match
Any
Select
Add condition
1 participants found
First name
Last name
First name / Last name
Email address
Roles
Groups
Last access to course
Status
Nastasja Mladinovic
miladinovicnastasija@yahoo.com
Teacher
No groups
1 sec
Active
Choose...
With selected users...
Enrol users
Here you can see the list of all course participants- students, teachers, and other roles. You can search for users, view roles and enrollment status, invite and add participants (if you have privileges), sned messages to coures members.



This tab allows you to track grades and results for all activities within the course. You can view students grades, configure grading methods, export grades to excel or CSV, enter grades for manual acitivites, etc.



This tab provides detailed reports on student activity and behavior., such as activity completion - who completed which lessons, course participation - who participated and when, logs -who did what and when, statistics - overview of interactions over time



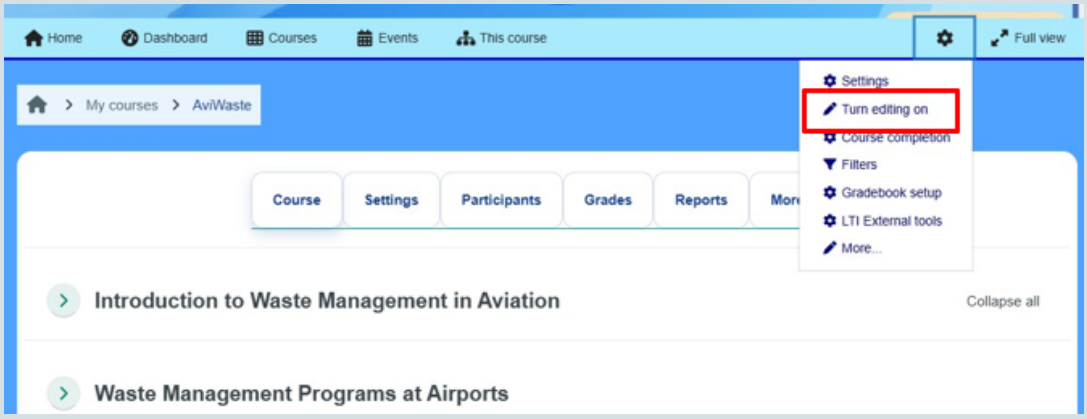
Moodle has a built-in Content Bank - this is where H5P files live before being added as activities. You can upload them and use them across different courses.

Adding content to a course

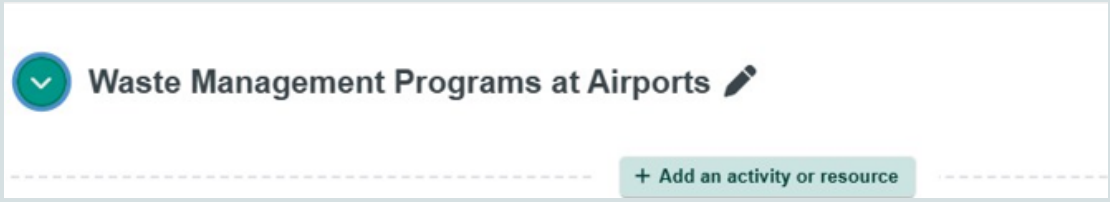
In this section, we will cover how to add content to a Moodle course and how to create content directly within Moodle. We will first go through adding exported content from external sources like Lumi, and then move on to creating content directly inside Moodle.

Adding Exported Content (H5P/SCORM from Lumi or other sources)

1. Turn editing on in your course.

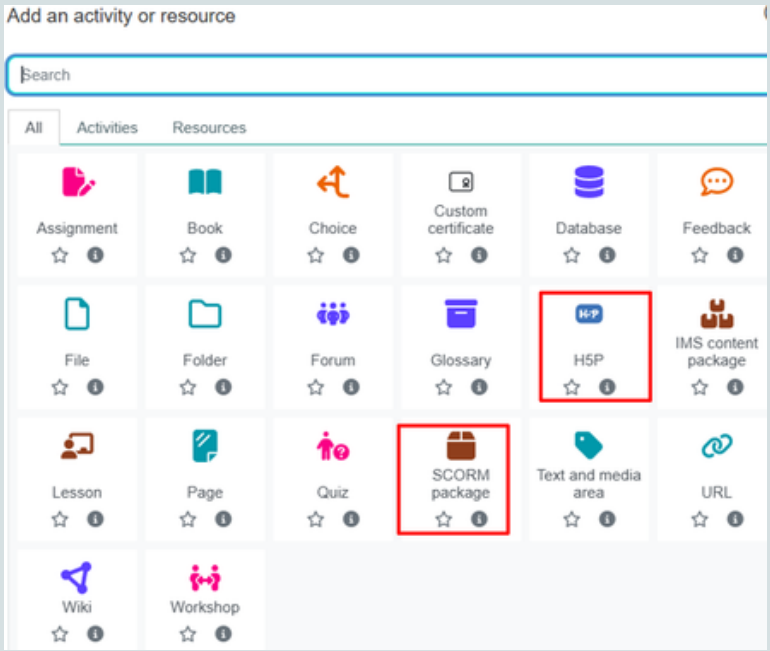


2. Navigate to the section where you want the content.
3. Click “Add an activity or resource.”



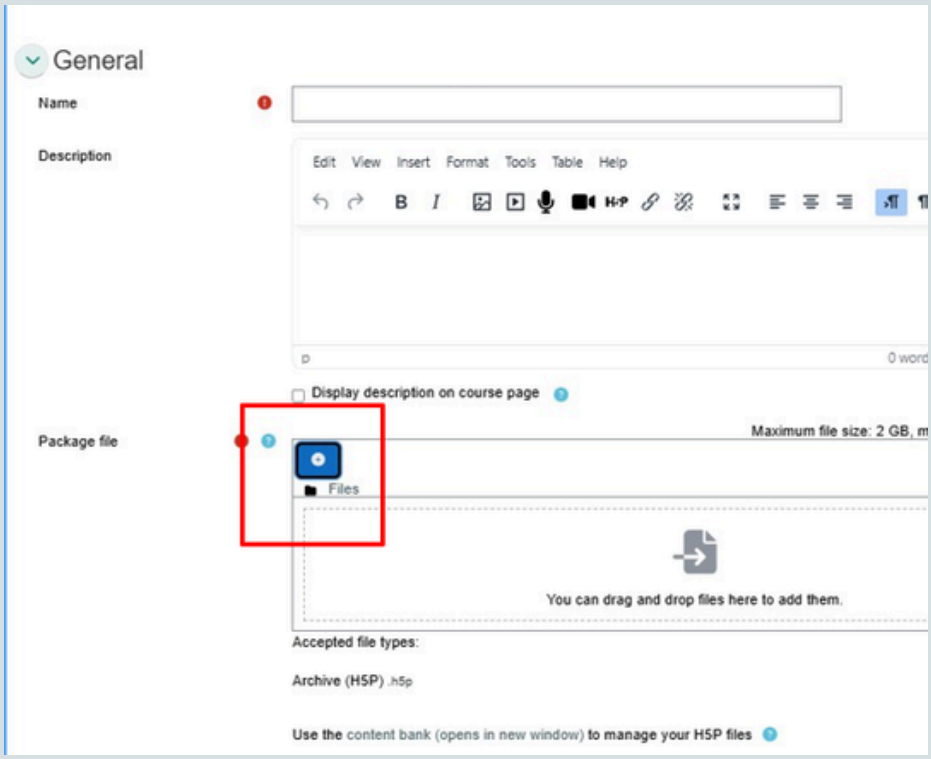
4. Choose the type of activity:

- oH5P (Interactive Content) for.h5p files
- oSCORM package for SCORM files (.zip)

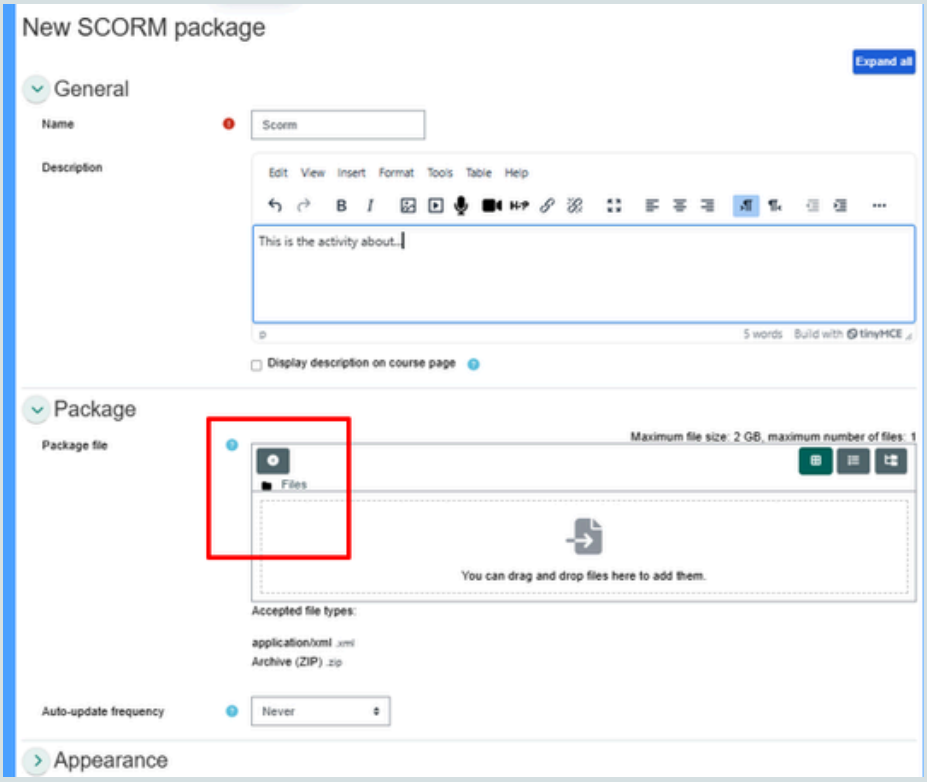


5. Upload the exported file:

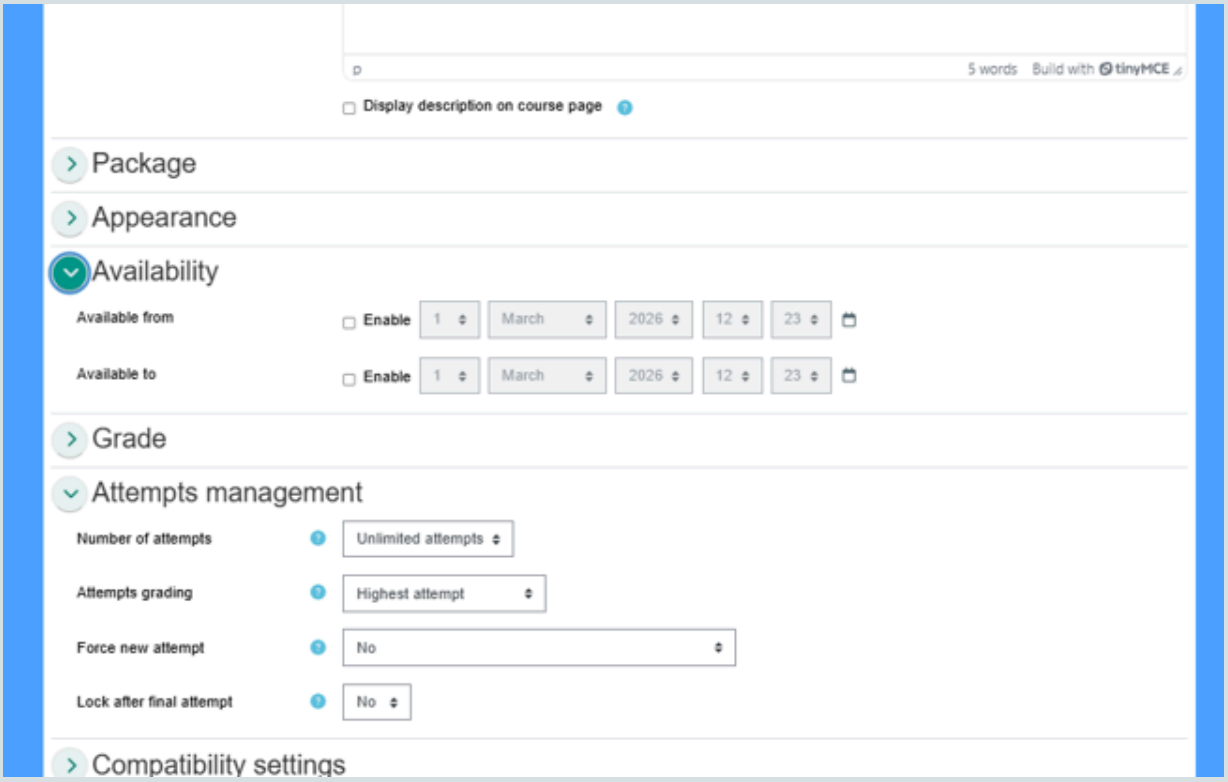
- For H5P:upload your .h5pfile using the file pickeror select fromthe Content bank.

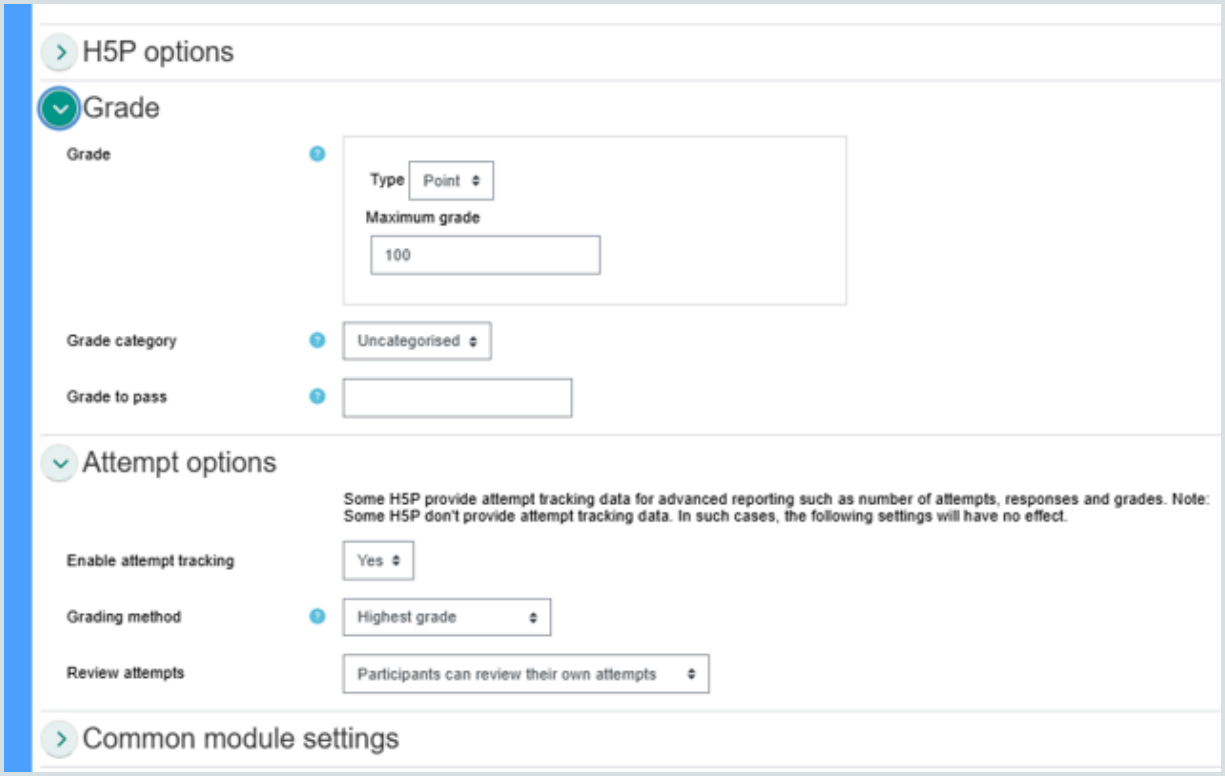


- For SCORM: upload the .zip package. Keep it zipped.



6. Configure activity settings as needed (name, description, grading, availability).

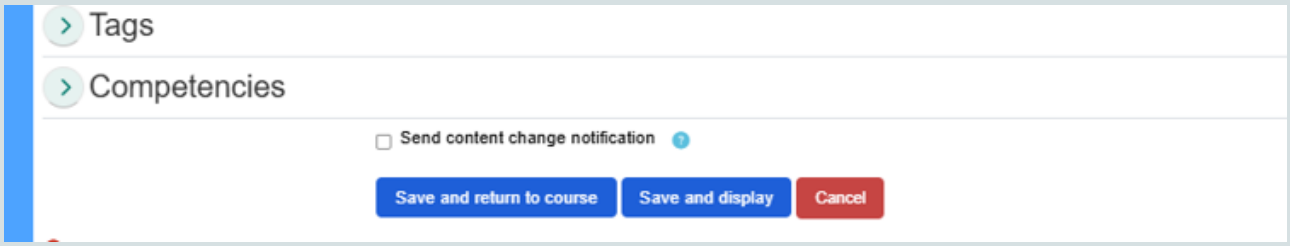




Completion conditions refer to whether a student must manually mark a lesson/activity as completed when they access it. You can set this option for any activity or resource you add to the course, allowing you to track which students have completed specific tasks.



7. Click **Save and return to course.**



Notes: Students will access the activity from the Course tab. Grade sand completion tracking will appear in the Grades and Reports tabs, as explained in the previous section.

Creating Content Directly in Moodle

Moodle also allows you to create interactive content directly, without exporting from external tools:

1. Turn editing on in the course.
2. Click “Add an activity or resource”.
3. Choose the activity type you want to create, for example:

- Page – for text, images, or embedded content.

Note: This activity is ideal for listing references or additional resources (some YouTube links, etc.) within your module or lesson

- Lesson – for step-by-step learning activities
- Quiz – for interactive questions

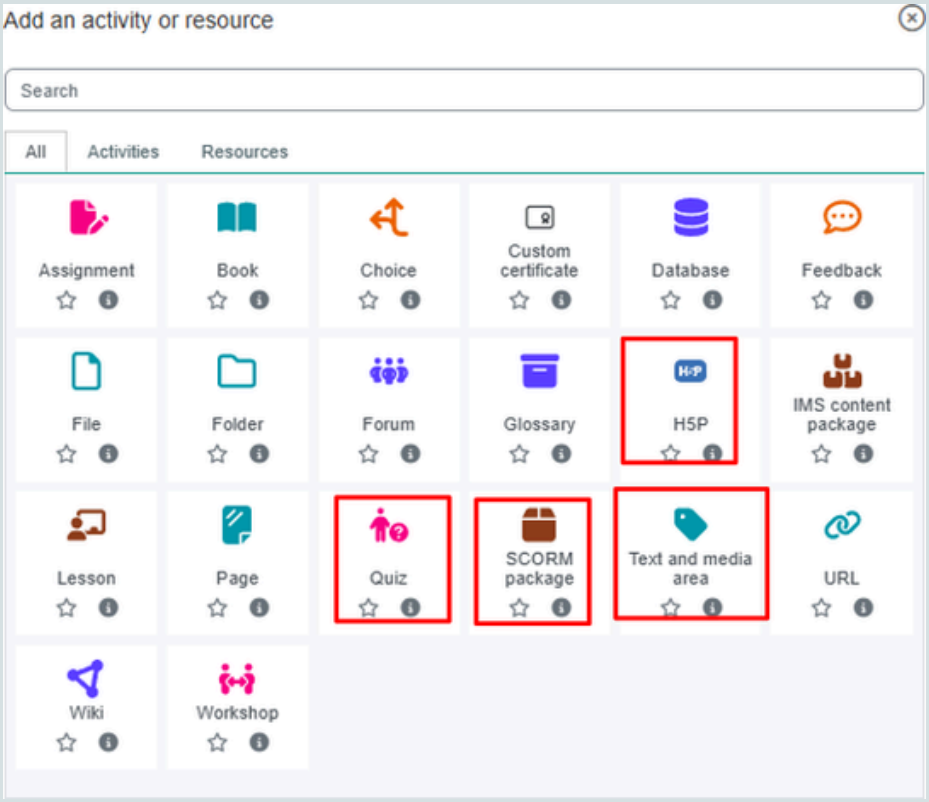
Note: This activity is ideal for an end-of-the-course test or course feedback at the conclusion of the module.

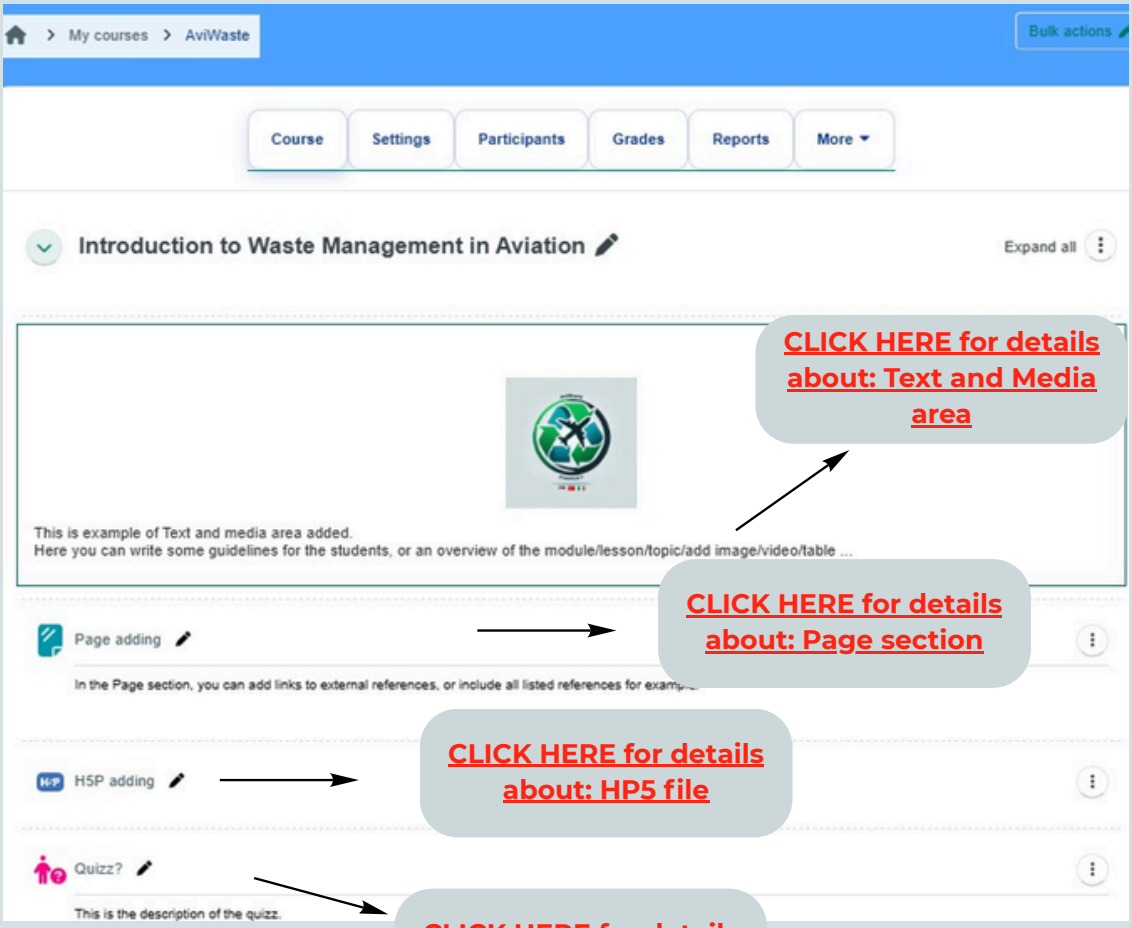
- H5P – if you have the H5P plugin installed, you can create content directly in Moodle

4. Fill in the required fields: name, description, content.
5. Adjust settings like grading, availability, and completion tracking.
6. Click “Save and return to course”.

Notes: This approach is ideal for creating content on the fly without exporting files from external tools like Lumi.

An exampleof activities added directly in Moodle is provided below. Please feel free to contact me if any step is unclear.





Text and media area

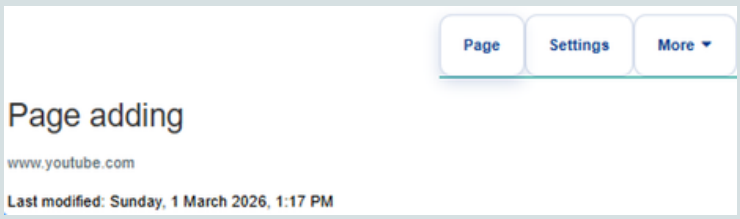
The Text and media area is a versatile Moodle resource that allows you to act as a spacer between resources on a course page,embed banners, images, sound, or video onthe course page. It is primarily used to enhance the visual layout of a course and provide in-line multimedia or text content without creating a separate activity.
How to use it?
Enable editing in your course and add a Text and media area from the “Add an activity or resource” menu.

- Add content using the text editor:
- Enter text and links (text in the example shown).
- Insert images by dragging them or using the “Add image” option (AviWaste logo in example)
- Add audio or video if multimedia filters are enabled.
- Save and return to course to display the content inline.

Page section

A Page resource in Moodle lets the teacher create a web page within a course that displays content created by the teacher. It functions as a standalone page students click to open. The content can include: text, images, audio/video, etc.
All of this is added using Moodle’sText editor. Pages are generally more accessible and easier to view onlinethan uploading separateWord or PDF documents.
How to use it?
With editing turned on in a course, choose Page from “Add an activity or resource.”

- Enter a Name (title) and optional Description.
- In the Content area, add the text, images, media, links, or embedded content you want displayed.
- In Appearance, you can choose whether to show the “last modified date.”
- Save and display the page
- Students then click the link on the course page to view the content.

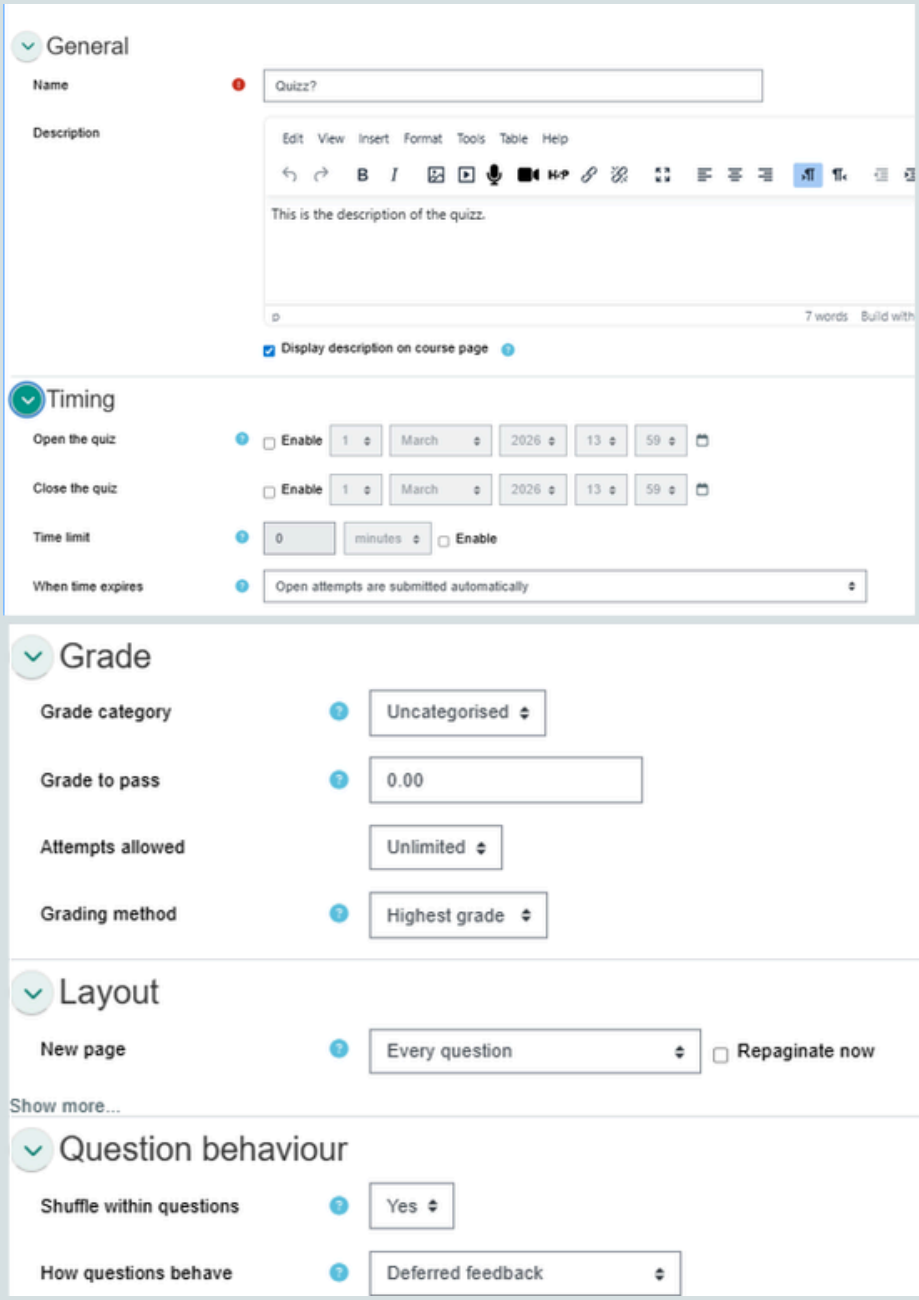


Use Page when you want students to open a *dedicated* screen for lengthy text or multimedia. Better than uploading simple documents when the content is meant to be read online. Teachers can edit the page later by opening it and selecting *Settings*.

Quizz activity

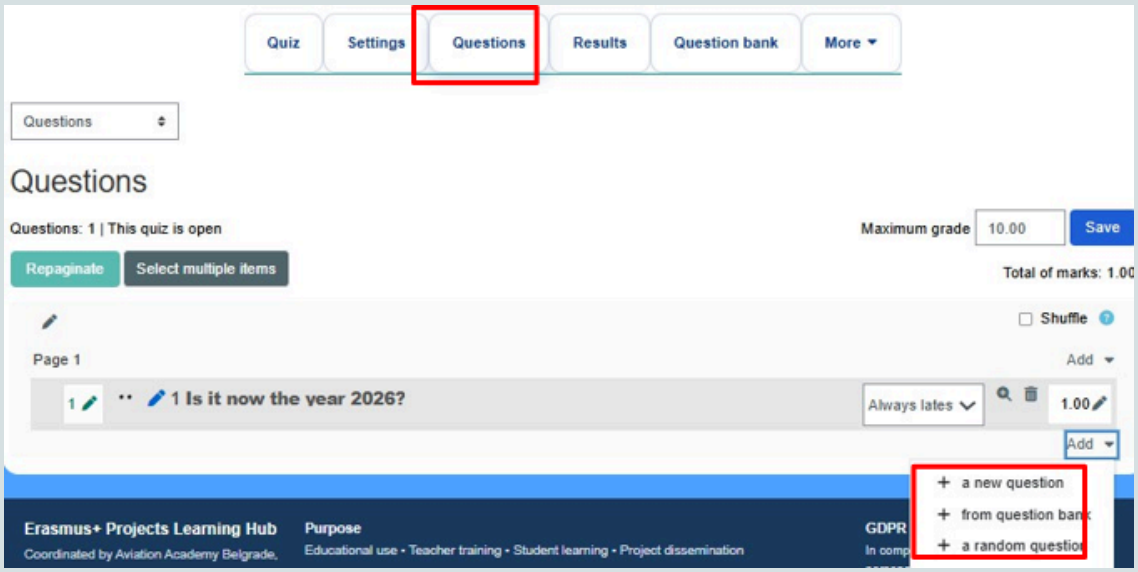
The Quiz activity in Moodle is a powerful assessment tool that allows a teacher to create and deliver quizzes to students. It supports a variety of question types and integrates with the Moodle Questionbank for reuse.
With editing turned on, add a Quiz from the activity chooser.

- Name the quiz and add an optional description.
- Configure settings such as time limits, layout, attempts, and feedback.



- Save and display the quiz.

- Click *Edit quiz* to add questions from scratch, from the question bank, or randomly from categories.



- Select the question type you want to put in



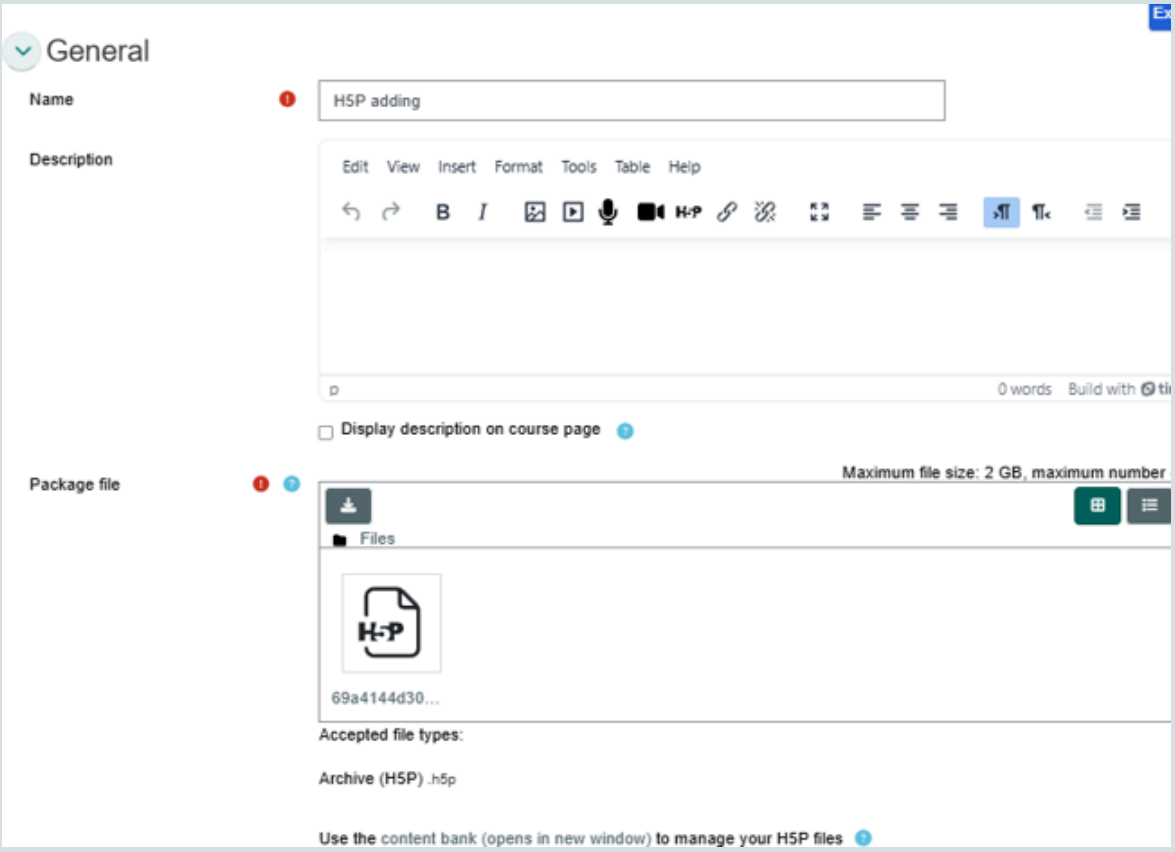
- Teachers can allow students to navigate between questions freely or one per page.
- Students completethe quiz and click Submit all andfinish to record attempts.
- Depending on settings, scores and feedback may be shown immediately or later.
- Teachers can view attempts and results via the quiz's reports.

Note: Questions are stored in the Question bank and can be reused.Supports a range of question types (e.g., multiple choice, short answer, true/false). Settings control timing, layout, feedback, and attempts. Automatic scoring (except for certain types like essays) and integration with grades.

HP5 Activity

In a course with editing turned on, choose “H5P” from the activity chooser.
How to use it?

- Give the activity a name and (optionally) a description. Under Package file, use the file picker to add your H5P file either from your computer or from the Contentbank.



- Adjust the settings in the othersections as needed, then click Saveand return to course.

Students click on the **H5P icon**/link in the course to launch the activity. Depending on the type of H5P content and settings, the activity may be gradable.
Students’ attempts and whether they completed the activity are shown in the **Attempts report** within the H5P activity.
The **Attempts report** shows success (e.g., achieving 100 %) and completion (going through the content fully), but this report is separate from Moodle’s Gradebook and Activity completion settings.
Teachers can view **all student attempts and results** via the Attempts report inside the H5P activity. The number shown corresponds to total attempts, not necessarily the number of students.

4. Managing VR Device Memory and Deploying Offline

HTML Content

This section is necessary in order to open and use the interactive content you create (including video recordings and 360° images)offline through the VR equipment you have available (such as Meta Quest 2/3, etc.)

Understanding Device Memory Architecture

Standalone VR headsets operate on an Android-based system and use two distinct types of memory:

RAM (8 GB)

RAM is used for real-time application execution and it is not manually accessible or user-manageable. Performance depends on content complexity. Large 360° videos, high-resolution textures, or complex WebGL scenes may cause lag or instability. RAM determines runtime performance but is not used for storing files.

Internal Storage (512 GB)

Internal storage is used for: installed applications, downloaded files, locally stored educational content (HTML packages, 360° images, videos, etc.). This is the storage location where exported Lumi HTML content must be copied for offline access.

Preparing HTML Content in Lumi

After exporting the content from Lumi as an HTML package (as explained in the section Exporting Content), you can proceed with transferring it to your VR device for offline use.

Important:

If you export it as .h5p file, you cannot opened directly on a VR headset without an LMS (e. e.g., Moodle – accessed through the Meta Quest browser). For offline VR deployment, you must export as a standalone **HTML** package.

Follow these steps after preparing your content in Lumi:

1. Open your project in Lumi
2. Select Export
3. Choose HTML (Standalone Package)
4. Save the exported folder/html file

If it is exported as a folder, it must contain: index.html, JavaScript files, asset folders (images, video, 360° content). **All files must remain inside the same directory**. Do not separate them. If it exports just the .html file, itself is enough.

Offline Verification (*critical step*)- check this before transferring to VR:

1. Disable internet on your computer
2. Open index.html locally
3. Confirm that all content loadscorrectly

If any element fails to load, the project contains online dependencies and will not function offline.

Transferring HTML Content to the VR Headset

Method 1 – USB transfer (recommended)

1. Connect the VR headset to a computer using a USB-Ccable
2. Put on the headset
3. Select Allow File Access
4. The device appears as an external storage drive
5. Navigate to: InternalStorage → Download or create a dedicated folder: Internal Storage → VR_content
6. Copy the entire exported HTML folder/file if only that is exported Do not rename internal files.

Method 2 – Wi-Fi Transfer: If file management applications are installed:

- Google Drive (for example, you can upload the exported folder to a shared AviWaste Drive link and access the HTML content directly from that Drive within the VR browser)
- Dropbox
- ·Local file-sharing apps

Upload the HTML folder → download it inside the headset → Store in Internal storage.

USB transferis more stable and recommended for institutional deployment.

Launching the HTML Tour Offline in VR

Because the content is standalone HTML, it must be opened via a browser. On Meta Quest devices, use: **Meta Browser** (built-in browser)

Opening via File Path	File Manager Launch
Open Meta browser. In the address bar enter: file:///sdcard/download/folder_name /index.html *link is changable depending on how you named folders and .html content The tour will launch completely offline.	Open a file manager application and navigate to the folder. Select index.html

Storage considerations
With 512 GB internal storage: space capacity is not a primary limitation and performance will depend more on file optimization than storage size

Fully Offline Operation Requirements
To sum everything up: for a VR tour to function offline: all assets must be local, there should not be external CDN links or online API calls, no embedded streaming content. If any element requires internet, the experience will fail withoutWi-Fi.

Online use – via LMS (Moodle)
If using an LMS such as Moodle: upload .h5p file - access via browser - open course directly in VR browser - launch H5P content online. This method requires constant internet access and is not offline-compatible.

END OF GUIDEBOOK

13. R3 - Toolkit

This Toolkit is the third and final project result. It serves as a comprehensive reference resource that brings together all key aspects of the AviWaste project: the environmental context, the regulatory framework, best practices from partner countries, project activities and mobilities, and guidance on using the MOOC and VR resources.
The Toolkit is intended for use by:

- VET teachers integrating waste management into aviation curricula
- Students seeking a comprehensive reference on aviation waste management
- School administrators planning environmental education initiatives
- Industry partners and associated organisations interested in educational collaboration
- Policy makers and educational authorities seeking models for sustainability integration in VET

The Toolkit has been translated into Serbian, Turkish, and Italian. It is available on the AviWaste MOOC platform.

14. Mobilities

Transnational project meetings (TPMs) and Learning, Teaching and Training (LTT) activities are central to the AviWaste project. They enable partners to make decisions by consensus, share expertise, and build the collaborative relationships that underpin the quality of project outputs.

14.1. TPM1 - Antalya, Turkey

The first transnational project meeting was hosted by Aksu Ucak Bakim Teknolojisi MTAL in Antalya. The meeting brought together all four partner organisations for the first time.

Participants included: Gulşen Topçu, Ayşe Demirci, Ali Kocaali, Gökhan İlçiktay, and Muhammed Denizli from Turkey; Loredana Caruso and Danielle Nuzzolese from Italy; and Danijela Manic, Isidora Milosevic, Petar Milosevic and Nastasija Miladinovic from Serbia (InterEdu).

Key Decisions from TPM1:

1. A document with defined topics and learning objectives for the course would be prepared. Turkey would prepare the framework template and Aviation Academy Serbia would prepare the evaluation criteria before the end of the year. The evaluation criteria document would be ready by January 2025.
2. A PDF document containing all selected materials (maximum 3 pages per topic) would be ready by June 1, 2025. Each topic's materials must include bibliography and source references. Digital tools and apps would also be researched and selected by this date. Materials to be evaluated by English teachers and VET teachers; associated partners to be consulted. All materials to be sent to InterEdu for final compilation.
3. The Learning, Teaching and Training (Train the Trainer) mobility in Belgrade was confirmed for 5–9 May 2025, covering: VR Hardware and Software Overview; Pedagogical Principles of VR Integration; VR Content Creation for Education; and Classroom Management Strategies for VR Experiences. One draft lesson per country to be completed before the LTT.









ANTALYA, TURKEY

14.2. LTT - Belgrade, Serbia

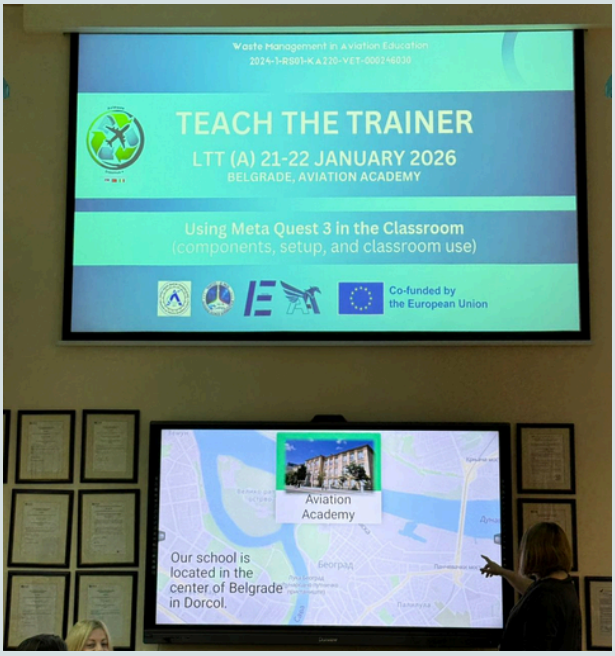
The Second Transnational Project Meeting was held in Belgrade alongside the LTT activity. Partners from Serbia, Turkey, and Italy reviewed progress, aligned on remaining deliverables, and planned the final phase.

Key Results Confirmed

- Main outcomes remained on track: the Moodle online course, the VR virtual tour, and the teacher toolkit.
- The final test was set to 20 questions with three attempts allowed for certification.
- Entry surveys and student VR perception polls were established.

Final Activities

- Course piloting was conducted with students from partner institutions to gather data for final improvements.
- Lesson plans, curricula, and key teaching materials were translated into Turkish, Italian, and Serbian.







BELGRADE, SERBIA

14.3. TPM2 - Rome, Italy

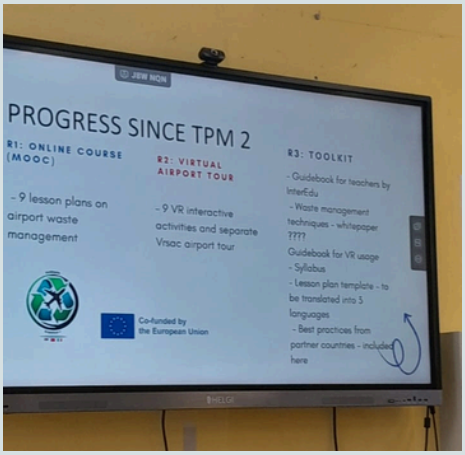
The Third and Final Transnational Project Meeting was held in Rome in May 2026, hosted by Istituto Tecnico Trasporti e Logistica Francesco De Pinedo. The meeting brought together all partners for a comprehensive review of all project results, evaluation feedback, piloting planning, and final coordination ahead of project closure in July 2026.

Progress on Project Results

All nine lesson plans for the MOOC were confirmed as completed and hosted on the Erasmus+ Learning Hub. Each lesson follows a learning-outcome-based methodology incorporating clear lesson sequencing, structured workload estimation, practical examples and case studies, and self-assessment support. Key competences integrated across the course include green competences, digital competences, critical thinking, problem-solving, language competences, and social skills.

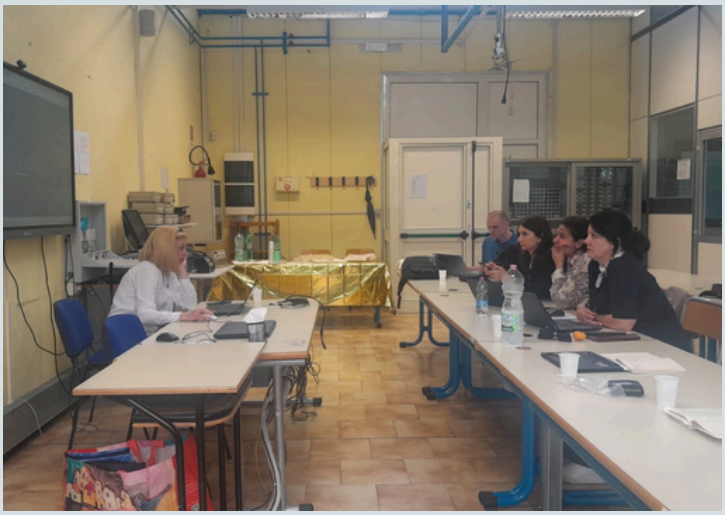
The Virtual Airport Tour was implemented as a full virtual tour of Vršac Airport, covering general airport knowledge, a short history of the airport, sustainability practices, waste management procedures, and real airport operations. Developed using Lumi and uploaded to Moodle, the tour is accessible offline, reusable, and compatible across partner school contexts.







ROME, ITALY



The Toolkit content was agreed: environmental threats and waste management techniques; best practices from partner countries; a teacher guidebook (Lumi-Moodle); the lesson plan template; nine specific lesson plans translated into all partner languages; curriculum; a user manual for VR devices; two checklists (printable and fillable); and evaluation survey results. A White Paper, implemented by InterEdu, was confirmed as a supporting research component underpinning all three project results.

Piloting Phase

Course piloting was confirmed to run from 1–15 June 2026, with 20 students per partner institution completing the MOOC and 5 students per partner piloting three VR scenarios developed by their own school. Before-and-after VR perception surveys were prepared by Aksu MTAL as Google Forms. External stakeholders, including airport representatives and aviation sector professionals, were invited to participate in course piloting for feedback and labour market validation purposes.

Green and Inclusive Approach

Partners confirmed that green practices were actively implemented throughout the project. This included promoting walking during TPMs and the LTT in Belgrade, use of reusable and recyclable materials at meetings, reduction of single-use plastics, and digital-first collaboration. Inclusiveness features were incorporated in the virtual tour (audio and text content for visually and hearing-impaired users) and across the course platform (downloadable, offline-compatible, self-paced, and adaptable activities).

Evaluation Feedback and Response

Partners addressed official evaluation recommendations, confirming the following actions: accessibility for persons with disabilities ensured in VR scenarios and course materials; a country-level overview of waste management challenges supported by measurable data incorporated into the White Paper; labour market relevance strengthened through direct engagement with airports including Vršac, Naples, Antalya, Ciampino, and Fiumicino; clearer learning outcomes and broader dissemination activities implemented; and the role of InterEdu formally strengthened with responsibilities covering adult education and youth work impact.

Final Coordination Priorities

- Timesheets with narrative descriptions
- Dissemination reports with links and photos
- Piloting documentation including photos and course certificates
- All financial documentation to be completed before submission of the final project report
- Long-term sustainability: all project results to remain available for a minimum of five years, integrated into partner school educational systems and shared as open-source resources

15. Key learnings and success stories

15.1. Key Learnings from project implementation

The AviWaste partnership has generated important insights about integrating sustainability into VET curricula that will be of value to other institutions considering similar initiatives.

- Cross-disciplinary collaboration is essential: Effective waste management education requires input from environmental science, regulatory compliance, logistics, and engineering. Bringing together teachers from different disciplines – as the AviWaste partnership does across its four organisations – produces richer, more accurate learning materials than single-subject approaches.
- Students respond strongly to real-world relevance: When learning about waste management is connected directly to the workplaces students aspire to enter – airports, airlines, MRO facilities – engagement and motivation increase significantly.
- VR dramatically improves preparation for work-based learning: Students who complete VR simulations before entering real workplace environments demonstrate greater confidence and competence in managing unfamiliar situations.
- International perspectives enrich national curricula: Seeing how partner countries approach the same challenges – through different regulatory frameworks, industry structures, and cultural contexts – broadens students' understanding and prepares them for careers in an international industry.
- Teacher training must precede content development: The decision to invest in a dedicated Train the Trainer mobility before finalising VR content was validated by the quality of materials produced. Teachers who understand both the technology and the pedagogy create significantly better learning experiences.

15.2. Succes stories

Aviation Academy Belgrade: Bridging Classroom and Workplace

Aviation Academy's long-standing dual education partnerships with Air Serbia, Nikola Tesla Airport, and JAT Tehnika have created a powerful feedback loop between industry and education. The AviWaste project has enabled the school to formalise and structure the environmental dimension of this partnership, with industry mentors contributing directly to the development of waste management lesson plans and associated partners reviewing course materials for technical accuracy.

Aksu MTAL Turkey: Student-Led Environmental Initiatives

Inspired by their participation in the AviWaste project, students at Aksu MTAL initiated a school-level waste audit project, documenting waste generation in their workshops and proposing improvements to segregation and disposal procedures. This student-led initiative demonstrated the power of environmental education to motivate action beyond the classroom and created a compelling example of project impact that was shared at TPM1.

De Pinedo Institute Italy: Integrating Logistics and Environment

De Pinedo's logistics curriculum provided a natural home for waste management content, as the management of goods flows within airports, including waste streams, is a core professional competence for logistics graduates. The school developed a bespoke lesson plan connecting airport waste logistics to the broader supply chain management concepts already embedded in their programme, creating a seamless integration that enhanced rather than disrupted the existing curriculum.

InterEdu: Building the Bridge Between Education and Impact

InterEdu's contribution to AviWaste demonstrated how a newly established non-profit organisation can serve as the connective tissue of an international partnership. As the coordination and dissemination hub of the project, InterEdu ensured that materials developed independently across three countries cohered into a single, high-quality set of outputs – managing the compilation of all course content, coordinating quality review processes, and maintaining communication across four institutions operating in three different languages and national contexts.

Beyond logistics, InterEdu brought a distinctive perspective to the partnership: that of an organisation rooted in non-formal education and lifelong learning. This lens enriched the project's approach to accessibility and inclusion, and directly shaped the decision to design all AviWaste resources – the MOOC, the VR activities, and this Toolkit – to be usable not only within formal school curricula but by adult learners, trainers, and industry professionals engaging with environmental education outside traditional classroom settings.

InterEdu's authorship of the project White Paper represents a particularly significant contribution. By grounding the AviWaste resources in a rigorous, evidence-based overview of waste management challenges and practices across Serbia, Turkey, and Italy, InterEdu ensured that the project's outputs rest on a credible research foundation – strengthening their value for policy makers, educational authorities, and sector stakeholders beyond the immediate partnership. The White Paper stands as a model for how VET projects can contribute not only practical learning tools but genuine knowledge to the fields they serve.

16. Surveys

16.1. 360 Panorama shooting survey

360° PANORAMA SHOOTING *Checklist*

OBJECTIVE

CAPTUREACOMPLETE SET OF OVERLAPPINGPHOTOGRAPHSTHATCAN BE STITCHED INTO A 360° PANORAMIC IMAGESUITABLEFOR USE IN VR (E.G.,LUMIVIRTUALTOUR.)

EQUIPMENT CHECKLIST

NO	ITEM	✓
1	Insta 360 camera	
2	Tripod or monopod	
3	Fully charged battery	
4	Memory card with free space	

LOCATION & LIGHTING

LOCATION DESCRIPTION	
LIGHTING CONDITIONS	
MOVING OBJECTS PRESENT	□ YES □ NO

CAMERA SETTINGS

PHOTO MODE	
RESOLUT ION	
LENS (WIDE / LINEAR)	
EXPOSURE LOCKED	□ YES □ NO

360° PANORAMA SHOOTING *Checklist*

OBJECTIVE

CAPTUREACOMPLETE SET OF OVERLAPPINGPHOTOGRAPHSTHATCAN BE STITCHED INTO A 360° PANORAMIC IMAGE SUITABLE FOR USE IN VR (E.G.,LUMIVIRTUALTOUR.)

SHOOTING LOG

SHOT TYPE	NOTES	NUMBER OF PHOTOS
HORIZONTAL (360°)		
UPWARD TILT		
DOWNWARD TILT		

REFLECTION

WHAT WORKED WELL?

WHAT WOULD YOU IMPROVE NEXT TIME?

TEACHER / TRAINER FEEDBACK

COMMENTS:

Link to online fillable checklist

16.2. VR Piloting evaluation report: Waste management in aviation education

1. Introduction

This report presents the evaluation results of the VR piloting activity carried out within the Waste Management in Aviation Education project. The aim of the evaluation was to understand participants' expectations, experiences, perceived learning benefits, comfort levels, and willingness to use VR in future aviation VET training activities.

2. Methodology

Data were collected through pre-survey and post-survey questionnaires. The pre-survey focused on participants' previous VR experience, expectations, and concerns, while the post-survey evaluated the actual VR learning experience, perceived effectiveness, physical comfort, and future use.

3. Survey results

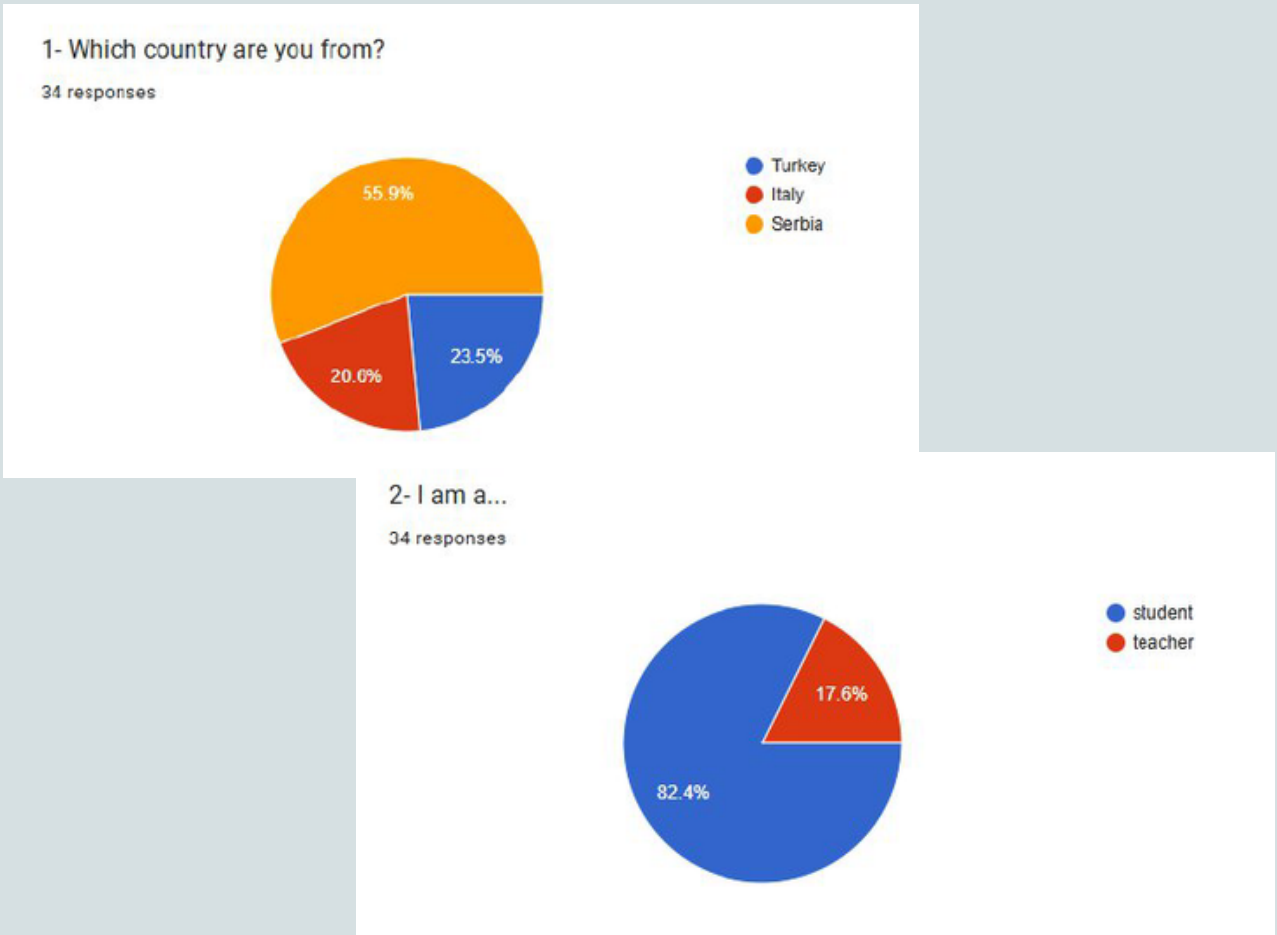


Figure 1: Participant profile

The demographic results show that a total of 34 participants took part in the survey. The country distribution indicates that the respondent group included participants from all three partner countries: 55.9% from Serbia, 23.5% from Turkey, and 20.6% from Italy. This demonstrates that the piloting activity had a transnational structure and reflected the international partnership dimension of the AviWaste project.

The participant profile also shows that the majority of respondents were students (82.4%), while 17.6% were teachers. This distribution is appropriate for the purpose of the piloting phase, as the main target group of the VR-supported learning activities was aviation VET students. At the same time, the participation of teachers provided an additional educational perspective on the usability and relevance of the VR-based lessons.

Overall, the demographic data confirm that the survey reached the intended target group and included representation from the project partner countries. This supports the evaluation of the VR piloting process within the context of the Waste Management in Aviation project.

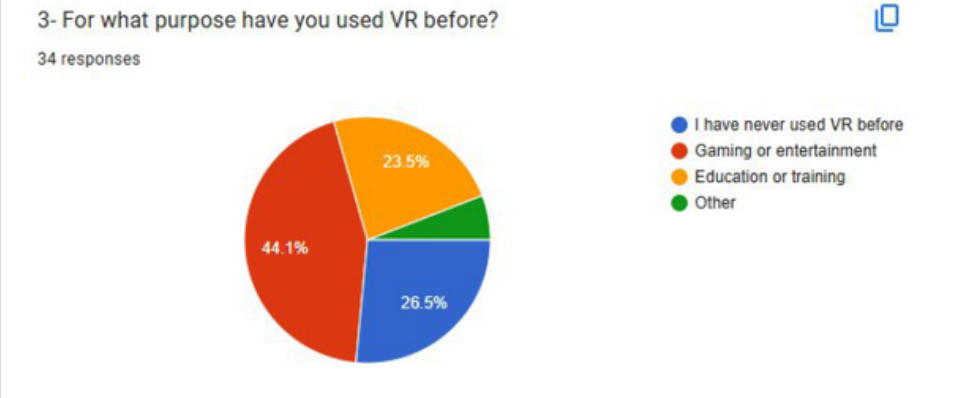


Figure 2: Previous Experience with VR

The results show that participants had different levels of previous experience with VR technology. The largest group, 44.1%, had used VR mainly for gaming or entertainment, while 26.5% stated that they had never used VR before. Only 23.5% had previously used VR for education or training, and 5.9% selected other purposes.

These findings indicate that although many participants were familiar with VR as a recreational technology, fewer had experienced it as a structured educational tool. Therefore, the AviWaste VR piloting activity provided an important opportunity to introduce VR as a learning method in aviation VET education. The presence of participants with no previous VR experience also shows that the piloting helped students and teachers gain new digital learning experience.

Overall, the data suggest that the project contributed not only to aviation waste management awareness but also to the development of digital competences by transforming VR from an entertainment-based technology into an educational tool for practical and immersive learning.



Figure 3: Perceived Effectiveness of VR for Practical Learning

These findings indicate that the VR-supported AviWaste lessons successfully supported practical learning. Although the post-survey result is slightly lower than the initial expectation, the overall evaluation remains strongly positive. This shows that VR was perceived not only as an attractive learning tool, but also as an effective method for helping students understand aviation-related practical training scenarios, especially in areas such as waste segregation, recycling practices, aircraft cabin waste, and sustainable ground handling.

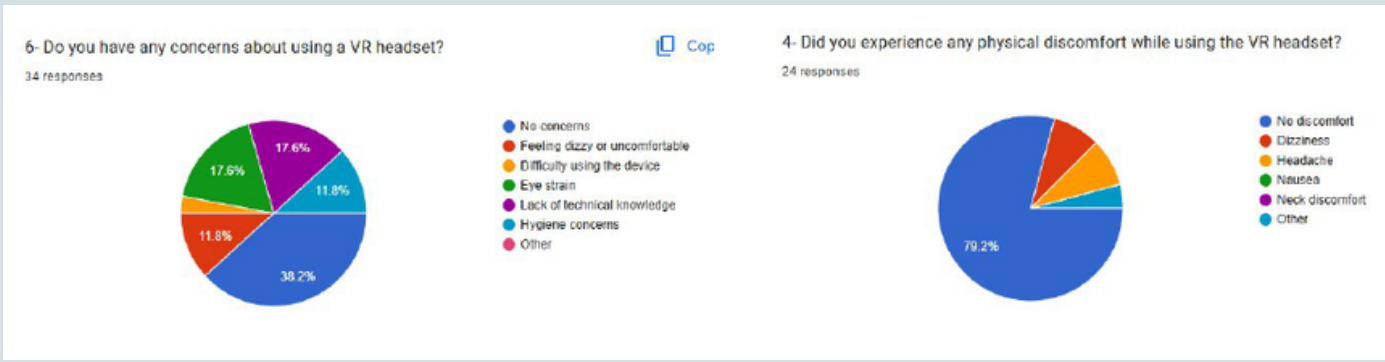


Figure 4: Concerns and Physical Comfort

Post-survey results show that the actual VR experience was largely comfortable for most participants. After using the headset, 79.2% of respondents reported no physical discomfort. Only a small proportion experienced issues such as dizziness, headache, nausea, or other minor discomforts.

This comparison indicates that many of the initial concerns about VR headset use did not turn into significant problems during the piloting activity. The high percentage of participants reporting no discomfort suggests that the VR-supported AviWaste lessons were generally safe, manageable, and suitable for use in aviation VET training. At the same time, the minor discomforts reported by some participants highlight the importance of providing clear instructions, proper headset adjustment, hygiene precautions, and short breaks during VR based learning activities.

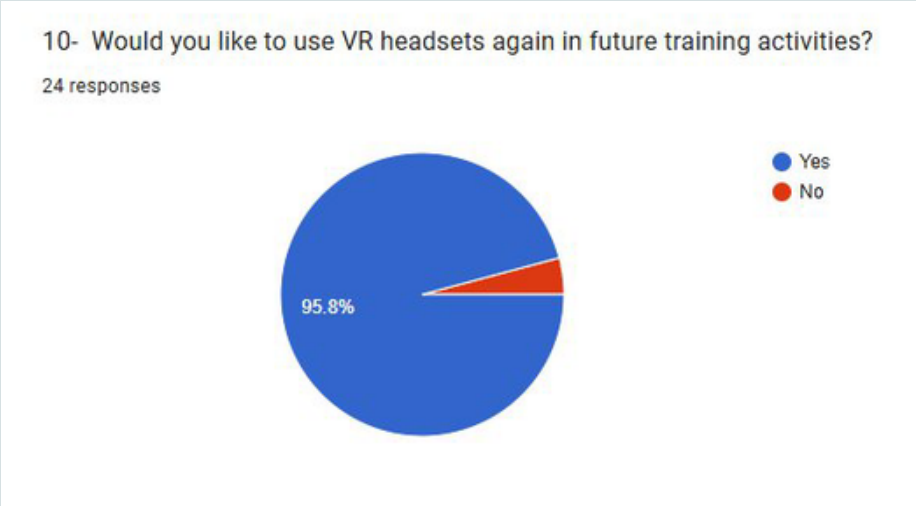


Figure 5: Willingness to Use VR in Future Training

This finding indicates that the VR-supported piloting activity was well received by the participants. The high level of willingness to use VR again suggests that students and teachers found the experience engaging, useful, and suitable for learning. It also shows that VR has strong potential to be integrated into future aviation VET training activities.

In the context of the Waste Management in Aviation project, this result is particularly important because it supports the sustainability and transferability of the VR-based learning approach. Participants' positive attitude toward future VR use shows that immersive technologies can continue to support practical learning, environmental awareness, and digital competence development in aviation education.

Participants' Expectations and Experiences Regarding VR Use

Pre-Test

The qualitative comments collected before the VR activity show that participants generally had high expectations regarding the use of VR headsets in training. Many students expected VR to make the learning process more interactive, enjoyable, engaging, and easier to understand. Several comments emphasized that VR could help students experience training scenarios in a more realistic way and support better understanding of both theoretical and practical topics.

A common theme in the responses was the belief that VR could improve motivation, attention, and knowledge retention. Participants stated that learning through VR could be more memorable than traditional methods and could help them understand how their future professional environment might look. This is directly relevant to the aims of the Waste Management in Aviation project, as VR-supported lessons are intended to connect classroom learning with realistic aviation-related scenarios.

At the same time, participants expressed some concerns before using the VR headset. The most frequently mentioned concerns were eye strain, dizziness, headaches, physical discomfort, hygiene issues, and possible technical difficulties. Some respondents also noted that VR should be used carefully, especially for long periods or when reading long written texts. Teachers highlighted the need for proper training, suitable VR applications, curriculum integration, and safe use of the equipment.

Overall, the comments show a positive attitude toward VR before the piloting activity. Participants were curious, motivated, and open to using new technology in aviation education. However, the responses also indicate that successful VR implementation requires clear instructions, appropriate content design, short and purposeful activities, hygiene precautions, and teacher preparation.

Post-Test

The qualitative comments collected after the VR activity show that participants generally had a very positive experience with the VR-supported training. Many respondents described the experience as enjoyable, interesting, excellent, amazing, fun, productive, and immersive. Several participants stated that VR made the lesson topics more understandable and helped them learn more easily compared with traditional learning methods.

A strong theme in the comments is that VR increased engagement and concentration. Participants emphasized that the immersive environment helped them focus on the lesson and reduced distraction. Some respondents also noted that interacting with images, audio tracks, and realistic scenarios made the learning process more effective and memorable. This is especially important for the Waste Management in Aviation project, as VR allows students to experience aviation-related waste management topics in a more practical and realistic way.

The comments also show that participants generally found the VR headset easy to use, especially after a short introduction. However, some suggestions for improvement were mentioned. These included improving headset comfort for longer sessions, increasing image quality, adding more interactive activities, creating more realistic scenarios, making control buttons easier to find, and including safety features such as time limits or warning systems. A few participants also stated that VR should not be used for too long due to possible health concerns.

Overall, the post-activity comments confirm that VR was perceived as a valuable and motivating educational tool. The experience supported better understanding, increased learner interest, and provided a unique learning environment. At the same time, the feedback highlights the importance of careful planning, appropriate session duration, clear instructions, technical support, and well-designed interactive content for future VR-based training activities.

4. Conclusion

The survey results show that the VR piloting activity was positively received by participants. The majority of respondents found VR engaging, effective, and suitable for aviation VET training. The results also indicate that VR can support practical understanding, learner motivation, environmental awareness, and digital competence development within the Waste Management in Aviation project.

Although some participants reported concerns related to eye strain, comfort, hygiene, and technical use, the post-survey results show that most participants experienced no physical discomfort. Overall, the findings support the continued use of VR-supported learning activities in aviation waste management education.

16.3. Evaluation report on the Waste Management in Aviation - COURSE PILOTING ACTIVITY

1. Introduction

The Waste Management in Aviation Course was developed within the AviWaste project to improve students' knowledge, awareness, and practical understanding of waste management and sustainability in the aviation sector. The course focused on the main sources and types of waste generated at airports and on aircraft, including food waste, plastic and packaging waste, paper waste, hazardous waste, construction and demolition waste, electronic waste, and cabin waste.

The course also introduced students to important sustainability topics such as waste separation, recycling practices, aircraft material recycling, environmentally friendly airport ground services, sustainable aviation fuel, carbon emissions, and the relationship between air travel and climate change. In addition, students learned about waste management practices in the partner countries: Serbia, Turkey, and Italy.

Before starting the course, students completed a pre-test to measure their existing knowledge and awareness. After completing the course, they answered a post-test to evaluate what they had learned and how their understanding had changed. The results of these surveys were used to assess the learning impact of the course and its contribution to aviation VET education.

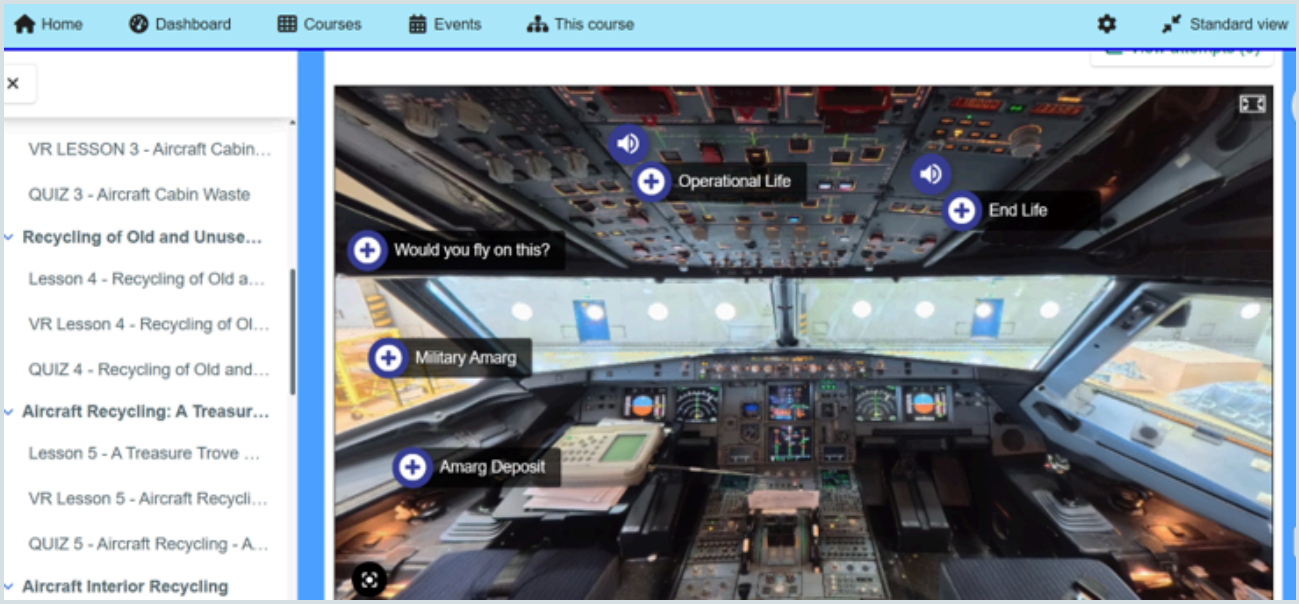


Figure 1: . Interactive VR-supported lesson screen from the Waste Management in Aviation course, presenting a 360° aircraft cockpit environment with clickable learning points

2. Methodology

The evaluation of the Waste Management in Aviation Course was carried out through pre-test and post-test questionnaires. The pre-test was completed by students before they started the course, while the post-test was completed after they finished the course. The aim was to measure students' initial knowledge, awareness, and expectations before the course and to evaluate their learning progress and opinions after the course.

A total of 51 students answered the pre-test. The pre-test participants included 27 students from Serbia, 20 students from Turkey, and 4 students from Italy. The post-test was completed by 49 students, including 25 students from Serbia, 20 students from Turkey, and 4 students from Italy. However, the piloting process is still ongoing, and the number of responses is increasing day by day as more students complete the course and the related questionnaires.

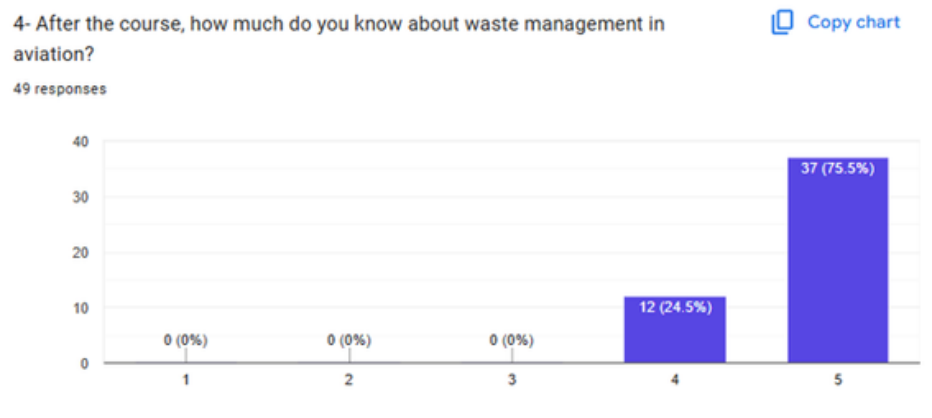
The survey questions focused on students' knowledge of aviation waste management, types of waste generated at airports and on aircraft, recycling practices, cabin waste separation, environmentally friendly ground services, sustainable aviation initiatives, carbon emissions, and environmental responsibility in aviation.

3. Survey results



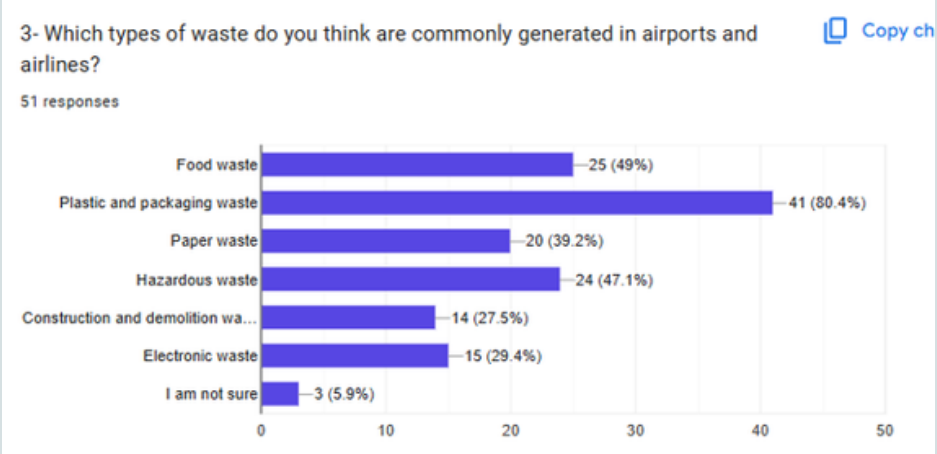
The pre-test results show that students' initial knowledge about waste management in aviation was mostly at a basic or moderate level. Before taking the course, 51% of students stated that they had "some" knowledge, while 29.4% reported knowing only "a little". 13.7% stated that they knew "a lot", and a small proportion indicated that they knew nothing. No students selected "very much". This shows that although students had some prior awareness of the topic, their knowledge was not yet at an advanced level before the course.

The post-test results show a clear improvement after completing the course. After the course, 75.5% of students rated their knowledge at the highest level, and 24.5% rated it at level 4. No students selected the lower levels. This indicates that all respondents evaluated their knowledge positively after the course.

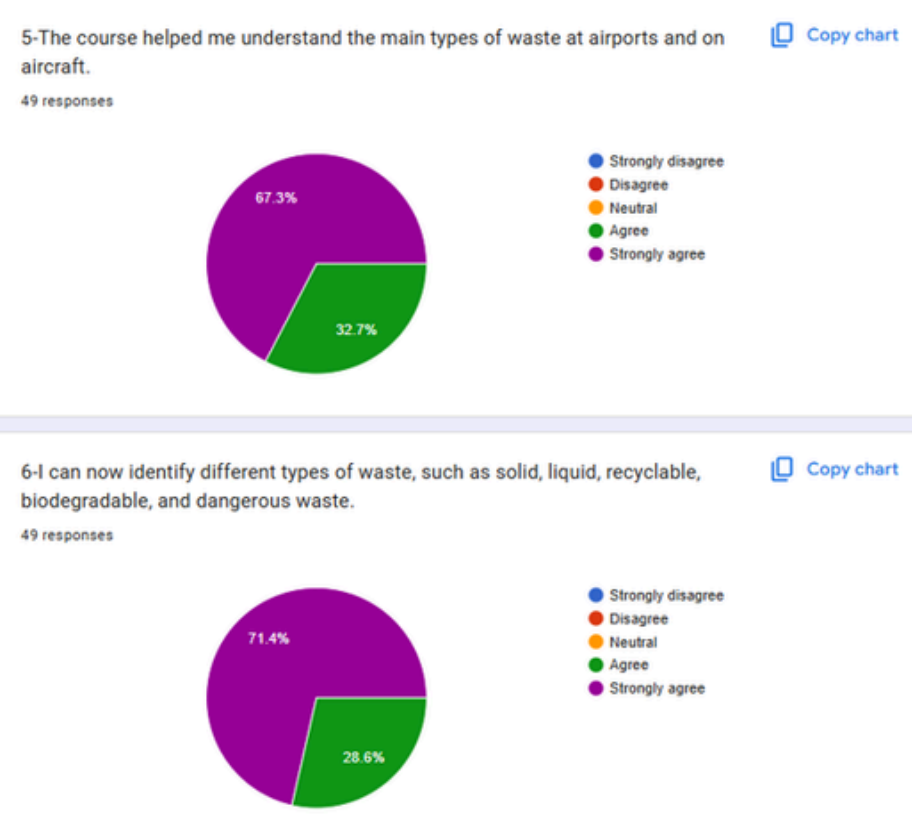


Overall, the comparison between the pre-test and post-test results demonstrates that the Waste Management in Aviation Course had a strong positive effect on students' understanding of aviation waste management. The course helped students move from limited or moderate prior knowledge to a much higher level of confidence and awareness after completing the learning activities.

The pre-test results show that students already had some awareness of the types of waste commonly generated in airports and airlines. The most frequently selected category was plastic and packaging waste, chosen by 80.4% of respondents. This indicates that students were especially familiar with visible and everyday waste types in aviation environments. Other commonly identified categories were food waste (49%), hazardous waste (47.1%), and paper waste (39.2%). However, fewer students selected electronic waste (29.4%) and construction and demolition waste (27.5%), while 5.9% were not sure. This suggests that before the course, students' understanding of aviation waste was stronger for common waste types but more limited for technical, operational, or less visible waste categories



The post-test results show a very positive learning outcome. After completing the course, 67.3% of students strongly agreed and 32.7% agreed that the course helped them understand the main types of waste at airports and on aircraft. This means that 100% of respondents gave a positive answer. In addition, 71.4% strongly agreed and 28.6% agreed that they could now identify different types of waste, such as solid, liquid, recyclable, biodegradable, and dangerous waste. Again, this represents 100% positive feedback.



Overall, the comparison shows that the course successfully improved students' understanding of aviation waste categories. While the pre-test results showed partial and uneven awareness, the post-test results demonstrate that students gained a clearer and more comprehensive understanding of different waste types after the course. This is directly aligned with the aim of the Waste Management in Aviation Course, which is to help students identify, classify, and manage different waste streams in aviation contexts.

The pre-test results show that students had limited knowledge about aviation waste management practices in the partner countries before taking the course. 23.5% of students stated that they had no knowledge, and 33.3% reported having very little knowledge. This means that more than half of the respondents had low or no prior knowledge about waste management practices in Serbia, Turkey, and Italy. In addition, 25.5% stated that they had some knowledge, while only 17.6% reported having good knowledge. No students indicated advanced knowledge.



The post-test results show a clear positive change after the course. 61.2% of students strongly agreed and 36.7% agreed that the course helped them learn about waste management at airports in Serbia, Turkey, and Italy. This means that 97.9% of respondents gave a positive answer. Only a very small proportion selected neutral, and no negative responses were recorded.



Overall, the comparison shows that the course successfully addressed an important knowledge gap. Before the course, students' familiarity with country-specific aviation waste management practices was limited. After the course, almost all students stated that they had learned about airport waste management practices in the partner countries. This result supports the transnational dimension of the Waste Management in Aviation Course and shows that the course helped students compare different national practices within a European aviation context.

4. Participations Feedback

The open-ended pre-test responses show that students expected to learn practical and sector-specific information about aviation waste management. Their main interests focused on how waste is managed in aviation, how cabin and environmental waste can be separated and recycled, how airports and airlines benefit from waste management, and how aviation can become more environmentally friendly. Some students also expressed interest in aircraft noise reduction, electric aircraft development, and sustainable waste management technologies. These responses show that before the course, students were curious about both practical waste management procedures and broader sustainability issues in aviation.

The post-test responses show that students were able to identify clear learning outcomes after completing the course. Many students stated that the most important things they learned were airport waste management operations, separating and recycling cabin waste after a flight, waste separation procedures at airports, and the importance of small procedures and policies in reducing waste and CO_2 emissions. Some responses also highlighted the importance of recycling aircraft materials and reusing aircraft components in an environmentally friendly way.
Overall, the participant feedback supports the quantitative survey results. Before the course, students had expectations and learning needs related to aviation waste management and sustainability. After the course, their comments became more concrete and practical, focusing on specific procedures, recycling practices, airport operations, and environmental responsibility. This indicates that the course helped students move from general curiosity to a clearer understanding of how waste management is applied in aviation contexts.

5. Conclusion

The results of the pre-test and post-test show that the Waste Management in Aviation Course had a clear positive impact on students' knowledge, awareness, and understanding of aviation waste management. Before the course, many students had only limited or moderate knowledge about waste management practices in aviation. After completing the course, students reported much higher confidence in understanding waste types, recycling practices, cabin waste separation, airport waste management systems, environmentally friendly ground services, and the connection between aviation, carbon emissions, sustainable aviation fuels, and climate change.

The post-test results also show that the course was well received by students. The high ratings for course enjoyment and the strong positive responses about learning outcomes indicate that the course content was understandable, relevant, and engaging. In particular, the VR scenarios and interactive elements appear to have increased students' motivation and supported practical learning.
Overall, the course successfully contributed to the aims of the Waste Management in Aviation / AviWaste project by strengthening students' green competences, environmental responsibility, and aviation-specific sustainability awareness. The findings support the continued use and further development of this course as an effective learning resource for aviation VET education.

Erasmus+

Co-funded by the Erasmus+ Programme of the European Union

17. White paper

Circular Economy Lessons from Turkey and Serbia

Executive Summary

Waste is aviation's less-discussed sustainability challenge. While emissions dominate the conversation, airports and airlines generate large, complex waste streams — cabin waste, terminal waste, maintenance waste, and construction waste — each with its own handling and compliance requirements. This white paper reviews how the sector is responding, and compares two contrasting journeys: Turkey's mature, policy-driven Zero Waste model, and Serbia's rapid, concession-driven transformation at Belgrade Nikola Tesla Airport.

70% Belgrade Airport recycling rate in 2023, up from ~5% in 2019 (VINCI Airports)	**4** Major aviation waste streams: cabin, terminal, MRO, and construction	**2030** Target year for zero waste to landfill at Belgrade Airport

The comparison points to four recurring success factors — prevention before recycling, source separation, digital monitoring, and stakeholder cooperation — and to two priorities for further progress in Serbia: expanding recycling infrastructure beyond major hubs, and building passenger awareness.

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1. The Growing Waste Challenge in Aviation

As air travel grows, so does the volume of waste generated across the passenger journey — from terminal retail and catering to aircraft maintenance and airport construction. Much of this waste is complex: mixed materials, biosecurity-sensitive cabin waste from international flights, and hazardous by-products from maintenance work. International bodies such as ICAO and IATA now treat waste as a core part of environmental management, encouraging airports and airlines to apply the waste hierarchy — prevent, reduce, reuse, recycle, recover — rather than defaulting to disposal (ICAO, 2022; IATA, 2022; European Commission, 2008).

"The most successful airports treat waste management as part of their overall environmental strategy — not as an isolated operational task."

2. Where Aviation Waste Comes From

Aviation waste falls into four broad categories, each requiring a different management approach:

- Cabin waste — food, packaging, and disposables from flights, often subject to strict biosecurity rules on international routes (WOAH, n.d.; IATA, n.d.).
- Terminal waste — municipal-type waste from passengers, retail, and offices, with strong recycling potential.
- MRO waste — scrap metal, oils, solvents, and batteries from maintenance, much of it classified as hazardous.
- Construction & demolition waste — debris from airport expansion, largely recoverable when managed properly (European Commission, n.d.).

3. What Good Practice Looks Like

Across leading airports and airlines, five practices recur: replacing paper processes with digital ones; phasing out single-use plastics; separating waste at the source with clearly labelled collection points; applying circular procurement (recycled-content purchasing, equipment refurbishment); and adding waste-to-energy or composting capacity for organic waste (IATA, 2022; ICAO, n.d.).

Waste Assessment Approaches

Strengths	Limitations
Records Examination • Provides weights and volumes of waste generated • Tracks major potential waste from the point of origin • Identifies the expensive or valuable components of an organization's waste • Documents financial benefits of reuse and recycling including total revenues and avoided disposal costs • Requires the least time and effort • Establishes baseline for metrics	• Lack of quantitative data for specific waste components • Does not provide qualitative data on how or why wastes are generated • Substantial effort necessary to collect and analyze data
Facility Walk-Through • Requires less time and effort than waste sorts • Allows first-hand examination of facility operations • Provides qualitative information about major waste components and waste-generating processes • Reveals waste reduction activities • Develops appreciation of logistics and obstacles tenants encounter in their efforts to recycle	• Limited identification of wastes generated • Multiple attempts may be necessary for comprehensive evaluation • Relies on estimates of waste generation
Waste Sort • Provides quantitative data on total waste generation and specific waste components • Allows problem solving and design of recycling program to be site specific	• Requires more time and effort than other approaches • Multiple attempts may be necessary for comprehensive evaluation • Does not provide qualitative data on how or why wastes are generated

Source: USEPA, Business Guide for Reducing Solid Waste, 1993.

4. Two Journeys, Compared: Turkey and Serbia

Turkey and Serbia illustrate two different starting points for the same goal. Turkey's national Zero Waste Project gives airports and airlines a standardized framework to plug into; Istanbul Airport and Turkish Airlines have built source-separation, digital monitoring, and food-waste reduction on top of it (Republic of Türkiye, n.d.; İGA Istanbul Airport, 2023; Turkish Airlines, 2023). Serbia's progress has instead been driven by a single transformation event — the 2019 concession of Belgrade Nikola Tesla Airport to VINCI Airports — which brought new sorting infrastructure and a global environmental strategy to a system that previously had little recycling capacity (VINCI Airports, 2019–2023).

Dimension	Turkey	Serbia
Driving framework	National Zero Waste Project (Sıfır Atık Projesi)	VINCI Airports global environmental strategy
Key sites	Istanbul Airport, Turkish Airlines	Belgrade Nikola Tesla Airport
Core mechanism	Standardized source separation + national reporting	New sorting infrastructure after 2019 concession
Measured outcome	Continuous recycling-rate monitoring (İGA, 2023)	Recycling rate up from ~5% (2019) to ~70% (2023)
Main remaining gap	Scaling passenger-facing awareness campaigns	Recycling infrastructure outside major urban areas

The headline result: Belgrade Airport's recycling rate rose from roughly 5% in 2019 to around 70% by 2023, alongside new wastewater treatment and water-reuse practices (VINCI Airports, 2019–2023). The remaining gap is less about the airport itself and more about the surrounding system — recycling infrastructure beyond major urban areas, and passenger-facing awareness.

5. Key Lessons and Recommendations

- Lead with prevention, not just recycling — digital processes and optimized catering reduce waste before it is generated.
- Separate at the source — clearly labelled, well-placed collection points are the single biggest driver of recycling-rate improvement.
- Invest in monitoring — digital tracking of waste volumes supports both compliance and continuous improvement.
- Treat waste management as a shared responsibility — airport operators, airlines, concessionaires, contractors, and passengers all need to be part of the system.
- Where infrastructure is new (as in Serbia), prioritize expanding recycling capacity beyond the airport itself and investing in passenger awareness.

6. Conclusion

Sustainable waste management has moved from a peripheral concern to a core part of airport and airline strategy. Turkey and Serbia, despite very different starting points, converge on the same fundamentals: prevention first, separation at the source, digital monitoring, and cooperation across every stakeholder that touches the waste stream. For Serbia, sustaining the momentum built since 2019 will depend on extending these fundamentals beyond the airport fence line.

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18. Waste Management in the Aviation Industry: A Review of Innovative Practices with Insights from Turkey and Serbia

Irina Rucnov
Education Support Association InterEdu

Abstract

Waste generation has become an increasingly important sustainability challenge for the aviation industry, alongside the more widely discussed issues of emissions and fuel efficiency. Airports and airlines generate substantial volumes of municipal, catering, maintenance, and construction waste, requiring systematic approaches to prevention, reuse, recycling, and recovery. This paper reviews innovative waste management practices in the aviation sector, drawing on international guidelines from ICAO and IATA, and examines the waste hierarchy as applied to aviation-specific waste streams, including aircraft cabin waste, terminal waste, maintenance-repair-overhaul (MRO) waste, and construction and demolition waste. Through a comparative analysis of good practice, the paper presents Turkey's national Zero Waste Project and its implementation at Istanbul Airport and Turkish Airlines, alongside Serbia's progress at Belgrade Nikola Tesla Airport following its concession to VINCI Airports, where the recycling rate increased from approximately 5% in 2019 to around 70% by 2023 (VINCI Airports, 2019–2023). The comparison highlights common success factors — waste prevention, source separation, digital monitoring, and multi-stakeholder cooperation — and identifies opportunities for further development, particularly in Serbia, where recycling infrastructure and passenger awareness remain areas for improvement. The findings confirm that sustainable waste management has become an integral component of modern airport and airline operations, contributing to environmental protection, regulatory compliance, and operational efficiency.

Keywords: Aviation waste management; circular economy; airport sustainability; waste hierarchy; recycling; Turkey; Serbia

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1. Introduction

The aviation industry plays a vital role in connecting people, supporting global trade, and contributing to economic development. As air travel continues to grow, airports and airlines face increasing environmental challenges associated with their operations. While much of the public and scientific attention has focused on reducing greenhouse gas emissions and improving fuel efficiency, waste generation has become another significant sustainability issue. Large volumes of municipal, catering, maintenance, and packaging waste are produced daily by airports, airlines, and ground handling services, creating environmental, economic, and operational challenges.

Waste generated throughout the aviation sector originates from multiple sources, including passenger terminals, aircraft cabins, maintenance activities, retail facilities, and airport restaurants. In addition to conventional solid waste, aviation operations generate hazardous waste, food waste, plastics, metals, textiles, and electronic equipment. The complexity of airport operations, strict international regulations regarding catering waste, and increasing passenger numbers make effective waste management particularly challenging. Consequently, the aviation industry is gradually shifting from traditional waste disposal practices toward more sustainable approaches based on the principles of waste prevention, reuse, recycling, and resource recovery.

Recent years have seen the emergence of numerous innovative initiatives aimed at reducing waste generation and promoting circular economy principles within aviation. Airlines and airports are implementing digital technologies to minimize paper consumption, replacing single-use plastics with reusable alternatives, improving waste separation systems, optimizing catering processes to reduce food waste, and investing in recycling and waste-to-energy solutions. These practices not only reduce environmental impacts but also improve operational efficiency, decrease disposal costs, and strengthen corporate sustainability performance.

International organizations, including the International Civil Aviation Organization and the International Air Transport Association, encourage the adoption of sustainable waste management strategies as part of broader environmental management frameworks (ICAO, 2022; IATA, 2022). Their guidelines emphasize that waste prevention should remain the highest priority, followed by reuse, recycling, and recovery, in accordance with the waste hierarchy concept (European Commission, 2008).

The aim of this paper is to review innovative approaches to waste reduction, recycling, reuse, and recovery within the aviation sector through the analysis of selected best practices and case studies. By examining successful initiatives implemented by leading airports and airlines, the paper identifies practical strategies that contribute to more sustainable airport and airline operations. Furthermore, the study highlights key lessons learned and discusses opportunities for wider implementation of circular economy principles in the aviation industry.

2. Methodology

This paper is based on a review of secondary sources, including guidance documents and environmental reports published by international aviation bodies (ICAO, IATA), the applicable EU waste framework legislation, and publicly available sustainability disclosures from the two case-study organizations — İGA Istanbul Airport, Turkish Airlines, and VINCI Airports (as concessionaire of Belgrade Nikola Tesla Airport). Turkey and Serbia were selected as a comparative pair because they represent, respectively, a mature national zero-waste framework and a rapidly modernizing system undergoing concession-driven transformation, allowing common success factors to be identified across two different stages of development.

3. Aviation Waste: Definitions and Classification

Waste can generally be defined as any material, product, or substance that is no longer needed and requires appropriate collection, treatment, or disposal. In the aviation sector, waste is generated from a wide range of activities, including aircraft operations, passenger terminals, catering services, maintenance, administrative offices, ground support operations, retail facilities, and construction projects.

There is no universally accepted definition of waste, as its interpretation varies across legal frameworks, industries, and countries. In general, waste refers to materials that are discarded because they have no further intended use. International agreements, such as the Basel Convention, define waste as substances or objects that are disposed of, intended for disposal, or required by law to be disposed of (Basel Convention, n.d.). The Convention also emphasizes that waste should be managed in a manner that protects both human health and the environment.

Within the aviation industry, waste management presents additional challenges due to the distinction between domestic and international waste, as well as between hazardous and non-hazardous waste. Many countries have specific regulations governing waste generated on international flights because of potential biosecurity and public health risks (WOAH, n.d.). Hazardous waste, including materials that are flammable, toxic, corrosive, or otherwise dangerous, is subject to even stricter handling, transportation, and disposal requirements under both national legislation and international agreements.

Waste generated within the aviation sector is highly diverse due to the wide range of activities performed at airports and by airlines. It originates from passenger services, aircraft operations, maintenance activities, commercial facilities, and airport infrastructure. The classification of aviation waste is essential for selecting appropriate handling, treatment, and disposal methods, as different waste streams are subject to different environmental and legal requirements.

One of the most common classifications distinguishes waste according to its source.

Aircraft waste includes cabin waste generated during flights, such as food leftovers, disposable catering items, paper products, plastic packaging, and beverage containers. International flights often produce waste that is subject to stricter biosecurity regulations because it may contain food products or materials that pose a risk of introducing animal or plant diseases (WOAH, n.d.; IATA, n.d.).

Terminal waste is generated within airport buildings and consists mainly of municipal solid waste produced by passengers, airport staff, restaurants, retail shops, and office activities. Typical materials include paper, cardboard, plastics, glass, metals, and food waste. Since this waste is similar to municipal waste generated in urban areas, it offers considerable opportunities for recycling and composting when effective waste separation systems are implemented.

Another important category is maintenance, repair, and overhaul (MRO) waste, which is produced during aircraft maintenance and servicing. This waste stream includes scrap metals, composite materials, used oils, lubricants, solvents, batteries, electrical components, and chemical residues. Many of these materials are classified as hazardous waste because they may contain toxic, flammable, or corrosive substances requiring specialized treatment and disposal.

Construction and demolition waste is generated during airport expansion, renovation, and infrastructure projects. It typically consists of concrete, asphalt, steel, wood, glass, and construction debris. A significant proportion of these materials can be recovered or recycled, supporting circular economy principles and reducing landfill disposal (European Commission, n.d.).

Waste can also be classified according to its environmental characteristics. Non-hazardous waste includes recyclable materials such as paper, cardboard, plastics, glass, and metals, as well as organic waste suitable for composting or energy recovery. In contrast, hazardous waste comprises substances that present risks to human health or the environment, including chemicals, fuels, paints, solvents, contaminated absorbents, medical waste, and certain electronic equipment. Hazardous waste is subject to strict national and international regulations governing its storage, transportation, treatment, and disposal (European Commission, 2008).

Understanding these waste categories enables airports and airlines to implement targeted waste management strategies based on the principles of waste prevention, reuse, recycling, recovery, and safe disposal. Proper classification also supports regulatory compliance, improves recycling rates, and contributes to more sustainable airport operations.

4. Innovative Waste Management Practices: Case Studies

Effective waste management has become an essential component of sustainable aviation. Rather than relying solely on waste disposal, leading airports and airlines increasingly adopt circular economy principles that prioritize waste prevention, reuse, recycling, and resource recovery. These practices not only reduce environmental impacts but also improve operational efficiency, lower waste management costs, and strengthen compliance with national and international environmental regulations. The following sections present selected examples of good practice, focusing on Turkey and Serbia while relating them to broader international trends.

4.1. General Best Practices in Aviation

Successful waste management begins with waste prevention. Airports and airlines are reducing waste generation by replacing printed documents with digital boarding passes, electronic baggage tags, and paperless operational systems. Digitalization significantly decreases paper consumption while simplifying passenger processing and reducing administrative costs (IATA, 2022).

Another important practice is the reduction of single-use plastics. Many airlines have replaced disposable cutlery, cups, stirrers, and packaging with reusable or recyclable alternatives. Catering companies increasingly use lightweight packaging and optimize meal loading based on passenger demand, reducing both food waste and aircraft weight. Since lower aircraft weight decreases fuel consumption, waste prevention also contributes indirectly to lower greenhouse gas emissions.

Waste separation at the source is another widely adopted practice. Airports install clearly labelled collection points for paper, plastics, metals, glass, organic waste, and hazardous materials throughout passenger terminals and operational areas. Proper separation increases recycling rates while reducing contamination of recyclable materials.

Modern airports are also implementing circular procurement principles by purchasing products made from recycled materials, extending the lifespan of equipment through maintenance and refurbishment, and encouraging suppliers to minimize packaging. Several airports have introduced waste-to-energy systems or composting facilities for organic waste, further reducing dependence on landfill disposal (ICAO, n.d.).

These initiatives demonstrate that effective waste management requires cooperation among airport operators, airlines, catering companies, retail tenants, cleaning contractors, passengers, and regulatory authorities. The most successful airports integrate waste management into their overall environmental management systems instead of treating it as an isolated operational activity.

Waste Assessment Approaches

Strengths	Limitations
Records Examination • Provides weights and volumes of waste generated • Tracks major potential waste from the point of origin • Identifies the expensive or valuable components of an organization's waste • Documents financial benefits of reuse and recycling including total revenues and avoided disposal costs • Requires the least time and effort • Establishes baseline for metrics	• Lack of quantitative data for specific waste components • Does not provide qualitative data on how or why wastes are generated • Substantial effort necessary to collect and analyze data
Facility Walk-Through • Requires less time and effort than waste sorts • Allows first-hand examination of facility operations • Provides qualitative information about major waste components and waste-generating processes • Reveals waste reduction activities • Develops appreciation of logistics and obstacles tenants encounter in their efforts to recycle	• Limited identification of wastes generated • Multiple attempts may be necessary for comprehensive evaluation • Relies on estimates of waste generation
Waste Sort • Provides quantitative data on total waste generation and specific waste components • Allows problem solving and design of recycling program to be site specific	• Requires more time and effort than other approaches • Multiple attempts may be necessary for comprehensive evaluation • Does not provide qualitative data on how or why wastes are generated

Source: USEPA, Business Guide for Reducing Solid Waste, 1993.

4.2. Turkey: A Regional Example of Good Practice

Turkey has become one of the regional leaders in sustainable airport management, particularly following the introduction of the national Zero Waste Project (Sıfır Atık Projesi). The programme encourages public institutions and businesses to improve waste separation, recycling, and resource efficiency through standardized waste management systems (Republic of Türkiye, Ministry of Environment, Urbanisation and Climate Change, n.d.).

Istanbul Airport has incorporated these principles into its environmental management strategy. Separate collection systems are installed throughout the terminal for recyclable materials, organic waste, and hazardous waste. Waste generated by passengers, restaurants, retail outlets, and airport operations is collected separately before being transferred to licensed recycling and waste treatment facilities. Continuous monitoring enables the airport to measure waste generation and improve recycling performance over time (İGA Istanbul Airport, 2023).

An important feature of Istanbul Airport's approach is the integration of waste management with digital monitoring systems. Data collected from waste operations support planning and resource allocation while identifying opportunities for further waste reduction. Employee training and passenger awareness campaigns also play an important role in improving waste segregation and encouraging environmentally responsible behaviour (İGA Istanbul Airport, 2023).

Turkish Airlines complements airport initiatives through its own sustainability programme. The airline has introduced measures to reduce single-use plastics, improve recycling of cabin waste, optimize catering services, and reduce food waste. Digital documentation has significantly decreased paper consumption in flight operations and administrative processes. The airline also collaborates with suppliers to develop more sustainable packaging and increase the use of recyclable materials throughout its service chain (Turkish Airlines, 2023).

Food waste management represents another important area of innovation. By using passenger demand forecasting and improved catering logistics, Turkish Airlines aims to reduce unnecessary meal loading while maintaining service quality. This practice reduces both waste generation and aircraft weight, creating environmental and economic benefits simultaneously (Turkish Airlines, 2023).

Turkey's experience demonstrates that successful aviation waste management depends not only on technological solutions but also on national environmental policies, strong regulatory frameworks, and cooperation between airports, airlines, and public authorities.

4.3. Serbia: Current Practices and Future Opportunities

Compared with Turkey, Serbia is still at an earlier stage of implementing comprehensive aviation waste management programmes. Nevertheless, significant progress has been achieved at Belgrade Nikola Tesla Airport following the concession agreement with VINCI Airports.

Environmental management has become one of the airport's strategic priorities, with objectives that include reducing waste generation, increasing recycling rates, improving wastewater treatment, promoting circular economy principles, and achieving zero waste to landfill by 2030. These goals are aligned with VINCI Airports' global environmental strategy and international sustainability standards (VINCI Airports, 2019–2023).

One of the most important improvements has been the construction of dedicated waste management facilities on both the landside and airside of the airport. These transfer stations allow waste generated by passengers, airport staff, aircraft operations, and commercial activities to be sorted before being transferred to authorized recycling operators. The airport currently separates multiple recyclable waste streams, including paper, cardboard, PET bottles, aluminium cans, glass, metal packaging, plastic foil, tetra pak packaging, and hard plastics (VINCI Airports, 2019–2023).

According to VINCI Airports, Belgrade Airport increased its waste recycling rate from approximately 5% in 2019 to around 70% by 2023 through improved waste segregation systems and new recycling infrastructure (VINCI Airports, 2019–2023). This represents one of the most significant environmental improvements implemented during the modernization programme.

Hazardous waste generated through aircraft maintenance and airport operations is handled separately in accordance with Serbian legislation and international environmental requirements. The airport also monitors wastewater quality, operates wastewater treatment facilities, and promotes water reuse for irrigation purposes, demonstrating an integrated approach to environmental management rather than focusing exclusively on solid waste (VINCI Airports, 2019–2023).

Despite these achievements, Serbia still faces several challenges. Recycling infrastructure outside major urban areas remains less developed than in many European countries, and stronger cooperation between airports, airlines, waste management companies, and local authorities will be necessary to further improve recycling performance. Passenger awareness regarding waste separation also remains an important area for future development.

Additional opportunities include introducing smart waste collection systems, expanding circular procurement practices, increasing reuse of airport equipment and furniture, improving food waste recovery, and applying artificial intelligence to optimize catering logistics and waste forecasting. These measures have already demonstrated positive results at several European airports and could be gradually adapted to Serbian conditions.

5. Lessons Learned

The comparison between Turkey and Serbia illustrates different stages of sustainable aviation waste management. Turkey demonstrates the benefits of combining national environmental policy with airport and airline initiatives, while Serbia illustrates how significant improvements can be achieved through investment, international partnerships, and adoption of global environmental standards.

Several common success factors can be identified. First, waste prevention is more effective than relying solely on recycling. Second, separating waste at the source substantially improves recycling efficiency. Third, digital technologies support better monitoring, reporting, and decision-making. Finally, long-term success depends on cooperation among all stakeholders, including airport operators, airlines, concessionaires, government authorities, service providers, and passengers.

These examples confirm that sustainable waste management is no longer limited to environmental protection but has become an important component of modern airport management, improving operational efficiency, regulatory compliance, and corporate sustainability performance.

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19. Acknowledgements and disclaimer

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