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Report on Best Practices on Innovative Didactical Approaches and Digital Tools for Teaching and Learning

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1 Introduction

The AVIONIC Project (2022-1-RO01-KA220-HED-000086424) is an *Erasmus+ Higher Education Cooperation Partnership* dedicated to strengthening the capacity of higher education institutions (HEIs) to respond to the twin green and digital transitions in aviation education. It addresses the growing need for new qualifications, pedagogical methods, and technological infrastructures that can support the sustainable transformation of air transport and logistics systems. Within this framework, Work Package 2 (WP2) focuses on identifying emerging occupations, qualifications, and related competencies arising from digitalisation and sustainability in aviation, while Work Package 4 (WP4) aims to translate these findings into innovative, digitally supported learning designs and tools.

This report corresponds to Action 2.3 under WP2, whose purpose is to examine best practices in teaching and learning approaches and to analyse digital tools that facilitate the development of digital and green skills. It thus functions as a bridge between the skills-mapping work of WP2 and the digital innovation activities in WP4, ensuring that the design of future teaching tools is grounded in empirical evidence and pedagogical theory.

1.1 Rationale

Europe's aviation education ecosystem is under increasing pressure to align with the strategic objectives of the *European Green Deal* and the *Digital Education Action Plan 2021–2027*, both of which call for education systems to foster sustainability-related competencies and digital fluency (European Commission, 2022). These aims resonate with the *European Qualifications Framework* (EQF) and *ESCO* competence models, which promote cross-disciplinary, employability-oriented skillsets. Developing such capacities requires learning environments that integrate technology, systems thinking, and applied problem-solving—core elements of Education for Sustainable Development (UNESCO, 2020).

From a pedagogical standpoint, the report is grounded in well-established frameworks that emphasize constructive alignment (Biggs & Tang, 2011), hierarchical learning processes (Bloom, 1956), and learning as an iterative design science (Laurillard, 2012). These perspectives recognize that teaching innovation depends on rethinking how learning experiences are structured and supported through digital ecosystems. Accordingly, information technology (IT) tools are treated here not merely as delivery platforms but as catalysts for active, collaborative, and personalized learning (Patala & Bruce, 2018).

1.2 Aims of the Report

The **Specific Objective 2 of WP2** seeks to identify good practices in teaching methods that improve the quality and relevance of digital and green skills in higher education. Within this objective, the report pursues two main goals:

1. To identify exemplary teaching and learning practices that enhance the development of digital and sustainability-related competences; and
2. To identify IT-based practices that can be applied to innovative teaching and learning

models supporting cross-disciplinary competences for managing sustainable systems in transport—systems that underpin economic efficiency, social benefit, and environmental responsibility.

To ensure alignment with other project activities, several sub-goals have been established:

- To understand the mechanisms and constraints of e-learning and IT tools;
- To identify ways to improve existing digital platforms and pedagogical approaches;
- To suggest new pedagogical approaches that support educators in course design and implementation; and
- To recommend digital tools that enhance teaching effectiveness and student engagement.

1.3 Methodological Orientation

The analysis underlying this report combines conceptual and empirical approaches. Three complementary methodological components were adopted:

1. A qualitative survey was conducted among project partner HEIs and training providers to collect examples of good practices in teaching and learning.
2. A classification of online learning platform features and functionalities, adapted from the *SEnDIng Project* framework, was used to prioritise the digital tools most relevant to aviation education.
3. A Learning Design Thinking approach (Laurillard, 2012) guided the synthesis of results and formulation of recommendations, ensuring that the findings could inform systematic course development within WP4.

Together, these methods form a mixed-qualitative research design in which the literature review (Section 2) establishes the conceptual basis for analysing innovative didactical practices and digital tools, and the survey (Sections 3–4) provides empirical validation and partner perspectives.

1.4 Research Questions

In line with the project's objectives, this report addresses two central research questions:

- What innovative didactical approaches are most effective for developing digital and green competences in higher education, particularly within aviation-related programs?
- Which digital tools and platform functionalities best support active, flexible, and technology-enhanced learning environments?

1.5 Contribution

By integrating theoretical, empirical, and design-based insights, this report contributes to the broader goals of AVIONIC by providing a research-driven foundation for curriculum renewal

and digital learning resource development. Its results will directly inform the activities of **WP4**, supporting the creation of an open, modular, and transferable framework for teaching innovation in sustainable and digital aviation education.

2 State of the art

2.1 Didactical Practices in Higher Education

Contemporary higher education increasingly emphasises *learning design* as a central component of curriculum innovation, particularly in contexts requiring rapid adaptation to technological and environmental change. Didactical practices—defined as the structured interactions between educators, learners, and learning materials—have evolved from traditional, teacher-centred instruction to learner-centred approaches that prioritise engagement, autonomy, and collaboration (Biggs & Tang, 2011; Laurillard, 2012).

A core theoretical foundation for these transformations lies in **Bloom's Taxonomy** (Bloom, 1956), which provides a hierarchical model of cognitive processes ranging from remembering and understanding to creating. The taxonomy remains a fundamental tool for designing learning objectives that align with progressively complex cognitive demands. More recent adaptations have integrated this model into outcome-based education frameworks, linking instructional strategies and assessments to specific competence levels (Anderson & Krathwohl, 2001).

In higher education, the integration of constructive alignment ensures that course objectives, teaching activities, and assessments are coherently structured to reinforce intended learning outcomes (Biggs & Tang, 2011). This principle is essential in digital and sustainability-related education, where learners must develop both technical and transversal skills—such as systems thinking, problem-solving, and teamwork (UNESCO, 2020). Methods such as project-based learning (PBL), flipped classroom models, and experiential learning have demonstrated high efficacy in developing these skills by promoting active engagement and real-world problem solving (Kolb, 1984; Freeman et al., 2014).

In the field of aviation and transport education, didactical innovation increasingly integrates simulation-based learning, gamification, and scenario-based teaching. These methods enable learners to experience authentic operational contexts and to reflect on decision-making processes in risk-free environments (Salas et al., 2009). Scenario-based learning has been shown to enhance critical thinking and adaptive expertise—qualities essential for professionals operating in complex systems such as air transport and logistics. Furthermore, collaborative and intercultural approaches enrich the learning experience, reflecting the internationalised nature of the aviation sector.

The literature also highlights the growing relevance of learning analytics and feedback-driven pedagogy in supporting personalised learning (Ferguson, 2012). These tools allow instructors to adapt content and activities to learners' progress and needs, promoting inclusivity and continuous improvement. However, effective implementation requires that educators possess sufficient digital literacy and institutional support—an issue that remains a recurring barrier across European higher education institutions (European Commission, 2022).Overall, the literature suggests that best practices in didactical innovation depend on three interrelated dimensions: (a) *pedagogical design* guided by cognitive theory, (b) *technological mediation* that enables interactivity and adaptability, and (c) *institutional support* for continuous

pedagogical development. These principles guided the conceptualisation of the AVIONIC survey questions focusing on teaching methods, engagement, assessment, and course design.

2.2 Digital Tools for Teaching and Learning

Digitalisation has profoundly reshaped the higher education landscape, enabling new modalities of learning that are interactive, flexible, and scalable. According to the *Digital Education Action Plan 2021–2027* (European Commission, 2022), digital tools are not merely instruments for content delivery but central enablers of innovation in pedagogy, inclusion, and collaboration.

Digital learning tools encompass a wide array of functionalities, including Learning Management Systems (LMSs), collaboration and communication platforms, assessment systems, and multimedia content creation tools. Research indicates that well-designed digital ecosystems—integrating synchronous and asynchronous learning—enhance motivation and knowledge retention (Martin et al., 2020).

Previous European initiatives have provided valuable insights into effective digital teaching environments. The SEnDIng Project introduced a systematic classification of online platform features and functionalities, offering a taxonomy for evaluating their pedagogical relevance. It emphasised usability, accessibility, and learner engagement as decisive factors in the success of digital learning environments. Similarly, the Acadigia Project (2021) identified a range of tools—from Moodle Virtual Campus to Microsoft Teams and Wooclap—that can facilitate hybrid and collaborative learning experiences while ensuring inclusivity and feedback integration.

From a theoretical standpoint, Instructional Design and Learning Design Thinking provide the methodological backbone for selecting and implementing digital tools. The ADDIE framework (Dick, Carey, & Carey, 2014) structures instructional design into analysis, design, development, implementation, and evaluation phases, promoting a continuous cycle of improvement. Laurillard's (2012) concept of teaching as a design science extends this logic, positioning educators as designers who iteratively refine learning experiences through data, reflection, and feedback.

Emerging trends, such as microlearning, mobile learning, and virtual or augmented reality, have also expanded the didactical toolkit for aviation and engineering education (Patala & Bruce, 2018). These technologies allow learners to interact with complex operational systems and sustainability challenges in immersive and experiential ways. However, their pedagogical effectiveness depends on the coherence between the chosen technology and the intended learning outcomes—a principle at the core of constructive alignment.

The literature further highlights the necessity of integrating digital tools with assessment for learning practices. Automated grading systems, adaptive quizzes, and simulation-based evaluation tools enhance efficiency while providing immediate feedback, supporting both learners and instructors (Spector, 2014). Yet, the successful integration of these technologies requires balancing automation with human interaction to preserve the formative and relational dimensions of education.

2.3 Implications for Survey Design

The review of previous research and European projects informed the methodological design of the AVIONIC survey in three keyways. First, it established that both *pedagogical strategies* and *digital infrastructures* must be analysed together to understand the interplay between teaching approaches and technological environments. Consequently, the survey was structured in two complementary parts: (1) innovative didactical practices and (2) digital tools and functionalities.

Second, insights from *Learning Design Thinking* (Laurillard, 2012) and the *ADDIE* framework (Dick et al., 2014) guided the formulation of survey items focusing on phases of course development—from analysis and design to evaluation. This ensured that responses could be mapped against established instructional design processes.

Third, findings from projects such as SEnDIng and Acadigia shaped the inclusion of specific categories and descriptors for digital tool assessment. The AVIONIC survey adopted the SEnDIng classification model to allow respondents to rate tools based on their perceived pedagogical utility (from "useless" to "must-have"), ensuring comparability with previous European benchmarks.

Overall, the literature review provided the conceptual scaffolding for the empirical component of this report. By connecting theory, prior research, and practice, it ensured that the survey captured not only descriptive information about partner practices but also insights relevant to broader discussions on educational transformation in the green and digital era.

3 Methodology

3.1 Research Design and Approach

This study adopted an exploratory mixed-methods research design within an interpretive paradigm. An exploratory approach was appropriate because the goal was to investigate a relatively under-examined area—namely, innovative didactical practices and digital tools supporting digital and green skills in aviation education—and to "illuminate how [the] phenomenon is manifested," uncovering its nature where it is not yet well understood (Hunter et al., 2019). Such exploratory research is broad-ranging and purposive, aimed at discovering patterns and insights rather than testing hypotheses.

Consistent with an interpretivist tradition, the emphasis was on understanding participants' subjective experiences and contextualized practices. The overall research strategy can be characterized as a small-scale qualitatively-driven exploratory study: it combined qualitative and limited quantitative elements to gain a comprehensive view. This approach aligns with recommendations to integrate methods for depth of understanding in educational research (Creswell & Plano Clark, 2018).

Specifically, we deployed surveys that included both open-ended questions (qualitative) and closed-ended items (quantitative), thereby following a convergent design. This allowed the research team to gather rich narrative descriptions while also capturing some measurable trends (e.g., feature rankings), providing complementary data for interpretation.

3.2 Survey Instrumentation

Two survey instruments were developed to collect data; each tailored to a different aspect of the inquiry. Importantly, this section focuses only on the tools used—not their results, which are analyzed in Section 4.

First, a questionnaire on *innovative didactical approaches* was designed to gather best teaching practices from partner institutions. This questionnaire contained seven questions in total: two multiple-response questions (to identify preferred teaching approaches from a given list) and five open-ended questions prompting detailed qualitative descriptions of the methods and use of technology. The full survey form used for this data collection is provided in Annex 1.

The multiple-choice items provided a snapshot of which approaches were most commonly favored, while the free-form questions allowed respondents to elaborate on *how* these approaches were implemented in their context. The survey form was delivered online (via Google Forms) and remained open for responses for approximately six weeks (early February to mid-March 2023).

Second, to evaluate digital tools and platform features for teaching and learning, we employed a structured classification tool adapted from a previous EU project (the SEnDIng project). This took the form of an Excel-based survey instrument that listed a comprehensive set of online learning platform features organized by category (e.g. Collaboration tools, Assessment features, etc.). Respondents were asked to rate each feature's importance using a Likert-style

scale of 0 to 3 (where 0 = “useless,” 1 = “nice to have,” 2 = “useful,” and 3 = “must have”). This tool – originally developed and validated in the SEnDIng project – provides a systematic framework for classifying e-learning platform functionalities and prioritizing them based on users’ experience.

By adapting this instrument, we ensured our survey on digital tools was grounded in an established taxonomy of features previously used in EU educational contexts. In addition to the numeric ratings, the Excel survey included space for respondents to add comments or notes for any given feature, thereby capturing qualitative remarks alongside the quantitative ratings. The link to the Excel survey was distributed in parallel with the first questionnaire, and it received inputs over the same collection period (February–March 2023).

Note: Only the structure and delivery of this instrument are described here. The analysis of the input it generated is presented separately in Section 4.2.

3.3 Sampling Strategy

The sampling strategy was *purposive* and driven by the project’s context. Rather than a random sample of a broader population, we targeted key informants – faculty and trainers within the project consortium who have direct experience with digital and sustainable skills education.

Purposive sampling is a common approach in qualitative research whereby participants are selected based on their expected usefulness in providing rich information relevant to the study’s focus. In this case, each partner university (and the affiliated training center) was invited to contribute, under the rationale that they would be especially *knowledgeable* about innovative pedagogical practices in their own institutions.

The goal was to leverage these information-rich cases (Patton, 2002) to gather exemplars of best practices. Ultimately, six respondents (one or more from each partner organization) completed the didactical approaches survey, and five respondents provided responses in the digital tools prioritization survey. These participants included academic instructors and curriculum developers, all of whom were involved in teaching subjects related to aviation sustainability or ICT and thus well-positioned to report on relevant teaching methods and digital tool use.

While the sample size was modest, its expert composition was appropriate for an exploratory, qualitative study. The goal was insight rather than generalizability. These respondents served as the empirical foundation for the results presented in Section 4.

3.4 Data Collection and Analysis

This section outlines how raw data were collected and prepared for interpretation. Descriptive and thematic results are covered later in Section 4.

Both surveys were launched concurrently on February 2, 2023. The didactical approaches questionnaire (via Google Forms) collected both structured and narrative responses. Raw responses are provided in Annex 2. The Excel-based digital tools survey was also distributed and returned by March 15, 2023.

All submissions were reviewed for completeness. Google Form data were exported to spreadsheets, and Excel responses were consolidated. Minimal data cleaning was required.

To avoid overlap with findings, the analytical techniques are outlined briefly here but applied interpretations are deferred to Section 4.

Quantitative elements (e.g., multiple-response selections and feature ratings) were summarized using descriptive statistics. For example, average scores per feature category were calculated automatically via Excel formulas.

Qualitative data (open-ended questions and comments) were analyzed using thematic content analysis (Braun & Clarke, 2006). Researchers familiarized themselves with the data, developed initial codes, and iteratively grouped them into themes. Thematic reliability was strengthened through team discussion and triangulation.

A full discussion of the insights, including ranked feature categories and didactical themes, appears in the relevant subsections of Section 4.

4 Results and Discussion

This section presents the findings of the study, structured around four key analytical dimensions: (1) innovative didactical practices for sustainability and digital skills development, (2) prioritized digital platform features, (3) emerging examples of integrated tool–pedagogy configurations, and (4) simulated operational learning practices. The structure aligns with the dual data collection approach described in Section 3 and reflects the themes that emerged from the analysis of both survey instruments.

4.1 Innovative Didactical Practices

The first part of the study focused on identifying effective didactical approaches used by partner institutions in the context of aviation-related sustainability education. Based on qualitative responses from six partner organizations, four key thematic areas emerged: course design and development, teaching and learning methods, student engagement and motivation, and learning assessment. These themes were analyzed in light of current pedagogical theory and frameworks reviewed in Section 2.

Table 1 provides a structured mapping of how instructional types—ranging from lectures to labs—have been adapted to online contexts through specific digital tools. These mappings reflect AVIONIC partners' strategies for aligning methods and technologies under varying instructional goals.

Table 1 Adapting Teaching Methodologies in Online Settings

Instruction Type	What to Use / For What?	Technology / Tools	Corporate Applications	Other Tools
Master Lesson, Expert Session, and Problem Classes	Virtual classes; synchronous sessions	Videoconferences	Blackboard Collaborate, Microsoft 365 (Teams)	Zoom
Master Lesson, Expert Session, and Problem Classes	Asynchronous video lessons (short lessons recorded on video)	Recorded video, video conference, creating videos	Blackboard Collaborate, Microsoft Teams, Zoom, Whiteboards	PowerPoint, OBS, Camtasia
Self-Evaluation	The student monitors progress; the teacher performs formative assessment	Questionnaires, Exams, Polls, Votes	Moodle, Microsoft Teams, Blackboard, Zoom	Kahoot, Socrative, Quizizz
Laboratory Practices	The student applies skills specific to their subject	3D practice simulations, recorded experiences	—	Virtual Laboratories
Cooperative Learning	Collaborative student work to	Forums, wikis, blogs, databases,	Moodle Platform,	Blogs, infographics,

	achieve common goals	chat, simultaneous writing, conferencing, shared storage, project platforms	Microsoft 365 (OneDrive, Planner)	shared documents, video presentations
Other Activities	Readings, searching for summaries, videos with embedded questions	Tasks, forums, videos	Moodle, Microsoft Teams	RSS, edpuzzle, content curation tools

Source: (Acagica Project, adapted by Patala, 2023)

4.1.1 Course Design and Development

Respondents consistently highlighted the importance of applying a systematic learning design approach that accommodates the diverse needs and learning preferences of students. This aligns with constructive alignment principles (Biggs & Tang, 2011) and Learning Design Thinking (Laurillard, 2012), which advocate for curriculum coherence and adaptability. Common practices included:

- Use of project-based learning (PBL) flipped classroom models, and experiential learning to foster student-centred, active learning.
- Consideration of multimodal preferences (visual, auditory, kinesthetic, reading/writing) when selecting resources and structuring lessons.
- Integration of hybrid education formats that combine online modules with face-to-face interaction to provide flexible learning pathways.
- Promotion of intercultural understanding through audiovisual resources and the inclusion of diverse perspectives.
- Collaboration across institutions through MOOCs and workshops, supporting shared curriculum innovation.

These approaches echo the literature on effective course design for sustainability and digital competence development (Kolb, 1984; UNESCO, 2020).

The pedagogical practices reported show a strong emphasis on methods that enable active and situated learning. Project-based learning, simulations, and case-based approaches emerged not only as frequent practices but as deeply aligned with the goals of sustainability and real-world application in aviation contexts. These methods support the acquisition of complex, cross-disciplinary competences and were consistently paired with digital tools that extend learning beyond the classroom.

4.1.2 Teaching and Learning Methods

The survey data revealed widespread use of digital and collaborative pedagogies. Tools such as forums, cloud-based platforms (e.g., Moodle, Google Drive), and multimedia simulations were used to support:

- Active learning through gamified content, simulations, and real-world case analysis.
- Peer collaboration using platforms that facilitate file-sharing, co-authoring, and teamwork.
- Flexible access to learning resources, including video lectures, interactive whiteboards, and podcasting tools.

This convergence of digital media and collaborative learning reflects the trend toward constructivist and networked pedagogical models (Laurillard, 2012; Freeman et al., 2014).

4.1.3 Promoting Engagement and Motivation

Technological integration was seen as a key enabler of engagement, particularly in hybrid and asynchronous learning environments. Educators reported:

- Use of Virtual Learning Environments (VLEs) for dynamic content presentation, learner tracking, and discussion facilitation.
- Promotion of teamwork through group projects aligned with student interests.
- Ongoing feedback mechanisms, including real-time discussions, class polls, and student reflection sessions.

These practices reflect the motivational principles of self-directed learning and social presence in blended contexts (Martin et al., 2020).

4.1.4 Learning Assessment

Assessment strategies emphasized both formative and summative elements:

- Preference for group projects, continuous assessment, and paper-based exams.
- Use of role-play and discussion-based assessments to evaluate student understanding of sustainability scenarios.
- Attention to alignment between learning objectives and assessment tasks, consistent with Bloom's Taxonomy (1956) and the ADDIE model (Dick et al., 2014).

Overall, the didactical practices reported by partners illustrate a strong alignment with progressive educational models that support digital and green competencies in aviation.

The reported didactical approaches align with various cognitive levels, from basic understanding to complex application and creation. Figure 1 maps these instructional strategies against Bloom's taxonomy, illustrating how the selected methods support progressive cognitive engagement in aviation-related sustainability education.

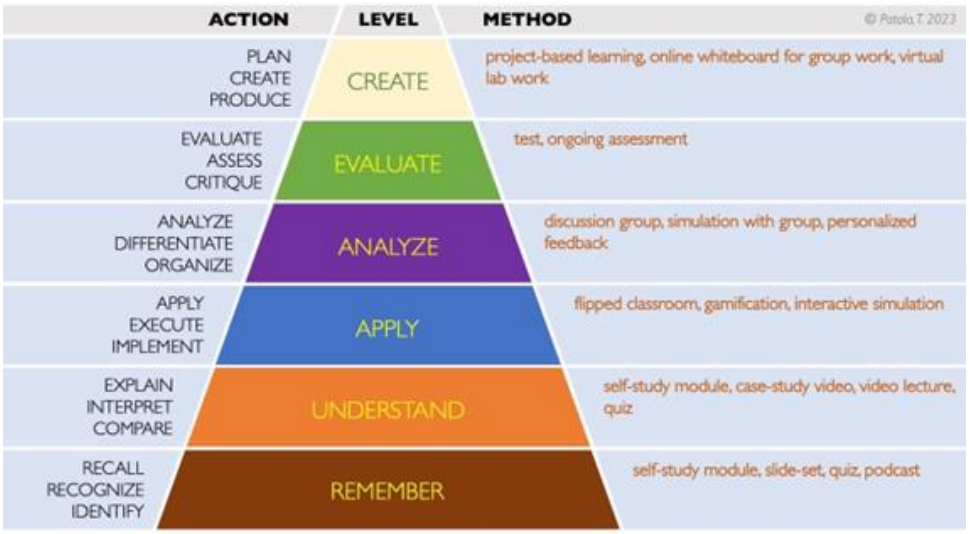

Figure 1 Alignment of didactical best practices based on cognitive demand for Avionic project (Patala 2023)

4.2 Digital Tools and Platform Features

The second part of the study aimed to classify and prioritise digital platform features based on inputs from five project partners. Using the Excel-based classification tool adapted from the SEnDIng project, respondents rated each feature's importance using a 0–3 scale. The results allowed categorisation of features into "must-have", "useful", and "nice-to-have" tiers.

Using a scale from 0 to 3, a weight was assigned to each feature, with informants also providing open comments. After data collection, the responses were aggregated into a centralized sheet that automatically calculated category averages. This enabled a structured comparison of priorities across categories.

Figure 2 provides an overview of the classification instrument used to assess digital tool functionalities, organized by category and rated importance.

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Survey participant information
Name: *fill in here*
Role in the project: *fill in here*
Partner organization: *fill in here*
Date of form completion: *fill in here*

Action 2.3 - Prioritization of the *Features and Functionalities of Digital Tools* for Teaching and Learning

Category	Feature	Weight (0=useless 1=nice to have 2=useful 3=must have)	Add below your additional notes and remarks when necessary	Cat. AVG
Collaboration	Discussion board	0		**0,0**
	Live chat	0		
	Online conferencing tools	0		
	Social networking	0		
Content Authoring & Management	Editor for content authoring (for basic graphical presentations)	0		**0,0**
	Editor for content authoring (advanced supporting interactions)	0		
	Shared content authoring	0		
	Support for standard document formats	0		
	Screen recording	0		
	Learning Wiki	0		
	Students can record or upload audio and video	0		
	Audio and video messaging	0		
	Content ranking	0		
	Editor for producing videos	0		
	Audio recordings	0		
	Multimedia-based simulations	0		
Assessment	Built-in assessment tools	0		**0,0**
	Support for external assessment/evaluation tools	0		
	Exam engine	0		

Figure 2 Classification and prioritization of online learning tools and platform features using the MS Excel -based tool

4.2.1 Must-Have Features (Avg. Score ≥ 2.5)

- Assessment Tools: Built-in quiz engines, support for external evaluations.
- Progress Monitoring: Analytics, progress tracking, and certification tools.
- User Management: Simplified registration, role configuration, course notifications.
- Usability and Access: Support for document formats, mobile accessibility, multilingual interfaces.

These results reflect the pedagogical emphasis on continuous assessment, learner autonomy, and accessibility—all central to effective blended learning environments (Patala, 2021).

4.2.2 Useful Features (Avg. Score 2.0–2.4)

- Content Authoring: Shared content creation, video editing, screen recording.
- Collaboration Tools: Online conferencing, forums, live chat.
- Personalised Learning: Calendars, notifications, and instructor-led course support.

While not ranked at the top, these tools were still valued for enhancing interactivity and content richness.

Category	Feature	Weight AVERAGE
Collaboration	Discussion board	2,2
	Online conferencing tools	2,4
Content Authoring & Management	Editor for content authoring (for basic graphical presentations)	2,5
	Editor for content authoring (advanced supporting interactions)	2,3
	Shared content authoring	2,7
	Support for standard document formats	2,8
	Multimedia-based simulations	2,3
Assessment	Built-in assessment tools	2,5
	Support for external assessment/evaluation tools	2,3
	Exam engine	2,7
	Peer-assessment	2
User Management	Self-enrollment	2,3
	Simplified user registration	2,8
	Course notifications	2,7
	Calendar / event management	2,5
Reports and progress follow-up	Tracking of personal progress	2,7
	Analytics & reporting (basic)	2,7
	Analytics & reporting (advanced incl. Visualizations)	2,2
	Certifications & cert. Management	2,2
	SCORM Support (incl. Use of external course packages)	2,2
Usability & access	Personalized learning	2,4
	Search	2,3
	Full support for mobile use	2
	Course catalog	2,7
	Support for instructor-led classes	2,3
	Multi-lingual user interface	2
	Offline mode	2
Maintenance & support	Automated updates	2,1
	Automated backups	2
Other	Support for external service integrations	2

Figure 3 Learning platform features and functionalities considered as "must have" or "useful"

4.2.3 Nice-to-Have Features (Avg. Score < 2.0)

- Features such as audio recordings, learning wikis, and advanced visualisation tools were rated lower, possibly due to lack of familiarity or integration in current institutional platforms.

These priorities confirm the importance of basic functionality and usability before adopting more experimental or resource-intensive tools. The full set of responses collected through the digital tools prioritization survey is provided in Annex 4.

A detailed overview of the digital platforms and tools used by project partners—along with their pedagogical purposes and modes of use—is provided in Annex 4. Summary of Digital Tools and Their Pedagogical Purposes Used by AVIONIC Partners

4.3 Emerging Integrated Practices

Cross-analysis of the survey findings shows that the value of digital tools is best realized when they are closely aligned with pedagogical aims and instructional models. Partners provided

several concrete examples where tools and teaching practices were effectively integrated to support learner engagement, sustainability literacy, and flexible learning pathways.

For instance, project-based learning approaches described by partners were often facilitated by digital platforms that supported real-time collaboration, file sharing, and discussion forums. This enabled teamwork distributed across campuses and institutions, extending the classroom into a virtual, problem-solving environment.

Simulation-based learning was another recurrent strategy. Airport College International employed multimedia-rich simulations to train learners in scenario-based safety procedures—tools that combined video, decision-tree logic, and embedded assessments. These tools align directly with experiential learning theories and demonstrate how interactivity can enhance practical understanding.

Gamification elements, such as digital badges or progress tracking dashboards, were used to motivate learners and maintain engagement over longer online modules. These features were frequently cited in the survey as "useful" or "must-have" in supporting learner persistence and autonomy.

Partners also highlighted the importance of pairing assessment strategies with supportive analytics. One university reported using quiz engines alongside learner dashboards to provide both students and instructors with real-time feedback—thus supporting formative assessment loops within hybrid courses.

These cases illustrate the emerging pedagogical configurations in which tool categories are no longer siloed but are used in orchestration with methods such as flipped learning, hybrid delivery, and continuous assessment. The AVIONIC project can build on these insights by designing course templates and toolkits that reflect this integration.

A key insight from the cross-analysis is that digital tools are most impactful when strategically aligned with pedagogical aims. Several integrated practices emerged from partner examples:

- Airport College International. Implemented scenario-based simulations using game-like interfaces to support aviation safety training. These simulations were closely tied to content authoring tools, multimedia playback, and progress tracking features.
- University of Strasbourg. Developed role-playing games in sustainability education, where learners acted as stakeholders in environmental debates. The activity leveraged collaborative tools, polling apps, and video conferencing features to enable distributed participation.

- **General Practices Across Partners**

    - Flipped classrooms supported by video authoring and LMS integration (e.g. Moodle, Teams).
    - Continuous assessment supported through built-in quiz engines and analytics dashboards.

- Self-paced modules delivered via mobile-optimized platforms with VLE integration.

These examples illustrate that the value of a digital tool is amplified when it is embedded within a coherent instructional design strategy—particularly one that supports collaborative, contextualized, and reflective learning.

4.4 Mimicking Operational Scenarios for Learning

One of the innovative practices identified through the AVIONIC project relates to the use of mimicked or simulated operational scenarios in digital and blended learning. Scenario-based learning offers a powerful way to develop learners' decision-making, reflection, and practical problem-solving abilities within realistic aviation environments. This aligns closely with the project's aim to build applied and transferable digital and green skills for sustainability in aviation.

Mimicking operational scenarios refers to learning designs in which students are placed in realistic yet simulated professional contexts, such as safety procedures, team communication, or decision-making in airport operations. These simulations are structured around interactive and feedback-rich sequences that progress based on learner choices. They may include elements such as role-play, branching narratives, score tracking, or time-based missions, thus blending experiential and game-based learning principles.

Airport College International, one of the AVIONIC partners, has implemented several forms of scenario-based training in its digital courses. These practices include:

- Action Simulation: Aimed at process learning, this simulation approach supports contextualized skill acquisition in virtual environments. Learners follow safety-critical procedures (e.g., fire safety, evacuation protocols) through visual, step-by-step actions and receive feedback based on their decisions. These simulations eliminate real-life risks and support mastery learning.
- Interaction Simulation: Designed for developing soft skills, this method simulates interpersonal communication or customer-facing tasks. Learners navigate story-based challenges—such as problem-solving during a service failure—while receiving feedback from virtual characters or coaches. This fosters reflection on behavioral consequences and enhances situational awareness.
- Virtual Role-Play: Focused on deep learning through emotional engagement and perspective-taking, virtual role-play immerses learners in multi-character scenarios. By adopting specific roles (e.g., supervisor, technician, team member), participants explore team dynamics, reflect on interaction strategies, and develop leadership and collaboration skills.

These methods support sustainability-related competencies by embedding learning in lifelike contexts. As emphasized in the literature (Laurillard, 2012; Patala & Bruce, 2018), experiential and design-based approaches are particularly effective in fostering complex cognitive skills and transversal competences. Scenario-based learning aligns well with both Bloom's higher-order cognitive objectives (analyze, evaluate, create) and instructional design models such as

ADDIE (Dick et al., 2014).

The implementation of such practices can be scaled across partner institutions using authoring tools, multimedia environments, or virtual reality, depending on technical capacity. A conceptual framework for designing these scenarios—adapted for aviation education—is proposed as a follow-up action for Working Group 2.

4.5 Findings from Other Research, Projects, and Experiments

To enrich the project's internal findings, this section synthesizes insights from related European and international initiatives focused on digital education, instructional tools, and innovative pedagogies relevant to sustainability and aviation. These benchmarks provide valuable cross-validation for the didactical practices and tool features identified in the AVIONIC project.

4.5.1 University of Strasbourg: Serious Game for Sustainable Airport Planning

A practical illustration of game-based learning in sustainability education comes from the University of Strasbourg, where an experimental serious game was designed to enhance students' comprehension of environmental issues in aviation planning. This initiative exemplifies the integration of experiential learning, stakeholder role-play, and flipped classroom models—key pedagogical directions supported by the AVIONIC project.

The activity, conducted by the ICUBE Laboratory, aimed to foster reflective, systems-level thinking through an inverted design model. In this approach, students first engaged with a fictional scenario involving a proposed airport expansion, before being introduced to the real-world environmental, social, and technical challenges that mirrored the narrative. This reverse sequencing—fiction first, reality second—was intended to activate learners' intuitive reasoning and surface preconceptions, thereby enriching subsequent analytical reflection (Kolodner, 2002; Barab et al., 2009).

Game Structure and Implementation.

The game unfolded in two facilitated sessions. Participants included six students from the engineering program and sixteen students from the bachelor's degree in ecodesign. Each student was assigned a stakeholder role, such as airport authorities, environmental NGOs, municipal planners, or logistics operators. These roles were accompanied by briefing documents outlining priorities, constraints, and environmental stances.

The gameplay was organized into the following phases:

1. Scenario Familiarization – Students received a fictional planning brief for the proposed airport extension, including economic forecasts, environmental assessments, and stakeholder maps.
2. Stakeholder Roundtable – Role-based negotiations simulated multi-party consultation and decision-making under time pressure and partial information.
3. Impact Reflection – Facilitators introduced real-world data corresponding to the fictional scenario, prompting comparisons, cognitive dissonance, and reassessment of prior decisions.

4. Synthesis & Debrief – Students synthesized insights in reflective journals and participated in a collective debriefing to discuss broader implications for sustainable infrastructure planning.

The game embedded affective and cognitive triggers to elicit emotional engagement and deeper ethical reflection—outcomes consistent with literature on transformative sustainability learning (Sterling, 2010; Wiek et al., 2011). Observations during the sessions indicated heightened student awareness of trade-offs between economic development, environmental protection, and social acceptability.

Learning Outcomes and Impact

The activity demonstrated notable gains in learners' ability to recognize competing stakeholder interests, apply systems thinking, and articulate arguments grounded in sustainability principles. Follow-up interviews and facilitator notes recorded shifts in student perspectives and increased engagement with the complexity of real-world decision-making.

This example illustrates how serious games and inverted pedagogies can be used not only to convey content but also to cultivate cross-cutting competencies such as critical thinking, empathy, and interdisciplinary collaboration. It provides a promising model for replication across AVIONIC partner institutions and supports the broader pedagogical goals outlined in Sections 4.1 and 4.4 of this report.

4.5.2 Tool Recommendations from the Acadigia Project

The *Acadigia* project (2020-1-PT01-KA226-HE-095042), funded under Erasmus+ for digital readiness in higher education, offers a structured framework for selecting digital tools according to pedagogical function. Partner institutions—including the Polytechnic Institute of Porto and the Polytechnic University of Madrid—classified tools into categories based on teaching purpose, such as content delivery, collaboration, and formative assessment.

Annex 6 illustrates how tools like collaborative whiteboards, discussion forums, or screen recorders serve different instructional objectives depending on whether the aim is synchronous engagement, independent practice, or peer feedback. These distinctions can support AVIONIC partners in aligning tool selection with their specific course designs.

4.5.3 Translating Teaching Methodologies for Online Contexts

Acadigia also explored the adaptation of common face-to-face teaching methods to online and hybrid environments. Table 2 (see Annex) synthesizes recommended methods such as:

- Translating lectures into short, pre-recorded videos and live Q&A sessions
- Replacing classroom discussions with forum-based peer review
- Shifting project-based learning into collaborative document editing or simulation tools

These translations are particularly useful for institutions transitioning to blended formats in aviation training.

4.5.4 Game-Based Approaches to Teaching Sustainability

The University of Strasbourg (ICUBE Lab) experimented with game-based pedagogies to

promote environmental awareness and systems thinking. Their serious game was structured around dual timelines—fictional and real-world—and included role-play among engineering and eco-design students. Conducted in multiple sessions, the activity was designed to trigger emotional engagement and foster critical thinking about environmental impact.

Preliminary observations indicated increased learner motivation and improved capacity to assess sustainability trade-offs. Such models of inverted design and emotional cognition could be adapted for AVIONIC's sustainability modules.

4.5.5 Assessing Organizational Maturity in Digital Skills (DSC 4.0 Tool)

Another relevant benchmark comes from the DSC 4.0 diagnostic tool developed by the University of Strasbourg in collaboration with industrial partners. Originally designed to assess digital maturity in Industry 4.0 contexts, it enables organizations—including higher education institutions—to:

- Evaluate their digital transformation readiness
- Identify skill gaps and training needs
- Structure course offerings aligned with competency frameworks

The tool's structure—an Excel-based self-assessment covering 24 indicators—can serve as a practical framework for AVIONIC partners to align institutional development with course innovation in the green and digital transition. A full structural overview of the DSC 4.0 tool—detailing its domains, indicators, and scoring logic—is provided in Annex 8.

4.5.6 The SkillUp Aviation Skills Portal

The SkillUp project (408540-EPP-1-2019-1-IT-EPPKA2-SSA) focused on the upskilling and reskilling of aviation professionals. Its outcomes include a publicly accessible portal of learning resources tailored to emerging roles in aviation. These include training content on environmental compliance, digital systems, and cross-disciplinary innovation. AVIONIC can benefit by mapping its curriculum innovations against the roles and competencies identified in SkillUp, particularly in aligning with ESCO and EQF standards. A summarized index of relevant SkillUp learning resources is provided in Annex 9.

AVIONIC can benefit by mapping its curriculum innovations against the roles and competencies identified in SkillUp, particularly in aligning with ESCO and EQF standards.

4.6 Designing Scenario-Based Learning: A Conceptual Framework for Mimicking Operational Scenarios

Scenario-based learning (SBL) has emerged as a pedagogically powerful approach in the context of digital and blended education, particularly for domains requiring applied problem-solving, critical reflection, and situational awareness. In the AVIONIC project, mimicking operational scenarios has been identified as a strategic method to enhance learners' practical understanding of sustainability and safety in aviation. This section presents a conceptual framework to guide the design and integration of such scenarios into instructional models across participating institutions.

4.6.1 Rationale and Theoretical Foundation

Scenario-based learning is grounded in experiential learning theory (Kolb, 1984) and design-based pedagogy (Laurillard, 2012), both of which emphasize the value of learning through doing, reflection, and iteration. By engaging learners in realistic decision-making processes within simulated environments, SBL supports the development of higher-order cognitive and transversal skills. These include systems thinking, ethical reasoning, teamwork, and adaptive expertise—all critical for sustainable aviation.

From a cognitive standpoint, scenarios provide authentic contexts that align with Bloom's taxonomy's upper levels: analysis, evaluation, and creation (Anderson & Krathwohl, 2001). Additionally, the scenario format facilitates learning cycles that include feedback and self-regulation, echoing principles of formative assessment and learner agency (Black & Wiliam, 2009).

4.6.2 Components of the Framework

The proposed framework comprises five key components that can be adapted according to instructional goals, technical resources, and learner profiles.

- Scenario Structure and Logic: Scenarios should follow a narrative arc consisting of context introduction, challenge articulation, decision points, and consequences. Decision pathways may be linear or branching, depending on the desired level of complexity.
- Role Definition and Perspective-Taking: Learners are assigned roles (e.g., airport operations manager, sustainability officer, technician) to facilitate perspective-taking and deepen contextual understanding. Roles may be individual or collaborative, encouraging social learning.
- Embedded Feedback and Reflection Points: At each decision node, learners receive immediate feedback on the implications of their actions. This may be automated (in digital formats) or guided by facilitators. Reflection prompts (e.g., "Why did this outcome occur?") reinforce metacognitive engagement.
- Integration with Assessment: Scenarios can serve both formative and summative functions. Rubrics may be developed to assess decision quality, ethical reasoning, and knowledge application. Progress through the scenario may also be tracked for analytics.
- Technical Delivery Modes: Depending on institutional capacity, scenarios can be delivered via multimedia authoring tools, learning management systems (LMS), or immersive environments (e.g., virtual reality). Low-tech versions may rely on slide decks or PDFs with facilitator support.

4.6.3 Application in the AVIONIC Context

Several AVIONIC partners, notably Airport College International, have piloted such approaches. Their models include:

- Action Simulation for procedural training (e.g., fire safety).

- Interaction Simulation for soft skills (e.g., conflict resolution).
- Virtual Role-Play for group-based problem-solving (e.g., sustainability planning).

The flexibility of this framework allows it to be adapted across academic and vocational settings. For example, technical universities may focus on operational simulations involving environmental trade-offs in airport logistics, whereas humanities departments may use stakeholder role-play to examine ethical dimensions of green transitions in aviation.

4.6.4 Next Steps and Scalability

Working Group 2 will take this conceptual model forward during the upcoming Strasbourg workshop. Partners will collaboratively develop scenario templates, identify required tools, and define integration pathways within their curricula. To support this, a repository of sample scenarios and authoring resources will be proposed. Further research will also evaluate the effectiveness of implemented scenarios on learner outcomes, particularly in digital sustainability competencies.

By formalizing and scaling scenario-based learning practices, the AVIONIC project can enhance the realism, relevance, and impact of sustainability education in aviation.

5 Conclusion and Recommendations

This report examined innovative didactical practices and the effective use of digital tools to support green and digital skills development in aviation-related higher education. It addressed the objectives of AVIONIC Work Package 2, Action 2.3, and provides a foundation for subsequent instructional design activities in Work Package 4.

A mixed-method approach was used to collect and analyse data from six higher education and workplace training partners. The findings revealed pedagogical strategies that emphasize active, flexible, and collaborative learning, supported by the strategic integration of digital platforms and tools.

Key insights include:

- Pedagogical innovation is strongly represented by project-based learning, experiential tasks, flipped classrooms, and hybrid delivery formats. These practices are aligned with constructivist and learner-centred educational theories and are particularly well suited to developing complex competencies such as sustainability literacy and digital fluency.
- Digital tools are not inherently valuable in isolation but gain significance when integrated within purposeful instructional designs. Features prioritised by partners—such as assessment engines, progress tracking, and user management—support feedback loops, learner autonomy, and accessibility.
- Tool-practice alignment emerged as a critical success factor. When tools were clearly mapped to pedagogical goals (e.g., simulations for real-world problem solving, collaboration tools for teamwork), their educational impact was notably enhanced.

These findings support the development of transferable models for course design within AVIONIC and beyond. They highlight the importance of an intentional approach to both pedagogy and platform selection in the digital transformation of higher education.

5.1 Recommendations

To ensure the sustainability and impact of these insights, we recommend the following actions:

For WP4 Instructional Design Teams:

- Develop modular course templates that incorporate high-impact pedagogical approaches (e.g., PBL, simulation, formative assessment) aligned with priority digital tools.
- Use the feature classification as a basis for selecting or customizing platforms for future learning activities.

For Educator Support and Capacity Building:

- Provide training on using core functionalities (e.g., assessment engines, collaboration tools) effectively within blended and hybrid models.

- Promote knowledge sharing through inter-institutional workshops showcasing integrated tool-practice examples from AVIONIC partners.

For Future Research and Implementation:

- Pilot the identified tool–pedagogy configurations in upcoming AVIONIC learning activities.
- Evaluate learner outcomes to validate and refine the proposed instructional designs.

By integrating these recommendations into the broader instructional design and implementation framework of AVIONIC, the project can contribute concrete, scalable practices to the transformation of aviation education in line with European green and digital policy goals.

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