



Integrating Sustainability and Environmental Education into the Drone Engineering Curriculum

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Abstract

The curriculum “Architecture and Avionics of Drones” has been evaluated against international academic and professional standards established by major educational and quality assurance organizations. It addresses current labor market needs by integrating unmanned aerial vehicle technologies, global navigation satellite systems, photogrammetry, and three-dimensional data processing. The program demonstrates strong academic quality through clearly defined learning outcomes, well-structured content, and rigorous assessment methods. It incorporates advanced hardware and software tools, including Arduino platforms, micro-electro-mechanical sensors, Pix4D, and Agisoft applications, supporting technological innovation and practical learning. The curriculum promotes active and project-based learning, encouraging interdisciplinary problem-solving and practical skill development. Inclusiveness is supported through bilingual instruction, with recommendations to expand English-language components to increase international accessibility. The program offers a balanced and innovative educational experience that prepares students to use unmanned aerial vehicle technologies responsibly and effectively in professional contexts.

Keywords: “Architecture and Avionics of Drones”; curriculum; environmental education; professional standards

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1. Introduction

In recent years, the curricular integration of Unmanned Aerial Vehicle (UAV) technologies has become an important direction in the modernization of engineering and STEM education. Recent review studies demonstrate that drones are increasingly used as educational tools for developing technical, digital, and interdisciplinary competences, while also improving student motivation, engagement, and experiential learning processes (Pergantis, P., & Drigas, A., 2024). Current research also shows a transition from isolated drone-based activities toward curriculum models that connect drone engineering with broader societal and environmental challenges. In this regard, recent studies on drone-enabled STEM curriculum design highlight the value of transdisciplinary learning pathways, where students engage not only with flight operation and system design but also with authentic real-world applications, innovation-oriented problem solving, and sustainability-related tasks (Yeung et al., 2025). Another important direction in the literature concerns the use of virtual, intelligent, and simulation-based learning environments for drone education. Recent studies indicate that virtual drone systems combined with three-dimensional terrain modeling improve spatial understanding, technical judgment, and decision-making, while AI- and data-driven instructional approaches support the development of skills in data acquisition, image interpretation, and environmental information analysis (Schleiss et al., 2026). At the same time, research in engineering education confirms that drone-focused programs strengthen learning outcomes related to engineering knowledge, experimentation, problem solving, teamwork, and the use of modern digital tools. These findings support the argument that the “Architecture and Avionics of Drones” curriculum should not be regarded only as a technical course, but as a strategic educational framework capable of contributing to the green and digital transition by preparing specialists able to use UAV technologies responsibly in environmental monitoring, sustainability assessment, and community-oriented innovation (Hussain et al., 2024; Konovets, 2025).

In addition, the literature emphasizes that the integration of drones into university curricula should be accompanied by interdisciplinary curriculum design, ethical reflection, and clear connections between learning outcomes, competences, and assessment methods. Such recommendations are essential for updating engineering curricula in line with international quality standards and contemporary labor market needs (Schleiss et al., 2026). Against this background, the project “Sustainable Environment through Drone Education” responds to the emerging need to integrate technology, education, and sustainability into a unified training framework. The initiative aims to promote innovative solutions to environmental challenges by harnessing the potential of drones for ecosystem monitoring and protection. By developing interdisciplinary competences in engineering, ecology, artificial intelligence, and data analysis, the project seeks to train a new generation of specialists capable of operating drones for environmental conservation and the responsible management of natural resources. The project “Sustainable Environment through Drone Education” responds to the emerging need to integrate technology, education, and sustainability into a unified training framework. The initiative aims to promote innovative solutions to environmental challenges by harnessing the potential of drones for ecosystem monitoring and protection. By developing interdisciplinary competencies in engineering, ecology, artificial intelligence, and data analysis, the project seeks to train a new generation of specialists capable of operating drones for environmental conservation and responsible management of natural resources.

An essential aspect of this endeavor is the analysis and reconceptualization of the “Avionics and Drone Architecture” curriculum so that it meets current labor market demands, ecological challenges, and the needs of future-oriented education. The revised curriculum must reflect global trends in digitalization, sustainability, and transversal skills, becoming a key tool for implementing green and technology-based education. The reconceptualization of the “Avionics and Drone Architecture” curriculum is directly reflected in the structural model

presented in Figure 1. The model illustrates how the curriculum is organized as an integrated system that connects administrative components, learning content, competencies, and the teaching–learning–assessment process with technological tools and real-world applications. In this framework, the content modules (e.g., avionics, GNSS, sensors, data processing) ensure alignment with current technological and labor market demands, while the competency-based approach supports the development of transversal skills such as problem-solving, teamwork, and digital literacy.

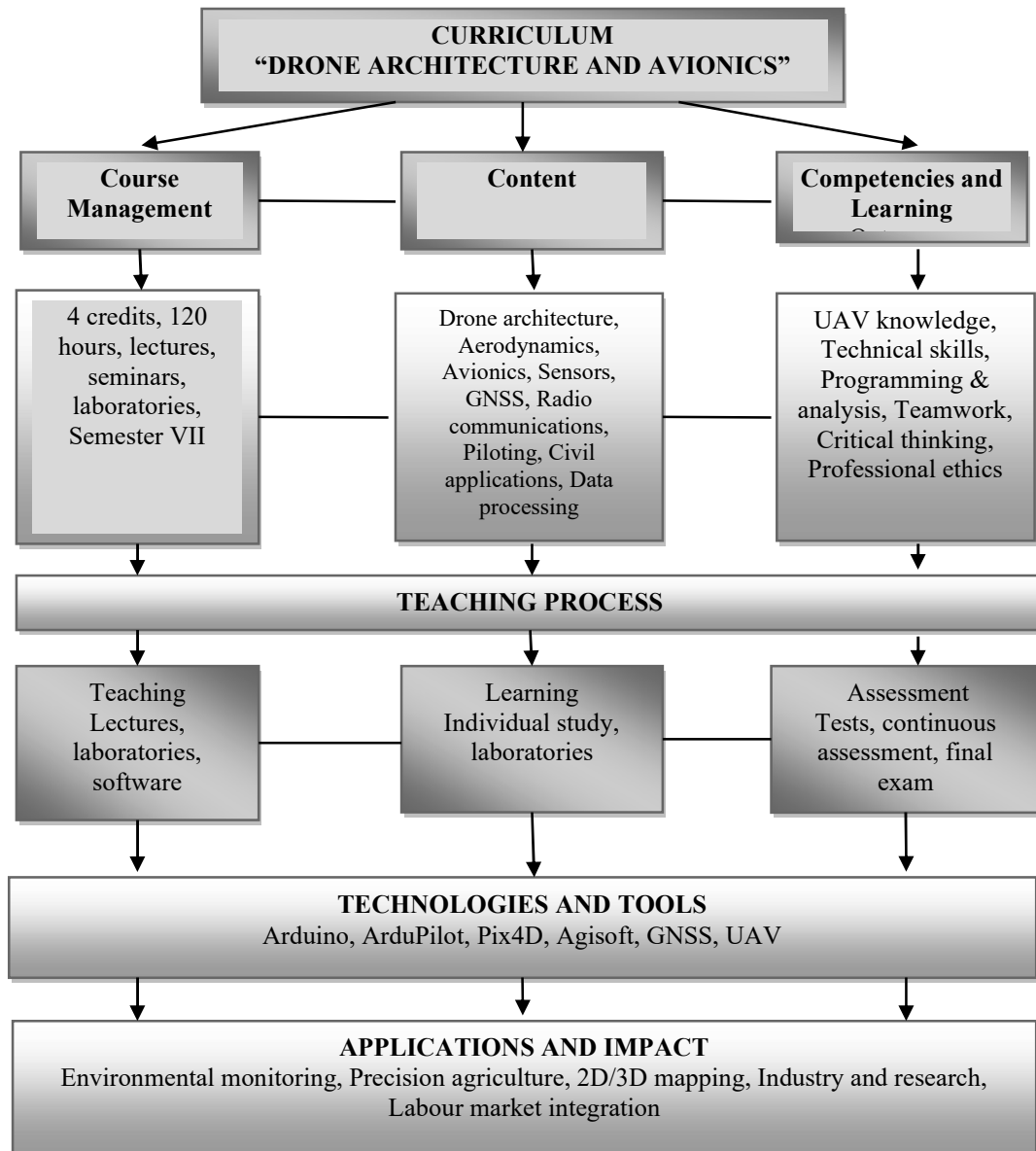


Figure 1. Structural model of the “Architecture and Avionics of Drones” curriculum, illustrating the interconnection between administrative structure, learning content, competencies, teaching–learning–assessment process, technological tools, and real-world applications

Furthermore, the teaching and learning dimension, based on practical activities, laboratories, and software tools (e.g., Arduino, Ardupilot, Pix4D, Agisoft), facilitates experiential and project-oriented learning, which is essential for future-oriented education. The assessment

component ensures continuous evaluation of both theoretical knowledge and applied skills. At the same time, the integration of applications and impact areas (such as environmental monitoring, precision agriculture, and 3D mapping) demonstrates how the curriculum contributes to sustainability and green education.

The article aims to analyze and highlight the role of drone-based education in promoting environmental sustainability through the adaptation of the “Avionics and Drone Architecture” curriculum to the current demands of the labor market, digitalization, and environmental protection. The necessity of this article arises from the increasing environmental challenges and the rapid development of drone-based technologies, which require the adaptation of educational systems to develop relevant and up-to-date competencies. It is essential to align the curriculum with the demands of the labor market, digitalization, and sustainability to support the responsible use of drones in environmental protection. At present, the course is available to undergraduate students from the Faculties of Physics and Engineering, Biology and Geosciences, as well as Mathematics and Computer Science within Moldova State University (MSU). In this context, we conducted an analysis of the “Drone Architecture and Avionics” curriculum for the first cycle of undergraduate studies, using several sets of internationally recognized indicators for quality assurance in higher education.

2. Theoretical Framework

In recent years, the use of drones in engineering and STEM education has become a strategic vector for curricular innovation. According to Pergantis & Drigas (2024), drones foster experiential learning and the development of interdisciplinary skills, combining physics, programming, and critical thinking. This perspective supports the reorientation of the “Avionics and Drone Architecture” program toward practical, experimental, and collaborative activities. Caballero-Martín et al. (2024) highlight that integrating artificial intelligence into UAV control enhances system autonomy and safety. This argument justifies the introduction of a new module in the curriculum — AI applied to drones and environmental data analysis — to prepare students for using drones in climate change monitoring, biodiversity assessment, and pollution analysis.

The Future-Proof STEM Education model proposed by Konovets (2025) advocates combining drones, AI, and 3D printing within a project-based learning (PBL) educational ecosystem. This vision aligns with the CDIO framework (Conceive–Design–Implement–Operate), which emphasizes creativity, innovation, and practical application of knowledge — elements that can redefine the structure and methodology of the “Avionics and Drone Architecture” course. In the same context, Hussain et al. (2024) introduce the concept of Droneduction, where UAV technology becomes an integral part of pedagogy in Industry 4.0. This educational model develops digital, collaborative, and problem-solving competencies, aligning with DigCompEdu and ABET objectives. The curriculum reconceptualization must therefore also include dimensions such as systems thinking, innovation, and technological ethics.

Schleiss et al. (2026) provide a framework for designing an interdisciplinary curriculum that clearly links competencies, learning outcomes, and assessment methods. These recommendations can be directly applied to the curriculum update process to ensure transparency and quality in educational outcome assessment. Integrating AI into engineering education requires a systemic shift—from theoretical instruction to learning grounded in real-world problems. This approach perfectly aligns with the project’s goals, which focus on developing competencies through applied environmental observation activities using drones.

A crucial dimension is the social and cultural aspect. Lai (2023) shows that the use of drones in the educational process promotes inclusion and intercultural collaboration, contributing to equitable and sustainable education. Thus, the “Avionics and Drone Architecture” program can serve as an example of learning for sustainability, in which technology serves the community. Yeung et al. (2025) confirm that introducing drones into STEM education fosters systemic engineering thinking and the application of the Project-Based Learning methodology. Similarly,

Kotarski et al. (2025) demonstrate the effectiveness of drones as educational platforms for integrated teaching of mechatronics, electronics, and computer science—areas that can be incorporated into avionics laboratory modules.

Găină (2025) emphasizes the importance of ethics and European regulations in UAV operation. Therefore, the program's reconceptualization must include a new module — Ethics, Safety, and Drone Legislation — to ensure compliance with EASA standards and awareness of the technological implications for the environment and society. These recent contributions confirm that the reconceptualization of the “Avionics and Drone Architecture” curriculum represents a strategic direction for the development of modern engineering education. The fundamental elements—artificial intelligence, ethics, interdisciplinarity, project-based learning, and a focus on sustainability—are consistently reflected in the 2023–2025 literature and underpin engineering education capable of supporting the green and digital transition.

The proposed curriculum model operationalizes the transition toward digitalization, sustainability, and interdisciplinary learning, transforming the course into a strategic educational tool aligned with contemporary societal and technological challenges.

The level of understanding is addressed through objectives such as “explain the operating principle of a brushless motor,” where the emphasis is placed not only on recognizing information but also on interpreting and expressing it in one’s own words, thus demonstrating comprehension of the content. Application is fostered through practical activities such as “use the ArduPilot Mission Planner,” which involves transferring theoretical knowledge into real or simulated contexts, thereby strengthening students’ operational skills.

Through the objective “evaluate launch and landing techniques,” the level of analysis is addressed, encouraging students to break down complex processes into components, identify causal relationships, and compare different technical solutions.

The level of synthesis is represented by activities such as “design and conduct research in the course field,” which involve generating new ideas, formulating hypotheses, and creating original products or concepts, reflecting a creative and integrative approach to knowledge.

Finally, evaluation is exemplified by the objective “propose programs for processing experimental data,” which requires making value judgments based on objective and well-argued criteria, thereby developing critical thinking and decision-making skills.

To provide a relevant update to the “Drone Architecture and Avionics” curriculum, it is necessary to have a clear understanding of the context in which the course was introduced into higher education. On June 4, 2018, Moldova State University inaugurated the didactic-scientific laboratory “Office for Education for Drones,” an integral part of the European project “eDrone – Education for Drone,” co-financed through the Erasmus+ Program (KA2 – Capacity Building in Higher Education, code 574090-EPP-1-2016-1-IT-EPPKA2-CBHE-JP, 2016–2020).

The main objective of the project was to develop advanced competencies in the use of drones for various professional applications, including data processing, the use of detection equipment, and compliance with applicable legal regulations. In this context, the Faculty of Physics and Engineering at MSU provided a modern laboratory, equipped in accordance with European standards, intended for the study and piloting of drones. The program's curricular structure was designed to train students in the specializations of Physics, Information Technology, Engineering, and Quality Management, as well as high school students from across the country, through the use of advanced technologies. A significant result of this project was the implementation of the continuing education course “Education for Drones,” initiated in the 2018–2019 academic year, authorized by the Ministry of Education, Culture, and Research of the Republic of Moldova, and subsequently accredited by NAQAER in 2020. The curriculum includes specialized modules such as Drone Architecture, Drone Avionics, Measurement and Monitoring Equipment, Piloting Techniques, Measurement Data Processing, Laws and Regulations Governing the Use of Drones, Drone Maintenance, and Civil Applications.

The Office for Education for Drones within the Faculty of Physics and Engineering continues to train successive generations of national specialists. As of October 14, 2025, the laboratory has trained approximately 180 trainees from various fields, within 13 editions of the continuing education program “Robotics and Mechatronics (Education for Drones – eDrone)”, accredited by NAQAER. Recently, the continuing professional education course “Education for Drones” was proposed for renaming to “UAV Technologies and Applications” and submitted to the Ministry of Education and Research, intending to align its title with the program's updated content and the modern technological requirements in aeronautics.

3. International Criteria for Evaluating Curricula

The purpose of this analysis was to assess the relevance, timeliness, and educational impact of the program. Thus, the curriculum was examined based on essential international criteria for ensuring academic excellence, among which are:

- European Standards and Guidelines for Quality Assurance (2021);
- European Quality Assurance Framework for Vocational Education and Training (EQAVET);
- Conceive–Design–Implement–Operate Framework (MIT Initiative);
- Bloom’s Taxonomy – for analyzing the depth of learning objectives (Bloom, 1956);
- NQF (National Qualifications Framework) (CNC, 2024).

The quality of higher education represents a fundamental pillar in the sustainable development of knowledge-based societies. In this context, the European ESG framework (Kohoutek et al., 2025)) provides a set of essential principles and guidelines for ensuring quality in higher education institutions. According to these standards, universities are called upon to design relevant study programs, adopt student-centered teaching and assessment methodologies, and ensure an appropriate professional environment for academic staff — all in accordance with the expectations and needs of stakeholders, including the economic sector, employers, educational partners, and the students themselves (*European Standards and Guidelines for Quality Assurance*, 2021).

To evaluate the compliance of a study program with the ESG requirements, the present analysis focused on four relevant standards:

- ESG 1.2 – Design and Approval of Study Programs;
- ESG 1.3 – Student-Centered Learning, Teaching, and Assessment;
- ESG 1.4 – Student Assessment;
- ESG 1.5 – Teaching Staff.

From the perspective of study program design (ESG 1.2), the analyzed curriculum stands out through a clear, coherent, and transparent structure, in which the objectives are formulated in terms of final professional competencies. This approach reflects a rigorous alignment with European best practices in academic design and supports the development of the skills required for integration into the labor market.

Concerning student-centered learning (ESG 1.3), the program includes various activities—laboratories, practical work, and projects—that promote students' active involvement in the educational process and the development of applied skills. This component is essential for fostering autonomy, critical thinking, and lifelong learning.

Concerning student assessment (ESG 1.4), it is mainly carried out through tests and individual activities, providing an objective evaluation of each student’s performance. However, diversifying the assessment methods could contribute to a broader reflection on the acquired competencies and a better correlation between evaluation and practical activity.

Regarding teaching staff (ESG 1.5), the instructors involved in delivering the course possess solid expertise in the field, thus ensuring the scientific and professional coherence of the

program. This expertise supports the program's relevance to current industry requirements and facilitates the training of well-prepared specialists.

As for the EQAVET criteria for ensuring the quality of the educational process, the evaluation of the program reaches an "advanced" level.

- In the area of planning, the objectives are well-defined, and the program structure is logical — performance rated as "excellent".
- At the implementation level, there is a clear balance between theoretical and practical components — rated as "very good".
- Regarding assessment and feedback, a formal feedback mechanism is absent (e.g., self-assessment, questionnaires), resulting in a "satisfactory" level.
- In the area of continuous improvement, there is a need to explicitly specify periodic updates (such as annual course review) — this element is rated as "good".

In the analysis of the curriculum from the perspective of Bloom's Taxonomy (1956), a balance and full coverage of all six cognitive levels is evident, reflecting an advanced level of complexity and efficiency in curriculum design. This aspect represents a significant strength, demonstrating that the course is not limited to the transmission of information but progressively develops students' cognitive competencies.

At the knowledge level, the curriculum aims to develop the ability to retain and reproduce fundamental information, exemplified by the objective *"to define UAV concepts and terms."* This ensures an essential terminological and conceptual foundation for the subsequent understanding of content.

The comprehension level is addressed through objectives such as *"to explain the working principle of a brushless motor,"* where the focus is not only on recognizing information but also on interpreting and expressing it in one's own words, demonstrating content assimilation.

The application is targeted through practical activities, such as *"to use ArduPilot Mission Planner,"* which involves transferring theoretical knowledge to real or simulated contexts, thereby strengthening students' operational skills.

Through the objective *"to evaluate launch and landing techniques,"* the analysis level is approached, encouraging students to break down complex processes into components, identify causal relationships, and compare different technical solutions.

The synthesis level is represented by activities like *"to design and conduct research in the course field,"* which involve generating new ideas, formulating hypotheses, and creating original products or concepts, reflecting a creative and integrative approach to knowledge.

Finally, evaluation is exemplified by the objective *"to propose programs for processing experimental data,"* which requires formulating value judgments based on objective and reasoned criteria and developing critical thinking and decision-making skills.

The analyzed curriculum demonstrates an advanced level of structuring learning objectives, fully corresponding to all six levels of Bloom's Taxonomy (Figure 2). Thus, the course makes a significant contribution to the development of both theoretical and practical competencies, stimulating critical thinking, creativity, and evaluative ability — essential aspects for comprehensive professional training.

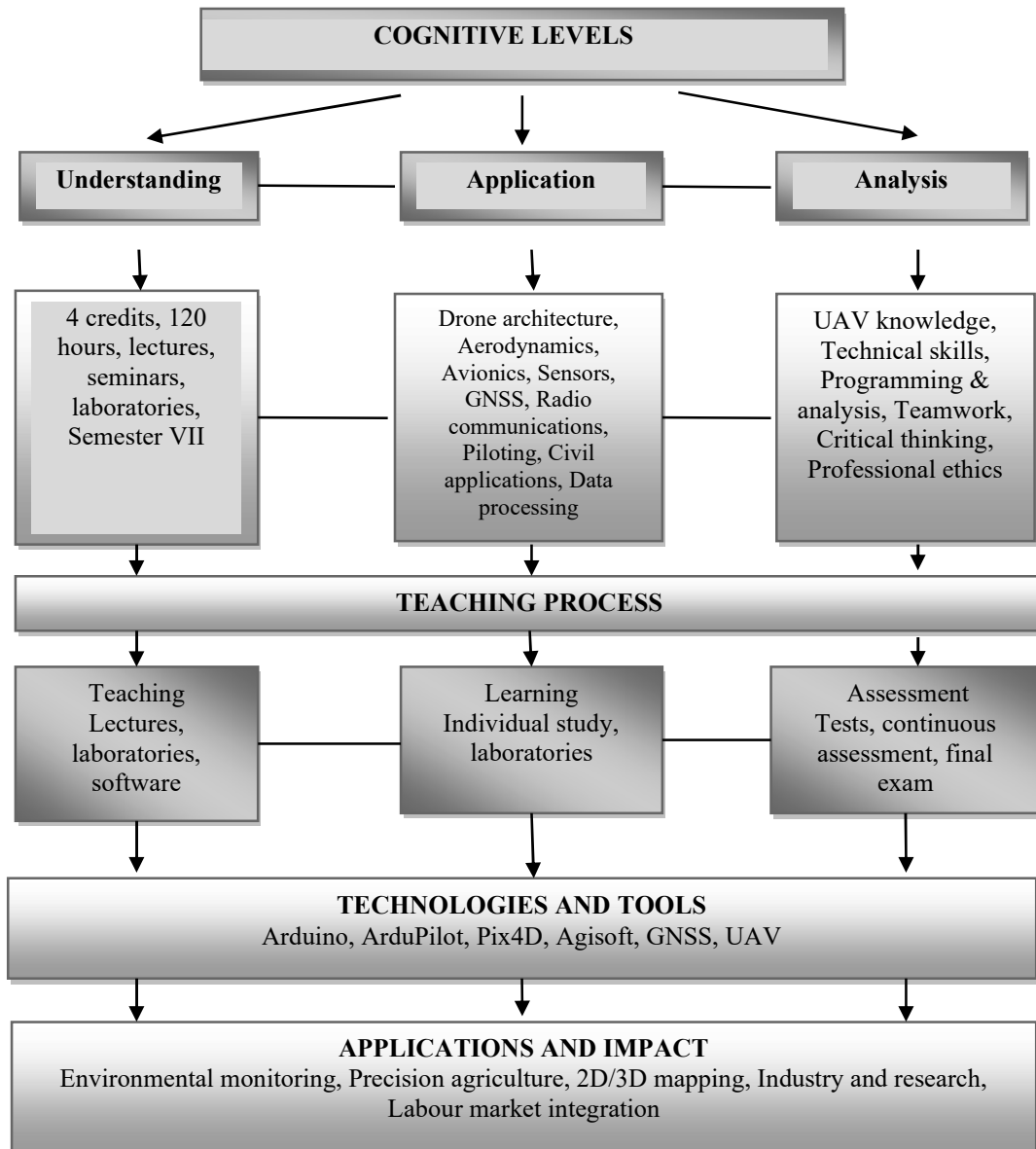


Figure 2. Mapping Curriculum Objectives to Cognitive Levels

This approach entails a complete cycle of product or technical system development, clearly reflected in the structure and content of the curriculum (CDIO). The analyzed course aligns naturally and effectively with the CDIO paradigm, which is internationally recognized in modern engineering education for the harmonious integration of theoretical and practical components in engineering education. In the Conceive phase, the course supports the development of the ability to define project objectives and configure initial UAV systems, thereby encouraging analytical thinking and strategic planning. The design phase is represented through UAV system and mission design activities, where students develop skills in modeling, component selection, and anticipating technical constraints. In the implementation phase, laboratory activities and work with UAV-specific software enable students to apply theoretical concepts and acquire practical technical skills. The operating phase is supported by applied activities such as piloting, flight mission simulation, and data processing, thereby developing operational and analytical abilities in conditions as close to real-world scenarios as possible.

The integration of the CDIO approach in this course is well executed, providing students with a comprehensive and relevant experience aligned with current engineering demands. The evaluation demonstrates a high level of coherence and practical applicability, with potential for further optimization through expanded interdisciplinary activities and real-world operational scenarios.

According to the evaluation based on the National Qualifications Framework (CNC), the curriculum at level 6, corresponding to bachelor's studies, is fully compliant with the specific descriptors for this level. The program ensures the acquisition of advanced theoretical knowledge in essential areas, including aerodynamics, avionics, navigation, and sensor systems. At the same time, it develops relevant practical and cognitive competencies, including piloting skills, data analysis, and UAV system programming. Additionally, the curriculum promotes student autonomy and responsibility through participation in individual and team projects, thereby strengthening integrated professional training.

The evaluation of the curriculum with respect to technological relevance and modernity is notable, as it integrates state-of-the-art technologies specific to the drone field, including multi-rotor and fixed-wing UAVs, GNSS systems, and specialized software such as Pix4D and Agisoft. The program also includes modern hardware technologies, such as MEMS, Arduino, and Ardupilot, reflecting a comprehensive and up-to-date approach. The emphasis is placed on practical applications with concrete impact in various civil sectors, including precision agriculture, environmental monitoring, and photogrammetry.

Furthermore, the "Drone Architecture and Avionics" curriculum aligns with European higher education quality standards (ESG, EQAVET) and internationally recognized models in engineering education, such as CDIO. Consequently, this course can be considered a model of good curricular practice, representing a significant benchmark for the UAV and applied engineering fields. There are also extended international criteria for STEM and engineering programs that can be used to analyze the curriculum further. The analysis of the curriculum against UNESCO/OECD criteria confirms a solid and balanced performance across all dimensions (Table 1).

Table 1. Criteria for the analysis of the "Architecture and Avionics of Drones" curriculum

Relevance	The program directly addresses current labor market demands and reflects emerging technological trends, including UAVs, GNSS systems, photogrammetry, and 3D data processing. This alignment ensures an excellent level of adaptability to industry needs.
Quality	The program structure is clearly defined, with measurable learning objectives and a coherent methodology. Assessment is conducted through tests and individual activities, ensuring objective and consistent evaluation of student performance. Academic quality is rated as very good.
Innovation	The curriculum integrates state-of-the-art technologies, including Pix4D, Agisoft, Arduino, MEMS, and nanotechnology. It is recommended that the content be expanded to include topics related to artificial intelligence and UAV data fusion to strengthen its innovative character further. Currently, innovation is rated as good, with potential for improvement
Inclusion and Accessibility	The program is offered in Romanian and Russian, facilitating access for students from diverse cultural and linguistic backgrounds. To enhance inclusion and international mobility, it is recommended that instruction be extended to English. This criterion is rated as good

The curriculum aligns well with UNESCO/OECD standards, demonstrating high relevance, very good academic quality, integrated innovation, and a good level of inclusion, with clear

recommendations for future improvements. It serves as a best-practice example in applied engineering education for UAVs.

The TUNING model, an integral part of the Bologna Process and the European Higher Education Area, aims to evaluate curriculum coherence by correlating competences, learning outcomes, content, and assessment methods. This approach ensures harmonized curriculum development oriented toward the development of relevant competencies for students.

Regarding the formulation of learning outcomes, all course units use clear, well-drafted statements beginning with “the student will be able to...”, reflecting a precise, action-oriented approach and remarkable didactic clarity, which is rated as excellent. The correlation between competences and outcomes is well-defined and functional, exemplified by the clear link between the use of the Ardupilot platform and the development of applied ICT competences. This effective connection contributes to integrated learning and is evaluated as very good.

Regarding the alignment of teaching methods, a classical, well-founded methodology is employed; however, opportunities for improvement exist through the integration of real-world problems and interdisciplinary projects, which would stimulate critical thinking and the practical application of knowledge. This component is rated as good.

The assessment of learning outcomes is based on exams and practical activities, providing a robust framework for measuring student progress. However, there is no explicit mention of assessment rubrics, which could enhance transparency and objectivity in performance evaluation. For this reason, this dimension is rated as satisfactory. In this context, the curriculum reflects robust programmatic coherence according to the TUNING model, with strengths in the clear formulation of learning outcomes and the alignment of competences, alongside opportunities for development in teaching methods and assessment criteria.

4. Curriculum Evaluation According to ABET Criteria (Accreditation Board for Engineering and Technology – USA)

The evaluation of the “Architecture and Avionics of Drones” curriculum from the perspective of the ECTS-QA criteria (Kohoutek et al., 2025) and modern pedagogical principles highlights a solid structure well adapted to the current requirements of higher education. ABET criteria are globally recognized as reference standards in engineering fields, including UAV-related specializations. The analysis of the “Architecture and Avionics of Drones” curriculum against these criteria highlights the following aspects (Table 2).

Table 2. Criteria for the evaluation of the “Architecture and Avionics of Drones”

Engineering Knowledge	The curriculum comprehensively covers fundamental domains, including aerodynamics, avionics, sensors, and UAV control, thereby providing a solid foundation in applied technical knowledge.
Analysis and Design	Topics and activities involving system analysis and flight simulation are included to develop engineering design competencies.
Experimentation and interpretation	The program incorporates practical laboratory work using UAV-specific software, facilitating applied understanding of theoretical concepts and interpretation of experimental results.
Communication and Teamwork	Although these competences are mentioned in general terms, clear and structured assessment methods are lacking, representing an area for potential improvement.
Professional Ethics	This aspect is not explicitly addressed in the curriculum; it is recommended that a dedicated submodule on “Ethics in Drone Operations” be included, aligned with both ABET requirements and

	EASA standards on operational safety and responsibility.
Lifelong Learning	The curriculum implicitly promotes this dimension through the continuous integration of emerging technologies, encouraging adaptability and ongoing skills development.
Societal Impact and Sustainability	Issues related to social impact and sustainability are partially addressed, particularly through civil applications such as environmental monitoring and precision agriculture.

Regarding the ECTS-QA criteria, the total program workload is correctly aligned at 120 hours, corresponding to 4 credits, in accordance with the standard of 30 hours per credit. The distribution of time across lectures (30 hours), laboratory work (30 hours), and individual activities (60 hours) is balanced, facilitating a complete and integrated learning process. Furthermore, the description of assessment methods is provided; however, the absence of clear weightings for different components (e.g., test = 20%, project = 40%) may affect the transparency and clarity of the evaluation process. The correspondence between learning outcomes and ECTS level 6 descriptors is ensured, encompassing specialized knowledge, practical application, and student autonomy in task completion.

From the perspective of modern pedagogical criteria, based on constructivist theories and the DigCompEdu digital competence framework, the program demonstrates partial implementation of active learning, particularly through practical UAV laboratory activities. Project-Based Learning is mentioned indirectly, but its formal integration is recommended to increase student engagement and develop interdisciplinary collaboration skills. The integration of digital technology is highly advanced, as evidenced by the use of modern tools such as Pix4D, Agisoft, and Arduino, which enable a practical and innovative approach.

The digital competence of the teaching staff is considered high due to the experience and qualifications of the curriculum authors. Thus, the “Architecture and Avionics of Drones” curriculum demonstrates strong compliance with European credit and quality-assurance standards and advanced integration of modern pedagogical methods, providing a balanced, relevant educational experience adapted to the contemporary demands of engineering education.

The current curriculum of the course aligns well with international requirements for structure, coherence, and competence-oriented design, as assessed by multicriteria analysis. A comparative summary according to international criteria is presented in Table 3.

Table 3. Comparative Summary Based on International Criteria

Set of Criteria	Observations
NAQAER	Very good, requires additional methodological details
ESG / EQAVET	Student-centered, can be improved in assessment
CDIO / Bloom	Excellent balance between theory and practice
CNC	Fully compliant with Level 6
Tuning	Good coherence, clear curriculum
ABET	Requires additions regarding ethics and communication
UNESCO / OECD	High innovation, good connection to societal needs
ECTS-QA	Coherence between workload and credits (4 credits = 120 hours)
DigCompEdu	Excellent integrated digital competencies

5. Discussions

By implementing these recommendations, the course has the potential to substantially enhance its scientific, applied, and professional value, becoming a model of best educational practice in the UAV engineering field, with relevance at both national and European levels. In particular, it is recommended to include modules dedicated to artificial intelligence applied to

UAV data analysis, alongside courses focused on professional ethics and operational regulations specific to the field. These components will foster the integrated development of advanced technical competencies and transversal skills, strengthening student autonomy, responsibility, and sustainability awareness.

Several contributions can be highlighted in the development of higher education curricula regarding the integration of drones. Kuzma et al. (2018) designed and implemented a university module on applied drone technology, highlighting integration strategies into a business curriculum, as well as the challenges and solutions associated with introducing an emerging technology into a traditional educational context. Kulhavy et al. (2023) highlight the value of systematically integrating drone technology into forestry and natural resources education, demonstrating its role in strengthening teaching, research, and service processes, as well as in developing students' practical skills, including preparing them as future drone operators. Morgan and Mathews (2025) have brought innovations through the use of drone technology in higher geographical education. To consolidate excellence and adapt to the emerging requirements of the labor market and technological innovation, we propose the following improvement suggestions in accordance with international standards of academic quality and professionalization.

It is recommended to integrate an interdisciplinary module on artificial intelligence applied to UAV data analysis, with a focus on image processing, LiDAR–photogrammetric data fusion, and automated analytics. Additionally, introducing a specialized course on professional ethics, European regulations, and UAV operational safety (in accordance with EASA and NATO SPS) is essential to strengthen normative competencies and social responsibility. These components directly address ABET standards and the UNESCO/OECD framework regarding education for responsible citizenship and safe innovation.

A clearer and more efficient structuring of content and learning outcomes is required. The development of a correlation table linking Level 6 of the National Qualifications Framework (NQF) to discipline-specific competencies, learning outcomes, and assessment methods is recommended. This tool ensures coherence between educational objectives, formative content, and evaluation, enhancing transparency and the effective guidance of the teaching process. Furthermore, an explicit rubric linking competencies, outcomes, activities, and assessment should be introduced, in accordance with best practices promoted by CDIO and TUNING. This integrative approach supports active, student-centered learning and facilitates adaptation to labor market requirements. Assessment weightings should be clarified to provide a balanced structure: 20% tests, 40% projects and laboratories, 10% digital portfolio, and 30% final exam. This distribution reflects the diversity of learning activities and supports continuous student progress. Implementing a transparent feedback and continuous improvement system—based on annual evaluations, periodic student consultations, and labor market needs analysis—is essential. Integrating these elements into curricular decisions maintains program relevance and fosters a culture of quality in higher education.

Instead of a purely traditional approach, the methodology should be extended to include:

- Integrated team projects (PBL);
- Learning scenarios inspired by engineering practice (CDIO);
- Problem-based learning and realistic simulations;
- Reflection sessions, self-assessment, and peer-assessment.

As a practical example, a CDIO mini-project titled “Designing and Operating a UAV Mission with LiDAR and Photogrammetry Data Analysis” can simultaneously develop technical, analytical, and project-management competencies.

To enhance academic visibility and international compatibility, a bilingual version of the curriculum (Romanian–English) is recommended. Explicit inclusion of ECTS equivalence (4 credits = 120 hours) and Erasmus+ compatible descriptions should be incorporated. The bibliography should include recent, relevant, and internationally validated sources.

To maintain and consolidate the academic excellence of the course “Drone Architecture and Avionics”, an integrated approach is essential, including: clear curricular alignment with international standards; inclusion of up-to-date thematic modules; methodological diversification through CDIO and active learning; clarity in assessment and correlation of competencies–learning outcomes–evaluation; updated bibliography and full digitalization of learning; internationalization and partnerships to support academic mobility; establishment of a sustainable feedback and continuous improvement framework.

6. Conclusions

Implementing these directions will enable full alignment of the course with international quality and innovation standards as well as with the requirements of national quality assurance systems. Furthermore, it will ensure greater curricular coherence, methodological flexibility, professional relevance, and international attractiveness of the study program. Thus, the course will not only adequately meet the current demands of the labor market and the digital society but will also actively contribute to the formation of a generation of specialists capable of innovating and operating responsibly in the field of unmanned aerial systems. These steps will strengthen the course's positioning as a modern and competitive educational program, capable of dynamically responding to technological transformations and supporting the training of professionals adapted to a constantly changing global environment.

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Abbreviations

ABET	Accreditation Board for Engineering and Technology
AI	Artificial Intelligence
CAA	Civil Aviation Authority
NAQAER	National Agency for Quality Assurance in Education and Research
RAQAHE	Romanian Agency for Quality Assurance in Higher Education
CDIO	Conceive, Design, Implement, Operate
EASA	European Union Aviation Safety Agency
ECTS-QA criteria	European Credit Transfer and Accumulation System & Quality Assurance
EQAVET	European Quality Assurance Framework for Vocational Education and Training
ESG	Standards and Guidelines for Quality Assurance in the European Higher Education Area
MSU	Moldova State University
NATO	North Atlantic Treaty Organization
NQF	National Qualifications Framework
OECD	Organisation for Economic Co-operation and Development
PBL	Project-Based Learning
STEM	Science, Technology, Engineering, and Mathematics
SPS	Science for Peace and Security
RAQAHE	Romanian Agency for Quality Assurance in Higher Education
UAV	Unmanned Aerial Vehicle
UNESCO	United Nations Educational, Scientific and Cultural Organization

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