



# Drone Soccer

CURRICULUM  
STARS PROJECT

## Sadržaj

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## Introduction

The Drone Soccer extracurricular curriculum is an educational programme designed for secondary school students, aimed at developing STEM competencies (science, technology, engineering, and mathematics) through experiential, project-based, and team-oriented learning. The programme integrates elements of robotics, programming, electronics, aerodynamics, and sport, enabling students to actively participate in contemporary technological and interdisciplinary activities.

Taking into account the rapid development of digital and robotic technologies and the increasing demand for practical technical skills, Drone Soccer represents an innovative learning approach that connects theoretical knowledge with real-world application. The activity stimulates students' interest in technical and vocational pathways and contributes to the development of digital, technical, and social competences essential for further education and future employment.

Drone Soccer as an educational concept is based on operating specially designed drones within a protected indoor environment, following clearly defined competition rules. This approach ensures a high level of safety while allowing students to experiment, learn, and improve their skills. At the same time, it fosters precision, strategic thinking, collaboration, responsibility, and fair play. Students are involved in all stages of the learning process—from drone assembly and maintenance, through programming and simulator-based training, to practical flight training and competitive matches.

The curriculum is designed as a flexible and adaptable programme that can be implemented in accordance with a school's organisational capacities and students' interests. Particular emphasis is placed on inclusion and equal participation, encouraging the involvement of girls and students from underrepresented groups, thereby promoting broader engagement in STEM fields.

The overall aim of the curriculum is to support the development of students' practical technical skills, critical and logical thinking, teamwork, and communication skills through a motivating and competitive learning environment. Students are encouraged to use technology in a safe, responsible, and creative manner and to take an active role in their own learning and problem-solving processes.

The target group consists of secondary school students. The curriculum is primarily intended for teachers of technical, vocational, and ICT-related subjects, as well as for other interested teachers who wish to implement modern, project-based extracurricular activities. The programme is delivered over a total of 70-72 hours per school year, organised as 35-36 sessions of 2 hours per week.

## Curriculum Methodology

The Drone Soccer extracurricular curriculum is based on a learner-centred, outcome-oriented, and experiential learning methodology that combines theoretical instruction with hands-on practical activities. The methodology is designed to actively engage students in the learning process, encourage collaboration, and support the development of technical, digital, and social competences through real-world application.

The curriculum is structured around progressive learning stages, allowing students to gradually build knowledge and skills—from basic concepts of drone technology and safety, through assembly and programming, to simulator training and competitive drone soccer activities. Learning activities are organised in a way that supports different learning paces and levels of prior knowledge, enabling differentiation and individualisation where necessary.

## Teaching and Learning Approaches

The curriculum employs a combination of the following teaching and learning approaches:

- Experiential learning, where students learn by doing through assembling, programming, testing, flying, and competing with drones.
- Project-based learning, in which students work individually and in teams to solve practical problems, improve drone performance, and prepare for matches.
- Collaborative and team-based learning, emphasising communication, role distribution, cooperation, and mutual support within teams.
- Problem-solving and inquiry-based learning, encouraging students to analyse technical challenges, test solutions, and reflect on outcomes.
- Simulation-based learning, using flight simulators to develop piloting skills in a safe and controlled environment before real-world application.

The methodology promotes active student participation and positions learners as creators, problem solvers, and decision-makers rather than passive recipients of knowledge.

## Organisation of Learning

Learning activities are organised into regular sessions that combine short theoretical introductions with extensive practical work. Each session typically includes:

- introduction of concepts and objectives,

- demonstration or guided instruction,
- hands-on student activities,
- reflection, discussion, and feedback.

Students work in small teams, with clearly defined roles such as pilot, technician, programmer, or strategist, which may rotate to ensure balanced skill development. This organisation supports the development of both technical competences and transversal skills such as teamwork, leadership, and responsibility.

## Role of the Teacher and the Student

The teacher acts primarily as a mentor, facilitator, and safety supervisor, guiding students through the learning process, providing technical support, encouraging reflection, and ensuring safe and responsible use of equipment. The teacher adapts activities to students' abilities, motivates participation, and fosters an inclusive and supportive learning environment.

Students take an active role in learning by exploring, experimenting, collaborating, and reflecting on their experiences. They are encouraged to take responsibility for their learning, contribute ideas, and evaluate their own progress as well as the performance of their teams.

## Flexibility and Adaptability

The curriculum methodology is designed to be flexible, allowing schools and teachers to adapt content, teaching strategies, and activity intensity to available resources, time constraints, and student interests. The modular structure enables partial implementation or integration with other STEM-related extracurricular or curricular activities.

Special attention is given to inclusion and accessibility, ensuring that all students, regardless of gender or background, have equal opportunities to participate and develop confidence in STEM-related skills.

# Educational Goals of Implementing an Optional Subject

Through participation in the Drone Soccer optional subject, students will:

- develop STEM competencies by applying knowledge from physics, electronics, robotics, programming, and engineering in practical and meaningful contexts;
- acquire practical technical skills related to drone assembly, maintenance, configuration, programming, and safe operation;
- enhance digital competence through the use of software tools, simulators, and control systems required for drone operation and optimisation;
- develop problem-solving and critical thinking skills by analysing technical challenges, testing solutions, and improving drone performance through iterative processes;
- strengthen teamwork, communication, and collaboration skills by working in structured teams, assuming different roles, and participating in cooperative and competitive activities;
- foster responsibility, safety awareness, and ethical use of technology, particularly in relation to drone operation, data protection, fair play, and respect for rules;
- increase motivation and interest in technical, vocational, and STEM-related education and careers, supporting informed educational and career choices;
- promote inclusion and equal participation by encouraging the involvement of all students, including girls and students from underrepresented groups, in technology-based activities;
- develop self-confidence and perseverance through hands-on learning, performance evaluation, and participation in training sessions and competitions;
- encourage lifelong learning attitudes by exposing students to emerging technologies and fostering curiosity, creativity, and adaptability in a rapidly changing technological environment.

# Educational Outcomes, Key Content and Levels of Mastery

Educational outcomes are defined as thematic learning units that describe what students are expected to know, understand, and be able to do upon completion of the Drone Soccer optional subject. Outcomes are achieved through progressive learning stages that combine theoretical understanding, practical application, and reflective learning.

The outcomes are organised to allow differentiation according to students' interests, abilities, and prior knowledge. The levels of mastery describe expected student performance and progression.

## 1. Drone Technology and Safety

### Educational Outcome

Students understand the basic principles of drone technology and apply safety rules during drone assembly, operation, and competition.

### Key Content

- Principles of flight (lift, thrust, yaw, pitch, roll)
- Drone components and their functions
- Battery safety and handling
- Indoor flight safety rules
- Ethical and responsible use of drones

### Levels of Mastery

- Basic level: Recognises main drone components and follows basic safety rules under supervision.
- Intermediate level: Independently applies safety procedures and explains basic flight principles.
- Advanced level: Anticipates risks, supervises safe operation within a team, and promotes responsible drone use.

## 2. Drone Assembly and Maintenance

### Educational Outcome

Students assemble, maintain, and repair drone soccer drones using appropriate tools and procedures.

### Key Content

- Drone frame and protective cage assembly
- Motors, propellers, and wiring
- Flight controller installation
- Troubleshooting common hardware issues
- Preventive maintenance

### Levels of Mastery

- Basic level: Assembles drone components following instructions with guidance.
- Intermediate level: Independently assembles and maintains a drone and replaces damaged components.
- Advanced level: Diagnoses technical issues, optimises assembly, and supports other team members.

## 3. Programming and Drone Configuration

### Educational Outcome

Students configure and optimise drone control systems to improve stability, responsiveness, and performance in drone soccer activities.

### Key Content

- Flight controller software basics
- Radio control configuration
- Control modes and calibration
- Introduction to tuning concepts
- Performance optimisation for competition

### Levels of Mastery

- Basic level: Configures basic settings with guidance.
- Intermediate level: Adjusts settings independently and evaluates flight behaviour.
- Advanced level: Optimises configurations strategically for different match situations.

## 4. Simulator Training and Flight Skills

### Educational Outcome

Students develop piloting skills using simulators and apply them in real-world drone soccer training.

### Key Content

- Flight simulators and controller setup
- Basic manoeuvres and control
- Precision flying and goal alignment
- Transition from simulation to real flight

### Levels of Mastery

- Basic level: Controls the drone in a simulator environment and performs basic manoeuvres.
- Intermediate level: Demonstrates controlled flight and precision in real-world conditions.
- Advanced level: Executes complex manoeuvres and adapts piloting style to tactical needs.

## 5. Drone Soccer Rules, Tactics, and Teamwork

### Educational Outcome

Students understand drone soccer rules and apply tactical thinking and teamwork during training and matches.

### Key Content

- Official drone soccer rules

- Field layout and scoring system
- Team roles and communication
- Offensive and defensive strategies
- Fair play and sportsmanship

#### Levels of Mastery

- Basic level: Understands basic rules and participates as a team member.
- Intermediate level: Applies tactics and communicates effectively within the team.
- Advanced level: Develops strategies, supports team coordination, and demonstrates leadership.

## 6. Competition, Reflection, and Personal Development

#### Educational Outcome

Students participate in competitions, reflect on their learning process, and identify further educational and career pathways.

#### Key Content

- Match preparation and competition participation
- Performance analysis and feedback
- Reflection on teamwork and problem-solving
- Career pathways in STEM and technology

#### Levels of Mastery

- Basic level: Participates in competitions and reflects on personal experience.
- Intermediate level: Analyses performance and identifies areas for improvement.
- Advanced level: Demonstrates strategic reflection and connects learning outcomes to future education or careers.

## Educational Outcomes and Development of Outcomes

Educational Outcomes	Development of Outcomes
1. Students understand basic principles of drone technology and apply safety rules during all activities.	Students learn fundamental concepts of flight and drone components and apply safety procedures during assembly, programming, training, and competition. They demonstrate responsible and ethical use of drone technology in an indoor environment.
2. Students assemble, maintain, and repair drone soccer drones using appropriate tools and instructions.	Students progressively develop hands-on skills by assembling drones, replacing components, performing maintenance, and troubleshooting technical issues, working independently or within a team.
3. Students configure and adjust drone control systems for stable and effective flight.	Students learn to use flight controller software and radio control systems, calibrate drones, and optimise settings to improve performance and responsiveness for drone soccer activities.
4. Students develop piloting skills through simulator-based training and real-flight practice.	Students use simulators to practice basic and advanced flight manoeuvres and gradually transfer these skills to real drones, improving precision, control, and confidence.
5. Students understand and apply drone soccer rules, tactics, and fair play principles.	Students learn official rules, field structure, scoring, and team roles, and apply tactical thinking, communication, and cooperation during training sessions and matches.
6. Students collaborate effectively in teams and assume different functional roles.	Through team-based activities, students rotate roles such as pilot, technician, programmer, or strategist, developing communication skills, responsibility, and mutual support.
7. Students participate in competitive activities and reflect on their learning process.	Students prepare for and take part in internal or external competitions, analyse performance, receive feedback, and reflect on technical, tactical, and personal development.
8. Students recognise connections between drone soccer activities and STEM education and careers.	Students identify how skills gained through drone soccer relate to STEM fields, vocational education, and future career pathways, fostering motivation and lifelong learning attitudes.

# Evaluation of the Adoption of Educational Outcomes

The primary purpose of evaluating the adoption of educational outcomes in the Drone Soccer optional subject is to support and improve student learning, encourage the development of practical skills and competences, and promote continuous progress in both technical and personal development. Evaluation is designed as an integral part of the learning process and focuses on monitoring students' achievement of defined educational outcomes rather than on summative grading.

Evaluation is primarily formative, with an emphasis on continuous observation, feedback, and reflection throughout the programme. Teachers monitor students' engagement, practical performance, teamwork, and problem-solving processes during activities such as drone assembly, programming, simulator training, and competitive matches. Feedback is provided regularly to guide students toward improvement and to support self-regulated learning.

A variety of evaluation methods are used to ensure a comprehensive and fair assessment of learning outcomes, including:

- observation of practical work and safe handling of equipment,
- evaluation of individual and team-based tasks and projects,
- assessment of participation and cooperation within teams,
- analysis of performance during training sessions and competitions,
- student self-assessment and peer assessment,
- reflective discussions and learning journals.

Special attention is given to evaluating the development of transversal skills such as communication, teamwork, responsibility, and ethical behaviour, alongside technical competences. Students are encouraged to reflect on their own learning, identify strengths and areas for improvement, and actively participate in setting personal learning goals.

Evaluation criteria are transparent and aligned with the defined educational outcomes, ensuring that students understand expectations and assessment processes. The teacher adapts evaluation methods to students' abilities, learning pace, and prior experience, supporting inclusivity and equal opportunities for success.

The results of evaluation are used to adjust teaching strategies, learning activities, and the pace of instruction, contributing to the continuous improvement of the curriculum and the quality of the learning experience. Evaluation outcomes may also serve as a basis for recognising students' achievements through certificates, digital badges, or participation acknowledgements.

# Curriculum Structure Overview

<b>Module</b>	<b>Lessons</b>	<b>Hours</b>
1. Introduction & Safety	3	6
2. Drone Fundamentals	4	8
3. Drone Assembly & Maintenance	6	12
4. Programming & Control	6	12
5. Simulator & Virtual Training	4	8
6. Drone Soccer Rules & Tactics	4	8
7. Practical Training & Matches	6	12
8. Competition	2	4
9. Evaluation	1	2
Total	36	72

# MODULE 1: Introduction & Safety (Lessons 1–3)

## Lesson 1 – What is Drone Soccer?

- History and concept of drone soccer
- Comparison with robotics & traditional sports
- Roles in drone soccer teams (pilot, co-pilot, strategist, technician)
- Examples of international competitions

This lesson introduces students to the concept of drone soccer as an innovative combination of technology, sport, and teamwork. Students explore the origins and development of drone soccer, learning how it emerged from advances in drone technology and competitive robotics. Through comparison with traditional sports and robotics competitions, students identify similarities and differences in terms of rules, teamwork, physical and cognitive skills, and the role of technology.

The lesson also introduces the structure of drone soccer teams. Students become familiar with different roles within a team, such as pilot, co-pilot, strategist, and technician, and learn how each role contributes to overall team performance. Examples of international drone soccer competitions are presented to provide context, motivation, and insight into how the sport is practiced globally.

The lesson aims to build initial interest and understanding while establishing drone soccer as a structured, rule-based, and educational activity.

## Lesson 2 – Safety, Ethics & Responsibility

- Indoor flight safety rules
- Battery handling (LiPo safety)
- Net cages, goggles, safe distances
- Ethics: privacy, fair play, respect

This lesson focuses on ensuring safe, responsible, and ethical participation in drone soccer activities. Students learn essential indoor flight safety rules, including safe take-off and landing procedures, controlled flight zones, and emergency response practices. Special attention is given to the safe handling and charging of lithium-polymer (LiPo) batteries, highlighting potential risks and preventive measures.

Students are introduced to protective measures such as safety nets, protective cages, goggles, and maintaining safe distances during drone operation. In addition to technical safety, the lesson addresses ethical aspects of drone use, including respect for privacy, adherence to rules, fair play, and responsible behaviour during training and competition.

By the end of the lesson, students understand that safety and ethics are fundamental prerequisites for all drone soccer activities and shared responsibility within the team.

### Lesson 3 – Teamwork & Club Organization

- Team formation
- Role assignment
- Communication protocols
- Introduction to fair play & inclusion

This lesson emphasises the importance of teamwork, organisation, and communication in drone soccer. Students learn how teams are formed and how roles are assigned based on interests, skills, and rotation principles to ensure balanced participation and learning. The lesson highlights the value of collaboration and mutual support in achieving both technical and competitive goals.

Students are introduced to basic communication protocols used during training and matches, including verbal signals, role-based communication, and respectful interaction. The lesson also introduces the principles of fair play, inclusion, and equality, reinforcing the importance of respectful behaviour, cooperation, and equal opportunities for all participants.

This lesson establishes a positive club culture and prepares students for effective participation in team-based activities throughout the programme.

#### Outcome:

Upon completion of Module 1, students understand the basic concept of drone soccer, recognise the importance of safety and ethical behaviour, and are familiar with team structure and roles necessary for effective participation in drone soccer activities.

## MODULE 2: Drone Fundamentals (Lessons 4–7)

### Lesson 4 – How Drones Fly

- Lift, thrust, drag, yaw, pitch, roll
- Motors, ESCs, propellers

This lesson introduces students to the fundamental principles of drone flight. Students learn how lift, thrust, and drag interact to enable a drone to take off, hover, and manoeuvre in the air. Key flight movements—yaw, pitch, and roll—are explained in relation to motor speed and propeller direction, helping students understand how drones change direction and maintain stability.

The lesson also covers the basic function of motors, electronic speed controllers (ESCs), and propellers, emphasising how these components work together as an integrated system. Through demonstrations and guided discussion, students gain a foundational understanding of how control inputs translate into physical movement.

This lesson provides the theoretical foundation necessary for safe piloting, assembly, and later programming activities.

### Lesson 5 – Electronics Basics

- Power systems (battery, voltage, current)
- Flight controller basics
- Sensors (gyro, accelerometer)

This lesson focuses on the basic electronic systems that power and control a drone. Students are introduced to power systems, including batteries, voltage, current, and energy consumption, with particular emphasis on safe and efficient operation. The role of the flight controller as the central processing unit of the drone is explained, including how it receives input signals and controls motors.

Students also learn about key sensors such as gyroscopes and accelerometers and how they provide feedback for stabilisation and flight control. The lesson connects electronic principles to real-world drone behaviour, enabling students to understand how electronic components influence flight performance and reliability.

### Lesson 6 – Drone Soccer Drone Anatomy

- Protective cage design
- Ball vs goal structure

- Differences from camera drones

This lesson examines the specific design features of drone soccer drones. Students explore the structure and purpose of the protective cage, understanding how it enhances safety, durability, and suitability for indoor competition. The lesson explains the relationship between the drone's physical design and game mechanics, including the ball and goal structure used in drone soccer.

Students also compare drone soccer drones with camera and recreational drones, identifying differences in design priorities such as protection, agility, durability, and payload. This comparison helps students understand why drone soccer drones are uniquely designed for competitive indoor use rather than aerial photography or outdoor flight.

#### Lesson 7 – Pre-flight Checks & Diagnostics

- Visual inspection
- Calibration basics
- Common failures and causes

This lesson introduces students to systematic pre-flight inspection and basic diagnostic procedures. Students learn how to perform visual inspections of frames, propellers, wiring, and batteries to ensure readiness for safe operation. Basic calibration procedures are explained, including controller and sensor checks required before flight.

Common technical failures and their causes are discussed, helping students recognise warning signs and understand preventive measures. The lesson emphasises the importance of routine checks and responsible maintenance as part of safe and professional drone operation.

#### Outcome:

Upon completion of Module 2, students understand the basic principles of drone flight, recognise the function of key hardware and electronic components, and are able to perform fundamental pre-flight checks to ensure safe and reliable drone operation.

# MODULE 3: Drone Assembly & Maintenance (Lessons 8–13)

## Lesson 8 – Tools & Components

- Tools overview
- Screws, frames, motors, FC, batteries
- Reading assembly diagrams

This lesson introduces students to the tools and components required for assembling a drone soccer drone. Students become familiar with basic hand tools and learn their correct and safe use. The lesson presents the main drone components, including frames, screws, motors, flight controllers, electronic components, and batteries.

Students are guided in reading and interpreting assembly diagrams and technical documentation, enabling them to follow structured instructions and understand the relationship between individual components. The lesson establishes foundational technical literacy and prepares students for hands-on assembly work.

## Lesson 9 – Frame & Cage Assembly

- Building protective structure
- Mechanical stability
- Weight considerations

This lesson focuses on constructing the drone frame and protective cage. Students learn how to assemble the mechanical structure that provides stability, durability, and safety during indoor operation. Emphasis is placed on correct alignment, secure fastening, and structural integrity.

Students also explore the relationship between mechanical stability and flight performance, including how weight distribution and total mass affect agility and control. This lesson helps students understand the importance of precision and careful construction in achieving reliable drone operation.

## Lesson 10 – Motors & Propellers

- Motor mounting
- CW vs CCW props
- Balance and safety

This lesson covers the installation and configuration of motors and propellers. Students learn correct motor mounting techniques and the importance of secure attachment. The lesson explains the difference between clockwise (CW) and counter-clockwise (CCW) propellers and their role in stabilising flight.

Students are introduced to basic concepts of balance and vibration reduction, as well as safety considerations related to rotating components. Through guided practice, students gain confidence in handling motors and propellers safely and effectively.

#### Lesson 11 – Electronics & Wiring

- ESC connections
- Power distribution
- Cable management

This lesson focuses on connecting and organising electronic components within the drone. Students learn how electronic speed controllers (ESCs) are connected to motors and the flight controller, and how power is distributed safely and efficiently throughout the system.

Special attention is given to proper cable management to prevent interference, overheating, and mechanical damage. The lesson reinforces the importance of careful wiring and organisation for both safety and long-term reliability of the drone.

#### Lesson 12 – Testing & Troubleshooting

- Power-on tests
- Motor direction fixes
- Vibration issues

This lesson introduces systematic testing and troubleshooting procedures. Students perform controlled power-on tests to verify correct assembly and electrical connections. Common issues such as incorrect motor direction and excessive vibration are identified and addressed.

Students learn how to analyse symptoms, identify causes, and apply appropriate corrective actions. This lesson strengthens problem-solving skills and encourages a methodical approach to technical challenges.

#### Lesson 13 – Maintenance & Repair

- Replacing motors/props

- Cage repair
- Preventive maintenance checklist

This lesson focuses on maintaining and repairing drone soccer drones during regular use. Students learn how to replace damaged motors and propellers, repair or reinforce protective cages, and restore functionality after collisions.

The lesson introduces preventive maintenance practices, including the use of checklists to ensure ongoing reliability and safety. Students develop an understanding of maintenance as an essential part of responsible technology use and sustainable operation.

Outcome:

Upon completion of Module 3, students are able to independently assemble, maintain, and repair a drone soccer drone, applying appropriate tools, procedures, and safety practices to ensure reliable and safe operation.

## MODULE 4: Programming & Control (Lessons 14–19)

### Lesson 14 – Flight Controller Software

- Overview (Betaflight / similar)
- Firmware concepts
- Safety configuration

This lesson introduces students to flight controller software used for configuring and controlling drone soccer drones. Students gain an overview of commonly used platforms (such as Betaflight or similar systems) and learn the purpose of firmware in managing drone behaviour. The lesson explains how software settings translate into physical flight responses.

Special emphasis is placed on safety-related configurations, including arming procedures, motor limits, and emergency cut-off features. Students learn that correct software configuration is essential for both safe operation and optimal performance, establishing a foundation for further programming and tuning activities.

### Lesson 15 – Radio Control Basics

- Channels & mapping
- Modes (Angle / Horizon / Acro – limited)
- Failsafe setup

This lesson focuses on the fundamentals of radio control systems. Students learn how control channels are mapped to drone functions and how pilot input is transmitted from the controller to the drone. Different flight modes are introduced, including stabilised and limited acrobatic modes, with emphasis on their appropriate use in indoor drone soccer environments.

The lesson also addresses failsafe configuration, teaching students how drones respond in case of signal loss or technical failure. By the end of the lesson, students understand the importance of reliable control systems and safe fallback behaviour.

### Lesson 16 – PID Concepts (Intro Level)

- What PID does (no math-heavy approach)
- Stability vs agility

This lesson introduces the concept of PID control in an intuitive and accessible manner, without focusing on mathematical formulas. Students learn how PID settings influence drone stability, responsiveness, and overall flight behaviour.

The lesson explores the balance between stability and agility, helping students understand trade-offs involved in drone tuning. Through demonstrations and guided experimentation, students observe how adjustments affect flight performance, preparing them for practical tuning in later lessons.

### Lesson 17 – Assisted Programming Concepts

- Logic: inputs → outputs
- Sensor feedback
- Automation ideas (advanced groups)

This lesson introduces basic programming logic used in drone control systems. Students learn how input signals, sensor data, and outputs interact within the flight controller. The role of sensor feedback in maintaining stable and responsive flight is explained through practical examples.

For more advanced groups, the lesson introduces ideas related to assisted control and simple automation, such as predefined behaviours or performance adjustments. This lesson encourages analytical thinking and provides insight into how programming supports autonomous and semi-autonomous drone behaviour.

### Lesson 18 – Strategy-Oriented Control

- Fast acceleration vs precision
- Defense vs attack tuning

This lesson connects drone configuration with game strategy. Students learn how control settings can be adapted to different tactical needs, such as fast acceleration for offensive play or increased stability and precision for defensive roles.

The lesson encourages students to think strategically about how tuning choices influence team performance. By linking technical configuration with gameplay objectives, students develop an integrated understanding of technology and competition.

### Lesson 19 – Debugging & Optimization

- Logs (basic)

- Improving response
- Team-based tuning

This lesson focuses on analysing performance and improving drone behaviour through systematic debugging and optimisation. Students are introduced to basic logging and observation techniques to identify issues such as delayed response or instability.

Working in teams, students adjust settings, test outcomes, and evaluate improvements. The lesson reinforces collaborative problem-solving and iterative improvement as essential skills in both technical work and team-based activities.

Outcome:

Upon completion of Module 4, students are able to configure, adjust, and optimise drone control systems, applying programming and tuning principles to enhance performance and safety in drone soccer activities.

# MODULE 5: Simulator & Virtual Training (Lessons 20–23)

## Lesson 20 – Simulator Introduction

- Simulator setup
- Controller calibration
- Safety advantages

This lesson introduces students to the use of flight simulators as a safe and effective learning tool for developing drone piloting skills. Students learn how to set up the simulator environment and correctly connect and calibrate controllers to ensure accurate input and realistic behaviour.

The lesson highlights the safety advantages of simulator-based training, allowing students to practice flight manoeuvres without the risk of equipment damage or injury. By familiarising themselves with simulator tools, students gain confidence and prepare for the transition to real-world drone operation.

## Lesson 21 – Basic Flight Exercises

- Hovering
- Directional control
- Speed management

This lesson focuses on developing fundamental piloting skills through structured simulator exercises. Students practice hovering to maintain stable flight, directional control to move accurately in all axes, and speed management to ensure smooth and controlled movement.

The exercises are designed to build muscle memory, spatial awareness, and control precision. Through repetition and guided feedback, students gradually improve consistency and confidence in basic flight operations.

## Lesson 22 – Soccer-Specific Drills

- Target approach
- Goal alignment
- Defensive positioning

This lesson applies piloting skills to drone soccer-specific scenarios. Students practice approaching targets, aligning with goals, and positioning their drones accurately for

scoring or blocking actions. The drills emphasise precision, timing, and situational awareness within the simulated playing field.

Students also learn defensive positioning techniques, understanding how spatial control and anticipation contribute to effective gameplay. The lesson bridges the gap between basic flight skills and competitive drone soccer performance.

### Lesson 23 – Tactical Scenarios

- 1v1 situations
- Attack vs defense
- Team coordination drills

This lesson introduces more complex and dynamic simulator scenarios that reflect real match situations. Students engage in one-on-one (1v1) encounters, learning how to adapt their piloting strategies to offensive and defensive roles.

Team coordination drills are introduced to strengthen communication and cooperative decision-making in simulated matches. Students learn to anticipate teammates' actions and adjust their own movements accordingly, reinforcing the importance of teamwork and tactical awareness.

### Outcome:

Upon completion of Module 5, students are able to safely develop and refine piloting skills using simulators, apply these skills to drone soccer-specific scenarios, and demonstrate improved readiness for real-world flight training.

# MODULE 6: Drone Soccer Rules & Tactics (Lessons 24–27)

## Lesson 24 – Official Drone Soccer Rules

- Field layout
- Match duration
- Scoring system
- Fouls & penalties

This lesson introduces students to the official rules governing drone soccer competitions. Students learn about the structure and layout of the playing field, including goal placement and boundaries, as well as match duration and game flow.

The lesson explains the scoring system and outlines common fouls and penalties, emphasising how rules ensure safety, fairness, and consistency during matches. Understanding the rules enables students to participate responsibly and confidently in both training and competitive environments.

## Lesson 25 – Team Roles & Positions

- Striker, defender, support
- Communication during matches

This lesson focuses on functional roles and positioning within a drone soccer team. Students learn the responsibilities of different positions, such as striker, defender, and support player, and how each role contributes to team performance.

The lesson highlights the importance of effective communication during matches, including clear role-based signals and coordinated decision-making. Students learn how teamwork and role awareness improve efficiency and reduce errors during gameplay.

## Lesson 26 – Game Tactics

- Offensive strategies
- Defensive blocking
- Energy management

This lesson explores strategic thinking in drone soccer. Students learn basic offensive strategies, including positioning, timing, and coordinated attacks, as well as defensive techniques such as blocking, intercepting, and protecting the goal.

Energy management is also addressed, helping students understand how battery usage and flight intensity affect performance over the duration of a match. The lesson encourages students to adapt strategies based on match situations and team objectives.

### Lesson 27 – Refereeing & Fair Play

- Referee signals
- Dispute handling
- Respect and sportsmanship

This lesson introduces students to the role of referees and the principles of fair play in drone soccer. Students learn common referee signals and their meanings, as well as procedures for handling disputes and rule violations.

The lesson emphasises respect for opponents, officials, and teammates, reinforcing sportsmanship and ethical behaviour. Students gain an understanding of how fair competition contributes to a positive and inclusive sporting environment.

### Outcome:

Upon completion of Module 6, students understand the official rules of drone soccer, apply tactical thinking during matches, and demonstrate respect, fairness, and sportsmanship in competitive situations.

# MODULE 7: Practical Training & Matches (Lessons 28–33)

## Lesson 28 – Basic Arena Training

- Take-off/landing drills
- Goal approach

This lesson introduces students to practical flight training within the drone soccer arena. Students practice safe and controlled take-off and landing procedures, focusing on precision, stability, and awareness of the playing environment.

The lesson also includes goal-approach exercises, allowing students to apply piloting skills in a structured space. Emphasis is placed on spatial orientation, controlled movement, and adapting flight behaviour to arena conditions.

## Lesson 29 – Offensive Drills

- Shooting accuracy
- Speed control

This lesson focuses on developing offensive skills required for successful scoring. Students practice shooting accuracy by aligning drones with the goal and executing controlled approaches at appropriate speeds. Speed control exercises help students balance agility with precision, reinforcing the importance of timing and control in offensive play. The lesson encourages students to refine techniques through repetition and feedback.

## Lesson 30 – Defensive Drills

- Blocking
- Intercepting opponents

This lesson develops defensive strategies and skills. Students practice blocking techniques to prevent opponents from scoring and learn how to position drones effectively in defensive zones.

Intercepting opponent drones is introduced through controlled drills, helping students develop anticipation, reaction speed, and spatial awareness. The lesson emphasises defensive responsibility as a key component of team success.

### Lesson 31 – Team Coordination

- Passing simulations
- Communication exercises

This lesson focuses on coordination and cooperation within the team. Students participate in passing simulations that require precise timing and coordinated movement between team members.

Communication exercises reinforce the importance of clear, concise, and respectful interaction during flight activities. The lesson strengthens teamwork and collective decision-making under dynamic conditions.

### Lesson 32 – Practice Matches

- Short matches
- Role rotation

This lesson provides students with structured practice match experience. Short matches are organised to simulate competitive conditions while maintaining a focus on learning and improvement. Role rotation is encouraged to ensure that all students experience different responsibilities within the team. This approach supports balanced skill development and deeper understanding of team dynamics.

### Lesson 33 – Match Analysis

- What worked?
- What failed?
- Improvements discussion

This lesson focuses on reflection and performance analysis. Students review practice matches to identify successful strategies and areas that require improvement.

Guided discussion encourages students to analyse both technical performance and teamwork, fostering critical thinking and constructive feedback. The lesson reinforces the value of reflection as a tool for continuous improvement.

### Outcome:

Upon completion of Module 7, students gain practical match experience, apply offensive and defensive skills in real scenarios, and demonstrate effective teamwork and communication during drone soccer activities.

## MODULE 8: Competition (Lessons 34–35)

### Lesson 34 & 35 – Internal Tournament

- Group stage
- Finals
- Student referees & judges

These lessons are dedicated to the organisation and implementation of an internal drone soccer tournament that represents the culmination of the learning process. Students participate in a structured competition format that includes a group stage followed by final matches, allowing all teams to demonstrate the knowledge, skills, and strategies developed throughout the programme.

The tournament is conducted in accordance with official drone soccer rules, with emphasis on fair play, safety, and respectful behaviour. In addition to competing as players, students take on organisational roles such as referees and judges, gaining insight into match management, rule enforcement, and decision-making processes.

This module provides students with an authentic competitive experience that integrates technical skills, tactical understanding, teamwork, and sportsmanship. Participation in the tournament encourages responsibility, confidence, and reflective learning in a real-world context.

#### Outcome:

Upon completion of Module 8, students experience organised drone soccer competition, apply learned skills in a realistic setting, and demonstrate respect for rules, teamwork, and fair competition.

## MODULE 9: Evaluation (Lessons 36)

### Lesson 36 – Reflection & Future Pathways

- Skills gained (STEM & soft skills)
- Career links (engineering, robotics, IT)
- Feedback & certificates
- Planning next season

This lesson is dedicated to reflection, evaluation, and consolidation of learning achieved throughout the Drone Soccer programme. Students review the technical, digital, and transversal skills they have developed, including STEM-related competences, teamwork, communication, problem-solving, and responsibility.

The lesson encourages students to reflect on their individual and team progress, identify strengths and areas for further improvement, and provide constructive feedback on the programme and learning experience. Feedback discussions support self-assessment and peer learning, reinforcing the value of reflection as part of lifelong learning.

Students are also introduced to potential educational and career pathways related to drone soccer activities, such as engineering, robotics, information technology, and other STEM and vocational fields. This connection helps students recognise the relevance of acquired skills beyond the extracurricular context.

The lesson concludes with recognition of student participation and achievements through certificates or acknowledgements and includes planning discussions for future activities, competitions, or continuation of the programme in the following school year.

#### Outcome:

Upon completion of Module 9, students reflect on their learning experience, recognise the skills they have developed, and identify potential future educational and career pathways related to drone technology and STEM fields.