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Competence Framework and Learning Outcomes
ChessAIthon Project

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Introduction

This document aims to integrate the Methodology and provide teachers with a clear competence framework for understanding what students can learn throughout the ChessAIthon project approach and tools.

The aim is to make visible the knowledge, skills and attitudes developed through chess logic, programming, data representation, artificial intelligence and the final AI chess competition.

The structure follows the logic commonly used in Europass documents: first, competences are described by European framework; then, the activities and tasks through which students develop them are identified; finally, a chapter-by-chapter mapping table shows how contributes to competence development.

1. European Key Competence Framework for Lifelong Learning

The following key competences are developed progressively across the five chapters of the ChessAIthon Methodology and they are adapted to the specific learning context of Chess, AI, data and project-based work.

Multilingual competence

- Use English and/or another foreign language to understand basic chess, programming and AI-related instructions, especially when consulting documentation, datasets, notebooks or online resources.
- Improve technical vocabulary related to chess, artificial intelligence, data representation, coding environments, APIs, datasets, algorithms and competition rules.
- Communicate simple technical ideas orally and in writing when explaining a move, a data transformation, a model behaviour or a team decision.
- Read and understand short technical texts, tutorials, code comments, game notation and project instructions related to the ChessAIthon activities.
- Show respect for the linguistic profile of each student and adapt communication to different language levels during teamwork, peer explanation and presentations.

Mathematical, science, technology and engineering competences

- Apply logical, sequential and cause-effect reasoning when analysing chess positions and predicting possible consequences of moves.
- Use spatial reasoning, coordinates, patterns and structured representations to interpret the chessboard as a system of positions, movements and constraints.
- Break down complex problems into smaller elements, compare alternatives and select solutions based on evidence and reasoning.

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- Understand basic technological and engineering principles involved in building, testing and improving an AI-based chess system.
- Use models, representations and simulations to explore decision-making processes in both human and artificial intelligence contexts.

Digital competence

- Use digital tools, coding environments, notebooks and online platforms safely and effectively to explore chess data and AI models.
- Access, manage, filter, evaluate, create and share digital content related to chess positions, datasets, code, documentation and model outputs.
- Understand and use basic data formats such as FEN, PGN, CSV, JSON and Parquet, and recognise their different purposes in human-readable and machine-readable contexts.
- Manage and protect information, data, digital identities and shared resources, applying basic privacy, cybersecurity and responsible-use principles.
- Recognise and use software, artificial intelligence tools, datasets, algorithms and automated systems responsibly and critically.

Personal, social and learning to learn competences

- Work collaboratively in teams, distribute roles, communicate effectively and support peers during problem-solving, coding, debugging and competition activities.
- Learn and work both autonomously and collaboratively, organising tasks, managing time and persevering in the achievement of learning goals.
- Reflect on one's own decisions, mistakes and progress through post-game analysis, debugging logs, learning journals or group discussions.
- Show tolerance, empathy and respect for different points of view when comparing strategies, code solutions or interpretations of model results.
- Develop resilience, patience and emotional regulation by learning from losses, failed tests, errors, crashes or unexpected competition outcomes.
- Adopt responsible behaviour in the use of digital and physical resources, including energy use, equipment care, recycling and sustainable organisation of activities where possible.

Citizenship competence

- Act responsibly and respectfully in collaborative digital and classroom environments, following rules, fair-play principles and ethical guidelines.

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- Understand the importance of transparency, accountability and fairness in AI systems and in competitive settings.
- Use information and media sources critically, especially when consulting online chess engines, AI tools, repositories, tutorials or datasets.
- Respect intellectual property, open-source licenses, dataset conditions and authorship of code and digital resources.
- Recognise that artificial intelligence has social implications and must be developed and used in ways that respect human values, inclusion and democratic participation.

Entrepreneurship competence

- Transform ideas into action by designing, testing and improving a chess AI solution within a project-based learning environment.
- Plan tasks, manage resources, assume responsibilities and make decisions within a team project.
- Identify problems, propose solutions, test alternatives and iterate improvements based on evidence and feedback.
- Show initiative, creativity and strategic thinking when developing algorithms, improving models or preparing for the ChessAIthon competition.
- Present and justify results, explaining the value, limitations and possible improvements of the developed solution.

Cultural awareness and expression competence

- Recognise chess as a cultural, historical and international practice that connects different countries, traditions and ways of thinking.
- Understand how technology, AI and games can become forms of cultural expression and shared learning across educational contexts.
- Show openness and respect towards diverse approaches to strategy, creativity, communication and problem-solving.
- Express ideas creatively through game analysis, visual representations, digital interfaces, presentations or team projects.
- Respect cultural diversity, intellectual property and ethical use of digital and creative outputs.

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2. European Skills, Competences and Occupations (ESCO)

2.1 ChessAIThon in ESCO

The following learning outcomes translate the ChessAIthon curriculum into ESCO-oriented skills and competences related to ICT, data, artificial intelligence, teamwork and problem-solving. They are not limited to a single occupation, but are relevant for VET students developing digital and transversal competences.

ESCO is the European classification of Skills, Competences, Qualifications and Occupations, maintained by the European Commission. This revision uses ESCO v1.2.1, updated on 10 December 2025 [R2]. LO1–LO6 below are learning outcomes written for ChessAIThon. Their relationship to selected ESCO concepts is a contextual, partial correspondence; it does not establish occupational qualification, full competence equivalence or certification. The crosswalk in Section 2.1 identifies the relevant official labels, source records and evidence.

Learning Outcome 1: Analysing problems and designing digital solutions

- Identify the main problem to be solved in a chess position, a dataset transformation, an AI prediction or a competition scenario.
- Analyse available information, constraints, resources and expected outputs before selecting a solution.
- Apply logical, strategic and computational thinking to propose feasible solutions.
- Explain the reasoning behind the selected solution using clear technical language.

Learning Outcome 2: Representing, processing and managing chess data

- Interpret chess positions and games using structured formats such as FEN, PGN and move notation.
- Transform chess data into computational representations such as matrices, tensors or encoded moves.
- Use structured datasets in formats such as CSV, JSON or Parquet for AI training or analysis.
- Organise and document data transformation processes accurately and systematically.

Learning Outcome 3: Using digital tools, coding environments and AI resources

- Use notebooks, programming libraries, repositories and digital tools to explore, transform and analyse chess data.
- Run, test or modify simple AI-related workflows under teacher supervision.
- Use software tools responsibly, respecting data protection, cybersecurity and intellectual property principles.
- Consult documentation and technical resources to resolve doubts and improve the work produced.

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Learning Outcome 4: Understanding and evaluating AI decision-making systems

- Explain in simple terms how an AI system can learn from data and predict possible chess moves.
- Understand the basic role of data representation, model training, prediction, legal move validation and search strategies.
- Interpret model outputs and performance metrics critically, recognising that more than one valid solution may exist.
- Identify limitations, risks and ethical considerations linked to AI-based decision-making.

Learning Outcome 5: Developing, testing and improving an AI chess solution

- Participate in the development, configuration or improvement of a chess AI bot or related digital tool.
- Test the behaviour of the system through practice matches, debugging activities or controlled experiments.
- Identify errors, crashes, invalid moves or performance limitations and contribute to improvement actions.
- Document changes, results and lessons learned during the development and competition process.

Learning Outcome 6: Working collaboratively and communicating technical decisions

- Work effectively within a team, respecting assigned roles and shared responsibilities.
- Communicate technical problems, strategic decisions and project results clearly to peers and teachers.
- Provide and receive feedback constructively during analysis, debugging and competition preparation.
- Demonstrate fair play, transparency and respect for rules in collaborative and competitive contexts.

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2.2 ESCO crosswalk and evidence

The labels below are found in the ESCO records cited as S1–S3 in Section 8. Technical labels in S1 are verified through the software developer occupation record; this is a source link, not an assertion that students meet that occupation's requirements. Assessment applies only to the project tasks and the individual contribution demonstrated.

Outcome	Selected ESCO labels and source	Project task and individual evidence
LO1 Problem analysis	think critically [S3]	Compare alternatives in a chess or coding problem. Submit a reasoned choice identifying constraints.
LO2 Chess data	computer programming [S1]	Use a supplied script to transform FEN or PGN data. Provide input/output samples and explain validation checks. This covers the programming aspect, not the full data-management outcome.
LO3 Tools and resources	use software libraries [S1]	Run or adapt a notebook using a chess library. Provide the notebook and explain one function and its output.
LO4 AI evaluation	think critically [S3]	Compare model outputs, distinguish legal moves from strong moves and identify a limitation. Provide an annotated comparison.
LO5 Testing and improvement	debug software; develop software prototype [S1]	Reproduce a fault, test a correction or configuration change and record the result. Provide a test log and attributable change.
LO6 Collaboration	work in teams [S2]	Fulfil an agreed role and explain a team decision. Provide teacher observation, a role record and a short individual explanation.

The crosswalk is selective and many-to-many. Ethical AI knowledge, FEN/PGN-specific knowledge and the complete data-management outcome remain project descriptors rather than claimed exact ESCO matches. Keep the cited ESCO edition with assessment records; review the crosswalk if that edition changes.

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3. Other Competence Frameworks – LifeComp, DigComp and AI Literacy

In addition to the Key Competence Framework and ESCO, the ChessAIthon curriculum is especially aligned with LifeComp, DigComp and AI literacy. These frameworks help teachers observe personal, social, learning, digital and AI-related competences in concrete classroom activities.

This section uses LifeComp (2020) [R3], DigComp 3.0, fifth edition (2025) [R4], and UNESCO's AI competency framework for students (2024) [R5]. UNESCO is an international reference complementary to the European frameworks. Project activities and descriptors contextualise these sources for VET learners; they do not reproduce the full frameworks or demonstrate achievement of their complete proficiency levels.

LIFECOMP – Personal, social and learning to learn.

- Self-regulation: manage attention, emotions and impulsivity during chess decisions, coding tasks and competition pressure.
- Flexibility: adapt strategies when a move, model, dataset or technical solution does not work as expected.
- Wellbeing and resilience: handle mistakes, defeats, bugs and unexpected outcomes as part of the learning process.
- Empathy and collaboration: understand other perspectives during team analysis and peer feedback.
- Learning to learn: plan, monitor and evaluate one's own progress through reflection and iterative improvement.
- Growth mindset, L2 Critical thinking and L3 Managing learning: use feedback, justify conclusions and review progress.

DIGCOMP – Digital competence

- Information and data literacy: search, interpret, organise and use chess data and technical documentation.
- Communication and collaboration: cooperate through digital platforms, shared files, code repositories or group workspaces.
- Digital content creation: create or modify code, datasets, documentation, visualisations or digital interfaces.
- Safety: protect data, respect privacy and use online resources securely and responsibly.
- Problem identification and solving: identify errors and improve digital workflows. These are selected contextual links; the assessment levels in Section 7 are project levels, not DigComp proficiency certification.

AI LITERACY – Ethic and responsible use of AI

- Understand that AI systems depend on data, representations, models, rules and evaluation processes.
- Recognise the difference between human reasoning and machine processing in chess decision-making.
- Interpret AI outputs critically instead of accepting them automatically as correct.

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- Recognise basic ethical issues such as transparency, fairness, reliability, responsible use and limits of automation.
- Use AI as a learning and problem-solving tool while maintaining human judgement, explanation and responsibility.
- The reference is UNESCO's AI competency framework for students (2024), organised into four dimensions and the progression levels Understand, Apply and Create [R5]. ChessAIThon selects relevant elements; it does not claim complete coverage.
- Human-centred mindset: explain why people retain responsibility for the use and interpretation of a chess AI.
- Ethics of AI: identify concerns about reliability, attribution and transparency in project activities.
- AI techniques and applications: explain the relationship between data, training and predictions, and test outputs against chess rules.
- AI system design: document a workflow and test an improvement. Understand and Apply guide core activities; Create is an extension for learners who actually design and justify changes. LO4 and LO5 provide the main links, with LO2 supporting data work.

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4. Activities and Tasks Related to Each Framework

The following activities and tasks describe how the competences above are developed through the ChessAIthon Project. They are written in a format that teachers can easily use them for planning, observation and later recognition of learning outcomes.

ACTIVITY / TASK – Multilingual competence

- Use English or another foreign language to understand basic instructions related to chess, coding, AI tools, datasets and competition rules.
- Use technical vocabulary related to chess moves, data formats, algorithms, artificial intelligence and digital tools.
- Read short documentation, tutorials, code comments or online resources related to the project.
- Explain simple technical decisions orally or in writing using clear and appropriate language.
- Respect different language levels within the team and adapt communication accordingly.

ACTIVITY / TASK – Digital competence

- Use digital tools, notebooks, chess libraries, repositories or online platforms to complete learning tasks.
- Search for, select, organise and use digital information and datasets responsibly.
- Create, modify or share simple digital content such as code snippets, board representations, tables, diagrams or presentations.
- Apply basic data protection, cybersecurity and responsible-use rules when working with digital tools and AI systems.
- Use artificial intelligence tools critically, understanding their outputs and limitations.

ACTIVITY / TASK – Personal, social and learning to learn competence

- Work cooperatively with peers during chess analysis, programming tasks, debugging and competition preparation.
- Organise individual and team tasks, manage time and meet agreed deadlines.
- Carry out tasks both independently and with support when needed.
- Accept feedback, analyse mistakes and identify improvement actions.
- Show perseverance and resilience when facing complex problems, failed tests or competition setbacks.
- Reflect on learning progress through guided questions, learning journals or post-activity discussions.

ACTIVITY / TASK – Citizenship competence

- Respect rules, fair-play principles and ethical guidelines during chess, coding and AI competition activities.

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- Use online information and digital resources critically and responsibly.
- Respect intellectual property, authorship, licences and the originality of code and datasets.
- Understand that AI systems may affect people and therefore require fairness, transparency and responsibility.
- Participate positively in a collaborative learning environment based on respect, inclusion and shared responsibility.

ACTIVITY / TASK – Cultural awareness and expression competence

- Recognise chess as an international and culturally relevant practice connected to different historical and social contexts.
- Show openness to different ways of thinking, analysing and solving problems.
- Create visual, oral or digital outputs that communicate strategies, decisions or project results.
- Respect creative outputs, digital artefacts and cultural references used in the project.
- Reflect on how games, technology and AI can become shared forms of learning and expression.

ACTIVITY / TASK – ICT, Data and AI competence

- Identify user, team or project needs related to chess AI development and digital tools.
- Prepare and process chess data using appropriate formats and structured procedures.
- Use coding environments and libraries to transform, analyse or visualise chess positions.
- Test AI behaviour, identify technical problems and contribute to debugging or improvement actions.
- Document technical steps, decisions, results and lessons learned.
- Communicate technical explanations and provide support to peers when solving ICT or AI-related tasks.

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5. ChessAIThon Map of competences

The following table shows how the competences are distributed across the five chapters of the guide. This mapping helps teachers understand the pedagogical progression of the curriculum and identify which competences are mainly developed in each of the 5 Chapters: Chapter 1 – Programming foundations and chess logic; Chapter 2 – Chess logic and problem-solving strategies; Chapter 3 – Chess data, formats and computational thinking; Chapter 4 – Deep learning and data analysis for chess movement solving; Chapter 5 – Organising and competing with Chess and AI

Chapter	Main learning focus	Key Competence Framework	ESCO-oriented skills	LifeComp / DigComp / AI Literacy	Observable evidence
1	Understanding chess and programming as structured systems based on variables, rules, sequences, functions and logical decisions.	Mathematical competence; Digital competence; Learning to learn.	Apply logical thinking; analyse information; understand structured processes; use basic digital tools.	Computational thinking; focus; self-regulation; basic AI readiness.	Student explains simple algorithms, follows sequences, identifies inputs/outputs and connects chess rules with programming logic.
2	Using chess as a cognitive system to develop reasoning, strategy, metacognition and transversal skills.	Mathematical competence; Personal, social and learning to learn; Entrepreneurship competence.	Solve problems; make decisions; develop strategies; think analytically.	Critical thinking; adaptability; resilience; metacognition.	Student analyses positions, compares alternatives, justifies decisions, reflects on mistakes and adapts strategies.
3	Representing chess information through FEN, PGN, datasets, matrices, notebooks, version control and data-sharing environments.	Digital competence; Mathematical competence; Learning to learn.	Process data; use digital tools; apply computational thinking; document technical procedures.	Data literacy; digital problem solving; responsibility; systematic work.	Student interprets formats, transforms data, uses notebooks or repositories and explains the purpose of different data structures.
4	Understanding AI concepts such as CNNs, reinforcement learning, move encoding, Boolean masks, MCTS, performance metrics and model limitations.	Digital competence; Mathematical/scientific competence; Learning to learn.	Analyse data; evaluate technological solutions; use machine learning tools; interpret outputs.	AI literacy; critical evaluation; responsible AI; analytical reasoning.	Student explains how the AI predicts moves, interprets model outputs, recognises limitations and proposes improvement actions.
5	Applying learning in an AI chess competition through teamwork, testing, fair play, technical reliability, communication and reflection.	Social competence; Entrepreneurship competence; Digital competence; Citizenship competence.	Work in teams; communicate effectively; manage projects; adapt to change; follow ethical rules.	Collaboration; resilience; self-regulation; digital collaboration; responsible AI.	Student works in a team, manages time, documents progress, handles errors constructively, respects fair-play rules and presents results.

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6. ChessAIThon and EU frameworks interaction

The table below provides a compact overview of how the main frameworks interact in the ChessAIthon project. It can be used by teachers as a quick reference when planning activities, observing learning outcomes or preparing documentation such as Europass Mobility certificates or competence assessment tools.

Framework	Main competence areas in ChessAIthon	How students develop them	Main chapters	Assessment focus
European Key Competence Framework for Lifelong Learning	Multilingual; mathematical; digital; personal, social and learning to learn; citizenship; entrepreneurship; cultural awareness.	Through multilingual technical communication, logical reasoning, digital tasks, teamwork, ethical AI use and creative project outputs.	All chapters	Ability to transfer knowledge, skills and attitudes across contexts.
ESCO	ICT, data, AI, problem-solving, communication, teamwork and project-related skills.	Through data processing, coding environments, AI model understanding, testing, debugging and technical communication.	Chapters 3, 4 and 5	Performance of observable technical and transversal tasks.
LifeComp	Self-regulation, flexibility, collaboration, resilience, critical thinking and learning to learn.	Through reflection, strategy adjustment, post-game analysis, debugging and team-based activities.	Chapters 2 and 5, with links to all others	Reflection, autonomy, persistence and capacity to improve.
DigComp	Data literacy, digital content creation, digital collaboration, safety and digital problem-solving.	Through notebooks, datasets, coding, repositories, digital tools and AI-supported learning.	Chapters 3, 4 and 5	Responsible and effective use of digital technologies.
AI Literacy	Understanding AI systems, interpreting outputs, recognising limitations, using AI responsibly.	Through CNNs, move encoding, legal move validation, MCTS, performance analysis and AI competition.	Chapter 4 and Chapter 5	Critical, transparent and responsible understanding of AI decisions.

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7. Documentation and validation for Europass Mobility

The following project procedure supports the WP4 Europass commitment in the ChessAIThon Quality Plan [R7]. It applies to relevant organised learning mobility. Use the official Europass Mobility template and guidance published in 2024 [R6], or the official replacement available at issuance, and record the template edition used. Europass documents learning; it does not automatically award a qualification or academic credit.

Before mobility

The sending and hosting organisations agree with the participant which of LO1–LO6 are realistic for the mobility, the tasks, evidence, assessment criteria and support arrangements. Name the host assessor and the sending organisation reviewer. Record the agreement in the pre-mobility documentation. Distinguish learning undertaken in preparatory activities from learning demonstrated during mobility.

During mobility

Create an individual evidence record: participant and mobility identifiers, dates and location, outcome ID, task, evidence reference, individual contribution, support received, assessor and assessment date. Evidence may include notebooks, transformation samples, test logs, presentations and teacher observations. Group outputs require an attributable contribution and an individual explanation or demonstration. Participation and tournament ranking alone do not establish competence.

Assessment criteria and decisions

Outcome	Minimum task criterion
LO1	Identifies the problem and constraints, compares alternatives and justifies a feasible choice.
LO2	Interprets the selected chess format, completes the agreed transformation and explains checks on its output.
LO3	Runs the agreed workflow, explains the relevant tool or library and attributes reused resources.
LO4	Explains a prediction, distinguishes legality from move quality and identifies a limitation using evidence.
LO5	Records a reproducible test, makes an attributable improvement and compares the resulting behaviour.
LO6	Performs an agreed role, communicates a decision and demonstrates constructive feedback and fair play.

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For each selected outcome, record one project decision: Not yet demonstrated; Demonstrated with specified support; or Demonstrated independently for the agreed task. Record missing evidence as Not assessed. These categories are local assessment decisions, not EQF levels, DigComp levels or UNESCO certification. Learners may demonstrate outcomes through accessible equivalent tasks, provided the same criterion is assessed. Include only supported achievement statements in the final document, with the level of support where relevant.

After mobility

The host assessor checks evidence against the agreed criteria and prepares short achievement statements. The sending organisation reviews the record with the host and participant, resolves discrepancies and agrees the outcomes to document. Follow the official template's completion and signature rules; do not invent additional signature requirements. Give the participant the completed post-mobility document and explain how the sending institution will recognise the experience within its own procedures. Any credit or qualification recognition requires a separate institutional decision.

Conclusions

The ChessAIthon curriculum develops competences that go far beyond learning chess or using artificial intelligence as isolated topics. Across the five chapters, students progressively develop logical reasoning, computational thinking, data literacy, AI literacy, collaboration, resilience, ethical awareness and project-based problem-solving. By aligning these learning processes with the European Key Competence Framework for Lifelong Learning, ESCO, LifeComp, DigComp and AI literacy, the guide provides teachers with a clear and assessable framework for explaining what students learn, how they learn it and how these competences can be recognised in future, Europass Mobility documents and competence assessment tools.

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