

# Meta-Machine Learning (MML) — Spiral Curriculum for All Ages (v1.0)

**Purpose.** Establish a complete, age-progressive curriculum that treats AI as an *interactive epistemic amplifier*. Learners practice the meta-machine learning loop (Human → Prompt → AI Response → Reflection → Refined Prompt) and the triadic protocol (Generator/Enhancer/Critic) to produce, test, and improve knowledge. Ethics, co-authorship, and measurement (PER, MLEM, TCI) are embedded throughout.

**Learning Outcomes (global).** By the end of each pathway, learners can: - Orchestrate human-AI dialogue using prompt archetypes (Socratic, Role-Play, Counterfactual, Constraint-Driven). - Run G→E→C (Generator/Enhancer/Critic) loops and quantify progress with **PER** (prompt efficiency), **MLEM** (insight per iteration effort), **TCI** (convergence across agents). - Apply bias-aware, ethical practices and co-authorship norms; communicate provenance and limits. - Transfer MML skills to academic domains (STEM/Humanities/Arts), civic reasoning, and workplace scenarios.

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## Part I — K-12 Spiral (Spiral = revisit core ideas with rising complexity)

### K-2 (Ages 5-7) — *Curious Conversations*

**Themes.** Wonder → questions → turn-taking → noticing bias/kindness → co-creation. **Modules (6×35-45 min).** 1) **Ask-Me Game.** Learners ask a classroom “helper bot” simple questions; teacher models “why/how” follow-ups. *Artifact:* question card deck. 2) **Picture Prompts.** Learners describe an image; AI adds a sentence; learner edits; teacher spotlights clarity. 3) **Yes/No → Why?** Convert yes/no to why-questions; class chart of better questions. 4) **Constraint Fun.** “Tell it in 10 words.” Learners feel how limits focus thinking. 5) **Kindness & Fairness.** Discuss what makes a story kind/fair; flag stereotypes. 6) **Make-a-Mini-Book.** Child + AI co-author 4-page picture book; child dictates edits. **Assessment.** Observation checklist; oral retell; *PER-Lite:* 1-3 smiley scale for “Did your question help the answer get better?”

### Grades 3-5 (Ages 8-11) — *Prompt Patterns*

**Modules (8×45-60 min).** 1) **Prompt Archetypes I.** Socratic seeds; Role-Play (“act as park ranger”); Constraint (“50-word explain”). 2) **Idea Ladder.** Start broad → add constraint → add example → compare outputs. 3) **Editing Buddy.** Learner drafts; AI suggests; learner accepts/rejects with reasons. 4) **Fact-Check & Cite.** Simple verify routine; distinguish “sounds right” vs. sourced. 5) **Bias & Perspective.** Same prompt, two personas; compare tone/content. 6) **Creative Remix.** Co-write poem or scene; reflect on authorship. 7) **Mini-PER.** Rate utility of outputs vs. prompt effort; graph as bar chart. 8) **Showcase.** Class “Ask-an-Expert” newsletter. **Assessment.** Rubric: clarity, iteration, ethics; short self-reflection.

## Grades 6–8 (Ages 11–13) — *Loops & Metrics*

**Modules (9×50–60 min).** 1) **The MML Loop.** Human→Prompt→AI→Reflect→Refine; work examples across subjects. 2) **Triad Roles (Human-in-the-loop).** Peers play Generator/Enhancer/Critic before using AIs. 3) **PER & MLEM 101.** Define, estimate; maintain iteration journal. 4) **Evidence & Counter-Evidence.** Ask for sources; generate counter-claims; steelman. 5) **Ethics Studio.** Prompt auditing; privacy basics; co-authorship statements. 6) **Constraint Design.** Word limits, formats, personas; measure PER deltas. 7) **Domain Days.** Science explainer; history causation; literary analysis; art critique. 8) **Mini-Capstone.** 3-iteration inquiry answering a real question; use PER/MLEM. 9) **Public Share.** Gallery walk; feedback using “Warm/Cold/Next” protocol.

## Grades 9–12 (Ages 14–18) — *Orchestrating Intelligence*

**Semester Course (18 weeks; 2×/week).** - **Unit 1: Primer (Weeks 1–3).** Prompt archetypes; model constraints; loop discipline; risk registers. - **Unit 2: Prompt Architecture (Weeks 4–6).** Compose multi-step prompts; structure reasoning (define→compare→apply→predict). - **Unit 3: Triadic Refinement (Weeks 7–9).** Implement Generator/Enhancer/Critic with classmates, then with multi-agent AIs; intro **TCI**. - **Unit 4: Evaluation & Reproducibility (Weeks 10–12).** PER/MLEM logging; ablations (change one prompt element); replication packets. - **Unit 5: Ethics & Policy (Weeks 13–14).** Bias amplification; epistemic responsibility; civic uses; AI in exams. - **Unit 6: Capstone (Weeks 15–18).** 6–10 iteration project tied to a discipline; publish artifact + appendix with logs/metrics. **Assessments.** Weekly labs, midterm replication, capstone portfolio (prompt pack, logs, rubric, co-authorship page).

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## Part II — Undergraduate Pathways

### Option A: 12-Credit Minor

- **MML 101 — Meta-Machine Learning Foundations (3cr).** Dialogue as method; prompt archetypes; ethics. *Major assignment:* Prompt Pack v1.0 with PER analysis.
- **MML 201 — Prompt Architecture & Reasoning Design (3cr).** Chain-of-thought structures; constraint leverage; retrieval-augmented dialogue. *Studio:* 5 weekly design sprints.
- **MML 301 — Multi-Agent Orchestration (3cr).** Triadic protocol; consensus; TCI; tool APIs. *Lab:* build an orchestrator that runs G/E/C cycles.
- **MML 310 — Ethics, Law & Governance (3cr).** Auditing, privacy, copyright, co-authorship, risk.

### Option B: 3-Course Sequence for Non-Majors

Foundations → Applied Studio (discipline-specific) → Capstone with community partner.

**Undergrad Capstone Rubric (abridged).** - Problem clarity (20), Design of prompts/constraints (20), Evidence & verification (20), Metrics (PER/MLEM/TCI) + analysis (20), Ethics & impact (10), Communication (10). Total 100.

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## Part III — Graduate Certificate / MS Track

**Required (4).** 1) **MML 500 — Research Methods for Conversational Systems.** Experimental design for prompts; A/B/n; human-subject protocols. 2) **MML 520 — Multi-Agent Reasoning & Alignment.** Formal triadic/consensus methods; measuring convergence; failure modes. 3) **MML 540 — Evaluation & Benchmarks for Dialogue Work.** From task success to epistemic yield; instrumenting PER/MLEM/TCI. 4) **MML 560 — Ethics of Epistemic Systems.** Bias, fairness, provenance, co-authorship; governance frameworks.

**Electives (choose 2).** Human-AI Co-Creativity; Domain Studios (Science/Humanities/Design); Education & Assessment Tech; Productized Prompting.

**Graduate Practicum.** Partnered engagement (8–12 weeks): deliver an MML solution with dashboards; IRB-style ethics memo; open replication packet.

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## Part IV — Professional Development (PD)

### PD for K–12 Educators

- **5-Day Summer Institute.** Day 1 Primer; Day 2 Classroom protocols; Day 3 Ethics & safety; Day 4 Assessment & dashboards; Day 5 Unit design + peer review.
- **10-Week Coaching Cycle.** Plan → teach → collect logs → reflect using PER/MLEM; triads of teachers exchange critiques; publish lesson exemplars.
- **Micro-credentials.** Socratic Practitioner; Prompt Architect; Multi-Agent Orchestrator; Assessment Designer.

### PD for Industry/Nonprofits

- **Bootcamp (2 days).** Map workflows; build prompt packs; instrument metrics; governance guardrails.
  - **Apprenticeship (6 weeks).** Shadow → implement → scale; deliver ROI via Insight Yield and Iteration Depth.
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## Part V — Assessment & Analytics Toolkit

**1) Metrics.** - **PER (Prompt Efficiency Ratio).** Utility of output ÷ complexity of input. *K-12:* 1–3 stars + reasons. *HE/PD:* 5-point utility × clarity penalties; track deltas across iterations. - **MLEM (Meta-Learning Efficiency Metric).** Value of insight ÷ (prompt effort + iteration time). Keep per-assignment logs; require at least one high-MLEM redesign. - **TCI (Triadic Convergence Index).** Estimate change magnitudes across Enhancer/Critic turns; watch trend toward 0; cap iterations to 3–10 unless improvements persist.

**2) Instruments.** - **Iteration Log.** Timestamp, prompt version, output summary, changes, PER/MLEM, next action. - **Triad Sheet.** Who played what role; critique deltas; TCI chart; decision to stop. - **Prompt Audit Checklist.** Clarity, bias, privacy, sources, stakeholder impact. - **Co-Authorship Statement.** Human intent + AI synthesis; citations; licenses.

**3) Rubrics (snapshots).** - *Clarity (0–4), Evidence (0–4), Iteration Quality (0–4), Ethics (0–4), Communication (0–4).*  
Add bonus for high PER/MLEM uplift and low TCI at termination.

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## Part VI — Ethics, Safety, & Inclusion

- **Prompt Auditing** before deployment; defuse stereotypes; include counter-voices.
  - **Epistemic Responsibility.** Verify in high-stakes tasks; label uncertainty; avoid overclaiming.
  - **Privacy.** No sensitive PII; anonymize datasets; consent for sharing artifacts.
  - **Co-Authorship & Provenance.** Attribute human + AI roles; track sources; release replication packets.
  - **Accessibility (UDL).** Multiple representations (text/audio/visual); multilingual support; choice boards; assistive tech compatibility.
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## Part VII — Implementation Guide

**Staffing.** 1 coordinator, 2–4 teacher-leaders, IT support; student mentors (HS/UG) for peer coaching.  
**Schedule (K–12).** 1 period/week or 2-week intensives; integrate into ELA/Science/History/Arts. **Schedule (HE).** Studio-heavy; 30–40% of grade from iteration logs & replication. **Infra.** Classroom-safe AI, logging dashboards, versioned workspace, citation tools. **Family & Community.** Parent letters; open exhibitions; community problem briefs. **Equity.** Device access plan; offline alternatives; culturally responsive examples.

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## Part VIII — Core Lesson & Unit Templates

**A) Lesson Template (50–60 min).** - *Hook (5):* concrete problem/story. - *G (10):* first-pass output from AI or peer generator. - *E (10):* enhancement with constraints (format/length/audience). - *C (10):* critique—find gaps, counter-examples, risks. - *Cycle (10):* one more G→E→C; log PER/MLEM; estimate TCI. - *Share (5):* one sentence “what changed.”

**B) Unit Template (2–3 weeks).** - Driving question; vocabulary; artifacts; assessment plan; ethics checkpoints; family note.

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## Part IX — Prompt Packs (by level)

**K–2.** “Ask 3 why’s about \_\_”, “Tell it in 10 words,” “Make a kinder ending...”. **3–5.** “Explain X like a park ranger to 4th graders ( $\leq 80$  words), then list 2 examples.” **6–8.** “(1) define X, (2) compare to Y in a table, (3) one way it could be unfair, (4) one test.” **9–12.** “As a skeptical reviewer, list top 5 failure modes + quick test for each; then propose a fix ranked by PER gain.” **UG/Grad/PD.** Socratic, Role-Play, Counterfactual, Constraint Leverage, Reasoning Simulation bundles; discipline-specific variants.

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## Part X — Sample Year Plans

**Grade 7 (9 weeks).** Weeks 1–2 Primer; 3 PER/MLEM; 4 domain day; 5 ethics; 6 constraints; 7 triads; 8 project; 9 exhibition. **Undergrad Minor (2 semesters).** Sem 1: MML 101 + 201; Sem 2: 301 + 310 + capstone studio. **PD Cohort (12 weeks).** Alternating design sprints + classroom trials; publish playbook.

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## Glossary (select)

**PER** — Prompt Efficiency Ratio; **MLEM** — Meta-Learning Efficiency Metric; **TCI** — Triadic Convergence Index; **G/E/C** — Generator/Enhancer/Critic; **Iteration Depth** — number/quality of refinement cycles; **Insight Yield** — value of outcomes.

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## Appendices (printables)

- Iteration Log, Triad Sheet, Prompt Audit, Co-Authorship template.
- K–12 rubrics, HE capstone rubric, PD scorecards.
- Family letters (K–5, 6–8, 9–12) explaining MML and safe AI use.
- Example replication packet (inputs, outputs, decisions, metrics).