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Optimizing Triple Parallel Demonstration in AI and Machine Learning Education: An Agentic Approach to Integrated Scientific Reasoning

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Article Focus

Article Context

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How to Optimize Learning and Relational Dependencies

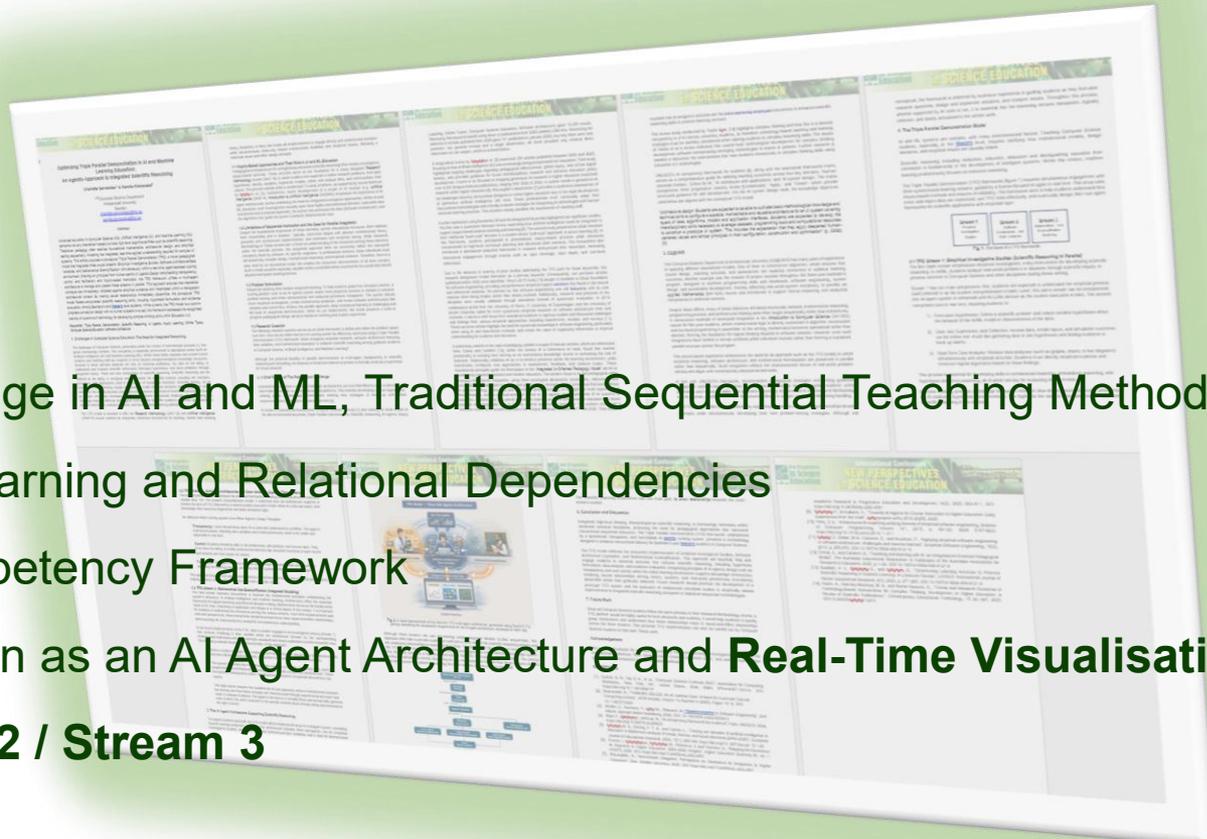
UNESCO's AI Competency Framework

Later Implementation as an AI Agent Architecture and **Real-Time Visualisation**

Stream 1 / Stream 2 / Stream 3

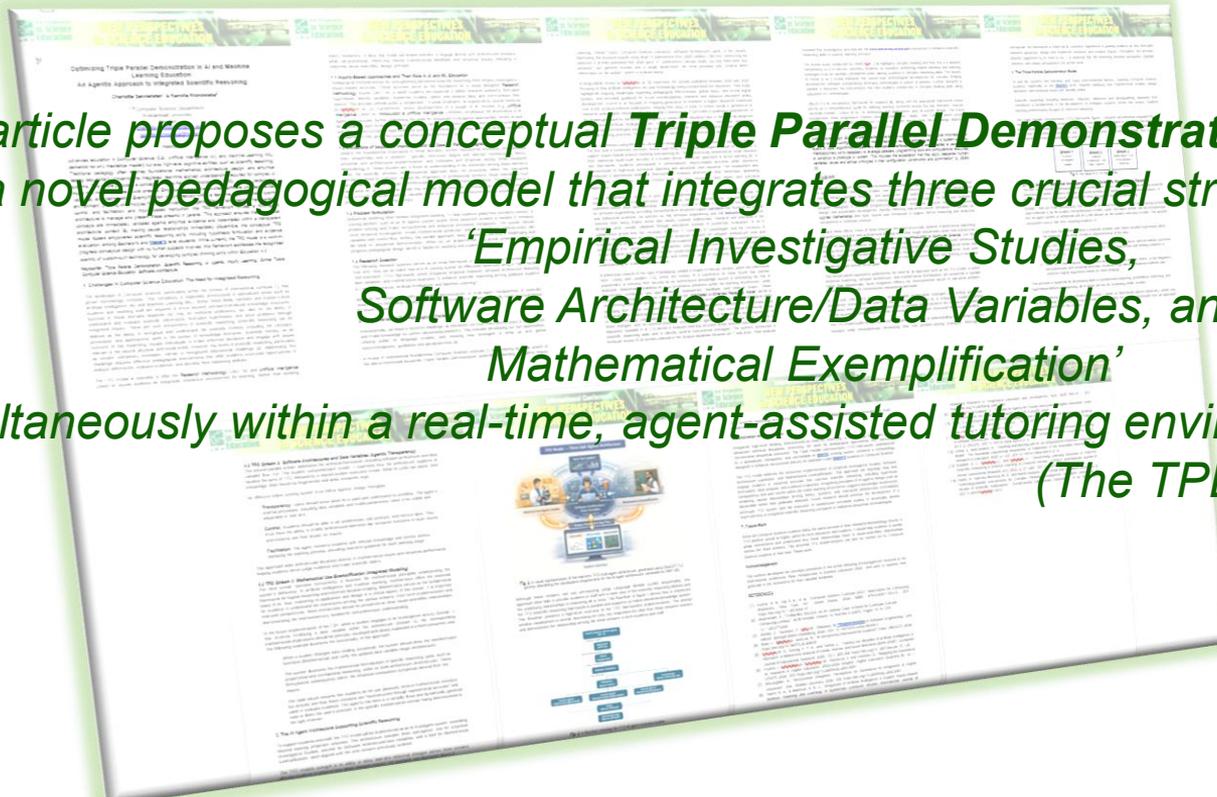
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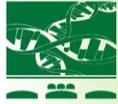
Future Work





*“This article proposes a conceptual **Triple Parallel Demonstration (TPD)**, a novel pedagogical model that integrates three crucial streams ‘**Empirical Investigative Studies, Software Architecture/Data Variables, and Mathematical Exemplification**’ simultaneously within a real-time, agent-assisted tutoring environment.”*
(The TPD article, 2026)





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Current Course
DA311B Research Methodology
Scientific Empirical Focus

for Software Development and Computer Engineering



Education 4.0

Education 4.0 refers to a transformation of education aligned with the Fourth Industrial Revolution (Industry 4.0) — characterized by AI, automation, data-driven systems, robotics, and digital interconnectedness.

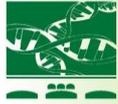
It represents a shift from traditional knowledge transmission toward **technology-enhanced, skills-oriented, and human-centered learning.**

1. Why "4.0"?

The term parallels industrial development stages:

Industrial Era	Education Model	Focus
1.0	Teacher-centered	Basic literacy
2.0	Standardized systems	Mass education
3.0	Digital learning	ICT integration
4.0	Intelligent, adaptive learning	AI, personalization, complex skills

(ChatGPT 080326)



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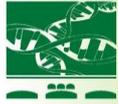
The Educational Challenge in AI & ML

Increasing complexity in AI/ML education

- Need for advanced scientific reasoning skills
- Current teaching often sequential and fragmented
- Mismatch with real-world integrated problem solving

“Scientific reasoning can be defined as the ability to recognize and understand the scientific method, including the concepts, processes, and applications used in the pursuit of knowledge formation. Scientific literacy, as an outcome of this reasoning, equips individuals to make informed decisions and engage with issues relevant to the natural, physical, and social world. However, low levels of scientific reasoning, particularly as content complexity increases, remain a recognized educational challenge [2]. Addressing this challenge requires effective pedagogical interventions that offer students structured opportunities to analyze information, evaluate evidence, and develop their reasoning abilities.”

(The TPD Article, 2026).



Problem Formulation

Sequential instruction limits integrated understanding

- Mathematics, architecture, and empirical work separated
- Lack of transparent, **real-time** pedagogical tools
- Research Question: How to optimize AI tutoring using Triple Parallel Demonstration (TPD)?

“Sequential teaching often hinders integrated learning. To help students grasp how concepts connect, a tutoring platform such as an AI agentic system and/or three projection screens is needed to enhance problem-solving and make computational and analytical processes transparent. The system should cover empirical investigation, model mathematical prediction, and reveal software architecture(s) like variables and control flow. Without this parallel approach, deep conceptual learning is challenging and fall back on sequential demonstration. While not yet implemented, this article presents a work-in-progress pedagogical design aimed at hands-on teaching and student experience.” (The TPD Article, 2026).



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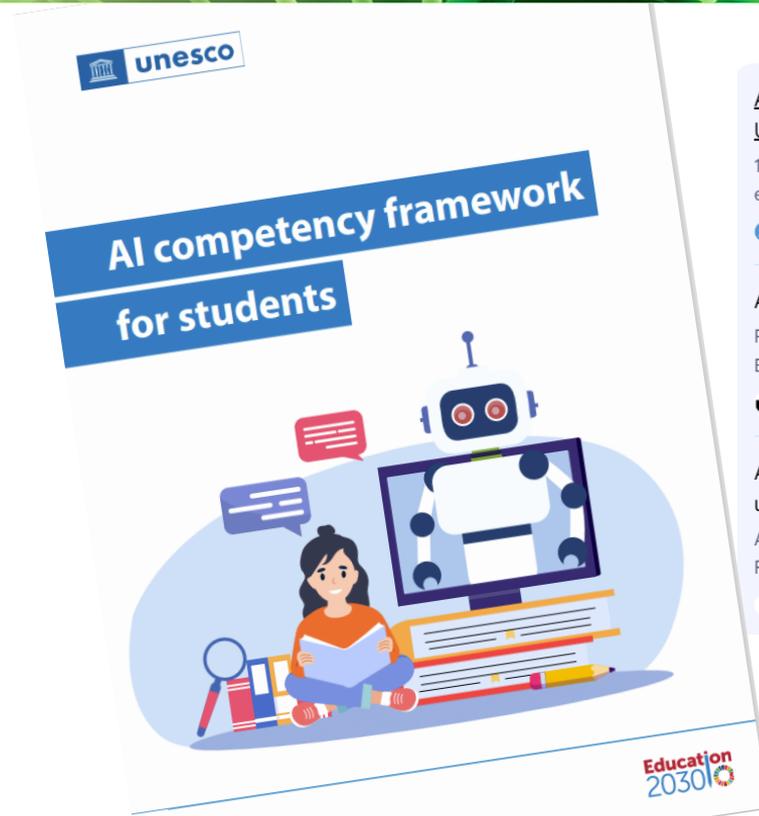
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These foundational principles guide the formulation of the '***Integrated AI-Oriented Pedagogy Model***' aimed at transforming classroom practice and teacher education.
(Creely and Carabott [12]).



“UNESCO’s AI competency framework for students [4], along with the associated framework matrix, serves as a comprehensive guide for defining learning outcomes across four key domains: ‘Human-centered mindset,’ ‘Ethics for AI,’ ‘AI techniques and applications,’ and ‘AI system design.’ The matrix incorporates three progressive mastery levels - ‘Understand,’ ‘Apply,’ and ‘Create’ - which provide structured guidance for skill development. For the AI system design track, the knowledge objectives cited below are aligned with the conceptual TPD model.”
(The TPD Article, 2026).



AI competency framework for students - UNESCO

16 jan. 2026 — This publication aims to help educators integrating artificial intelligence...

UNESCO



AI competency framework for students

Published in 2024 by the United Nations Educational, Scientific and Cultural...

Jönköping University



AI competency framework for students - unesco

AI competency framework for students * Miao, Fengchun [author] * Shiohira, Kelly [author] *...

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Guidance for generative AI in education and research

Miao, Fengchun, UNESCO,
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Table 1. The AI competency framework high-level structure: aspects and progression levels

Aspects	Progression		
	Acquire	Deepen	Create
1. Human-centred mindset	Human agency	Human accountability	Social responsibility
2. Ethics of AI	Ethical principles	Safe and responsible use	Co-creating ethical rules
3. AI foundations and applications	Basic AI techniques and applications	Application skills	Creating with AI
4. AI pedagogy	AI-assisted teaching	AI-pedagogy integration	AI-enhanced pedagogical transformation
5. AI for professional development	AI enabling lifelong professional learning	AI to enhance organizational learning	AI to support professional transformation

[*UNESCO AI Competency Framework.pdf](#)



The Triple Parallel Demonstration (TPD) Model

Three synchronized learning streams:

- Empirical Investigative Studies
- Software Architecture & Data Variables
- Mathematical Use & Modeling
- Real-time integration via AI multi-agent system



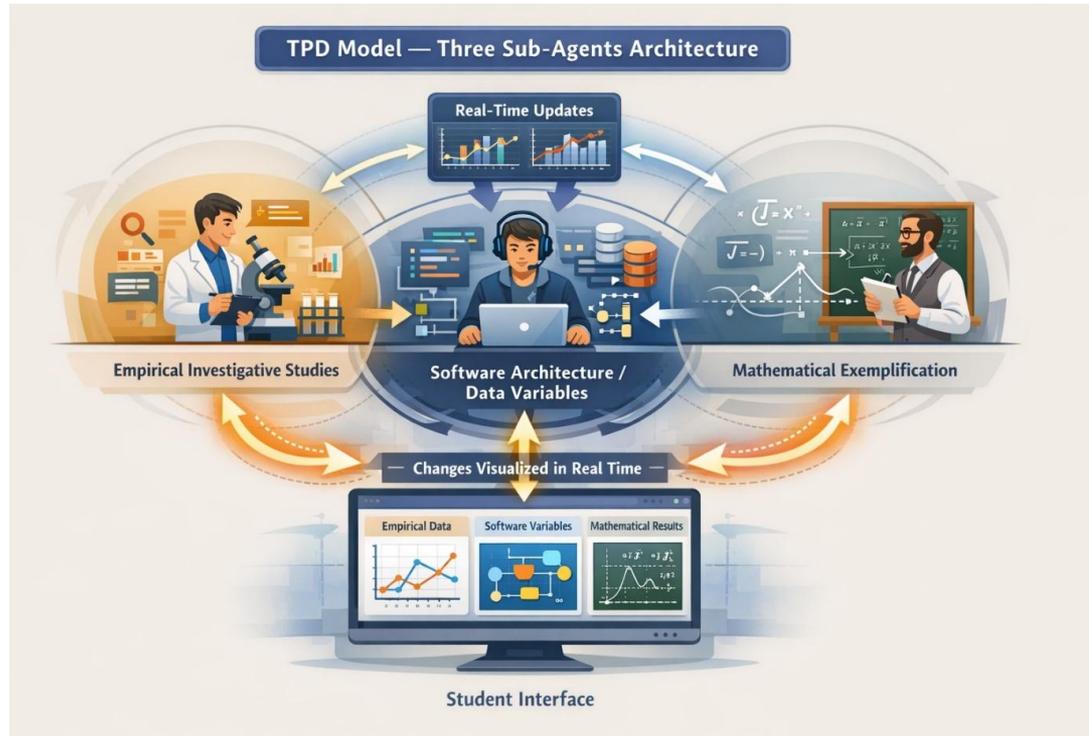


Fig. 2. A visual representation of the real-time TPD multi-agent architecture, generated using ChatGPT 5.2 (prompt describing the visualization requirements for the AI agent architecture, accessed on 09/01/26).



Stream 1 Empirical Investigative Studies	Stream 2 Software Architecture & Agentic Transparency	Stream 3 Mathematical Use & Modeling
Hypothesis formulation and testing	Visibility of variables, parameters, and control flow. Agentic Design Principles:	Mathematics as foundation of AI systems
Data exploration and collection	Transparency	Real-time visualization of transformations
Real-time analysis (graphs, statistics)	Control	Cause-and-effect linkage across streams
Supports correlational, probabilistic, and hypothesis-deductive reasoning	Facilitation	Example: Input scaling → mathematical transformation → empirical result
	Students modify architecture and observe impact instantly	



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Do you know any existing TPD framework in Science Education?

Future Work

Next steps are to implement this TPD framework (*Empirical Investigative Studies, Software Architecture/Data Variables, and Mathematical Exemplification*) to showcase how it could be useful in direct student learning situations.

Could possibly be student implementation projects based on the TPD framework.

Conducting controlled studies for indicating any learning outcomes.