



Peer-Review Report Form

Manuscript Title:	AI as a Pedagogical-Cognitive Integration Agent: A Theoretical Model for Interdisciplinary, Multidisciplinary and Transdisciplinary Learning
Type of Article:	Original Article

FIRST ROUND

Editor

<u>General Comments and Recommendations</u>
The reviewers acknowledge the significance of your manuscript and recommend several revisions to further improve its clarity, coherence, organization, and overall scholarly quality. In addition, you are advised to thoroughly review and validate all references included in the manuscript. Please ensure that all cited sources are accurate, accessible, and retrievable through Google Scholar to uphold the credibility and reliability of the study. Additionally, make sure to include the DOI or website link for every reference to facilitate verification and accessibility of sources. Furthermore, only sources that are cited within the manuscript should appear in the References section, and all entries listed in the References section must also be cited in the text. For example, if 20 unique sources are cited in the manuscript, then only those 20 sources should be included in the References section. Please note that repeated citations of the same source within the text are counted as a single reference entry; therefore, the total number of references may be lower than the total number of in-text citations.

Reviewer 1

<u>General Comments and Recommendations</u>
The manuscript discusses a timely topic and presents AI as a possible agent for integrating interdisciplinary, multidisciplinary, and transdisciplinary learning. The three proposed axes and classroom vignettes are understandable and potentially useful

<u>Specific Comments and Recommendations</u>
The manuscript directly introduces the cognitive, pedagogical, and systemic-design axes, but it does not explain how these exact dimensions were derived, why they are sufficient, or how the concepts and relationships were selected from the literature. The components mainly appear as a list of possible AI functions rather than an explanatory model with defined constructs, relationships, assumptions, boundaries, and testable propositions. The six vignettes only demonstrate imagined applications and cannot provide theoretical validation for the model. Because of this weakness, the strong claims that the model introduces a new conceptual



category and represents a significant theoretical advancement are not yet sufficiently established. The authors may improve the paper by providing a transparent conceptual-development procedure, systematically comparing the model with existing human–AI collaboration and AI-supported learning frameworks, clearly defining each construct, explaining the relationships among the three axes, and presenting propositions that can be empirically tested. Without these elements, the contribution remains an interesting conceptual discussion, but not yet a well-developed theoretical model.

Please indicate your recommendation by checking the appropriate box below.

<u>Decision</u>	
	Accept the manuscript for publication.
/	Reconsider the manuscript after the authors have satisfactorily addressed and complied with the reviewers' comments and recommendations.
	Reject the manuscript, as it is not suitable for publication.

Reviewer 2

<u>General Comments and Recommendations</u>
The intersection of interdisciplinary education and artificial intelligence is a critical frontier. You successfully identified a significant gap in the current literature: most research treats AI merely as a technical tool for personalization or assessment, rather than as an epistemic and pedagogical partner capable of deep cognitive integration. The theoretical grounding using frameworks like Beane's curriculum integration and the OECD Learning Compass is strong and appropriate.
<u>Specific Comments and Recommendations</u>
Your paper moves directly from the "Theoretical Background" into the "Rationale for Developing the Integration Agent Model" and then presents the model. Theoretical papers still need a methodology. How exactly did you arrive at the three axes (Cognitive, Pedagogical, and Systemic-Design)? You need to explicitly state your method of synthesis. Did you use a systematic conceptual review? Grounded theory based on existing literature? Please add a brief methodology section explaining the analytical process used to construct this specific model.
Figure 1 is currently a branching tree diagram that categorizes AI functions under three axes. A model should ideally show dynamic relationships, processes, or feedback loops. Right now, it illustrates what AI can do (e.g., linking concepts, designing inquiry routes) but not how these elements interact with the teacher and the learner. I strongly suggest redesigning the visual model. Show the flow of interaction. How does the Systemic-Design axis feed into the Pedagogical axis? Where do the teacher's epistemic validation and the learner's cognitive processing fit into this visual framework? Making the model dynamic will greatly enhance its theoretical value.
Throughout the manuscript, the term "Artificial Intelligence" is used broadly. AI is a massive field. The specific integrative capabilities you are proposing such as translating biological concepts into literary metaphors, generating inquiry routes, and synthesizing cross-disciplinary



patterns are heavily reliant on Large Language Models (LLMs) and Generative AI. Traditional Intelligent Tutoring Systems (ITS) or predictive AI cannot do these things dynamically. You must specify and operationalize what type of AI you are theorizing about. Acknowledging that your model specifically applies to Generative AI or LLMs will make your theoretical claims much more precise and defensible.

Section 5 provides six vignettes to demonstrate practical applications. While these are helpful for illustration, they are completely hypothetical and present a very frictionless view of AI integration. In a paper that lacks empirical data, your theoretical examples need to do more heavy lifting. Instead of just showing that the AI successfully bridges concepts, discuss the tensions in these scenarios. For example, in Vignette 2 (translating biological concepts into metaphors), how exactly does the teacher intervene to ensure the AI's metaphor doesn't create epistemic misconceptions? Highlighting the human-AI negotiation in these vignettes will prove that you are thinking critically about the limitations you mentioned in Section 6.3.

You noted that the teacher's role shifts to evaluating, validating, and contextualizing AI-generated outputs, and that the teacher is the "arbiter of conceptual depth". This is an excellent point, but it feels like an afterthought rather than a core part of the model. Integrate this human cognitive labor directly into your proposed axes. The "Pedagogical Axis" should not just be about what the AI does (e.g., designing inquiry routes), but how the AI and the teacher co-orchestrate the learning environment.

Please indicate your recommendation by checking the appropriate box below.

<u>Decision</u>	
	Accept the manuscript for publication.
/	Reconsider the manuscript after the authors have satisfactorily addressed and complied with the reviewers' comments and recommendations.
	Reject the manuscript, as it is not suitable for publication.

SECOND ROUND

<u>Decision</u>	<u>Editor</u>	<u>Reviewer 1</u>	<u>Reviewer 2</u>
Accept the manuscript for publication.	/	/	/
Reconsider the manuscript after the authors have satisfactorily addressed and complied with the reviewers' comments and recommendations.			
Reject the manuscript, as it is not suitable for publication.			