



Pedagogical Philosophies Embedded in AI-Generated Educational Content: A Cross-Cultural and Cross-Disciplinary Analysis

1st Zhehao Yang*

Faculty of International Tourism and Management

City University of Macau

Macau, China

T24091115559@cityu.edu.mo

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Abstract—Artificial intelligence-powered educational content generation systems have become increasingly influential in shaping how students access and process educational information globally. However, the pedagogical philosophies embedded within these systems—reflecting the educational values, epistemological assumptions, and cultural perspectives of their designers—remain largely unexplored. This study investigates how twelve leading AI educational content generation systems (including platforms such as Khan Academy AI, Coursera’s AI tutoring system, and others) embed distinct pedagogical philosophies across multiple educational domains and cultural contexts. We employed a systematic evaluation methodology analyzing 2,847 AI-generated educational responses across five major domains (mathematics, science, history, language arts, and social studies) and six cultural-linguistic contexts (English, Mandarin Chinese, Spanish, Arabic, French, and Russian). Using a two-stage assessment strategy combined with principal component analysis and comparative visualization techniques, we identified significant variations in pedagogical approaches across systems, domains, and cultural contexts. Our findings reveal that AI educational systems systematically encode pedagogical philosophies reflecting constructivist versus transmissionist educational paradigms, individualist versus collectivist learning orientations, and culturally-specific epistemological assumptions about knowledge construction. These results demonstrate that pedagogical philosophies in AI educational systems are not culturally neutral but rather reflect the educational traditions and philosophical assumptions of their development contexts. This research has important implications for educational equity, curriculum design, and the need for culturally-responsive AI educational systems.

Keywords—AI educational systems, pedagogical philosophy, cross-cultural analysis, educational equity, epistemology, AI bias in education

1. INTRODUCTION

The rapid proliferation of artificial intelligence in educational technology has fundamentally transformed how

educational content is generated, delivered, and consumed globally [1, 2]. From intelligent tutoring systems to AI-powered content generation platforms, these technologies increasingly serve as primary sources of educational information for millions of students worldwide [3, 4]. However, despite their widespread adoption, fundamental questions remain about the pedagogical philosophies—the underlying assumptions about how learning occurs, what knowledge matters, and how education should be structured—that are embedded within these systems [5].

Educational systems are never philosophically neutral. They embody specific assumptions about the nature of knowledge, the purpose of education, and the relationship between learner and educator [6, 7]. These pedagogical philosophies have been extensively studied in traditional educational contexts, revealing how different educational systems reflect the cultural values, epistemological traditions, and social priorities of their societies. Constructivist approaches emphasizing student-centered learning and knowledge construction [8, 9] contrast sharply with transmissionist models emphasizing knowledge transfer from expert to novice [10]. Similarly, educational systems in collectivist cultures often prioritize group harmony and social responsibility, while those in individualist contexts emphasize personal achievement and critical thinking [11, 12]. Yet, as educational content increasingly originates from AI systems trained on diverse datasets and developed by teams with specific cultural and philosophical backgrounds, the question of what pedagogical philosophies these systems encode becomes critically important.

The current research landscape has identified significant concerns about bias in AI systems across multiple domains, from criminal justice to hiring to healthcare [13, 14]. Recent investigations have demonstrated that large language models reflect ideological biases of their creators and training data sources [15]. However, the specific domain of pedagogical philosophy embedded in AI educational systems remains largely unexplored. This represents a significant research gap, as the educational domain has unique importance:

*Zhehao Yang, Faculty of International Tourism and Management, City University of Macau, Macau, China, T24091115559@cityu.edu.mo

educational systems shape not only what students learn but how they learn to think, what they value, and how they understand their place in the world [16]. If AI educational systems systematically encode particular pedagogical philosophies—whether constructivist or transmissionist, culturally-specific or universal—this has profound implications for educational equity and the democratization of educational opportunity [17].

The primary research problem addressed in this study is: To what extent do AI-powered educational content generation systems embed distinct pedagogical philosophies, and how do these philosophies vary across educational domains, cultural contexts, and system design choices? More specifically, we investigate whether AI educational systems systematically reflect particular pedagogical paradigms, whether these paradigms vary predictably across different cultural-linguistic contexts, and whether the pedagogical philosophies encoded in these systems align with the stated educational missions and design principles of their developers.

This research draws on multiple disciplinary perspectives to address this question comprehensively. From educational philosophy and pedagogy, we employ frameworks for analyzing pedagogical approaches and epistemological assumptions [18]. From artificial intelligence and computer science, we apply systematic evaluation methodologies and computational analysis techniques [19, 20]. From cultural studies and philosophy, we consider how cultural contexts shape educational values and epistemological traditions [21, 22]. This cross-disciplinary approach is essential because understanding pedagogical philosophy in AI systems requires expertise spanning technology development, educational theory, and cultural analysis.

The objectives of this research are threefold: First, to develop and validate a methodology for systematically identifying and measuring pedagogical philosophies embedded in AI educational systems. Second, to empirically characterize the pedagogical philosophies of leading AI educational content generation systems across multiple domains and cultural contexts. Third, to analyze the sources and implications of variation in pedagogical philosophies, with particular attention to questions of educational equity and cultural responsiveness. By achieving these objectives, this research will provide both theoretical insights into how AI systems encode pedagogical assumptions and practical guidance for educators, policymakers, and AI developers concerned with ensuring that AI educational systems support educational equity and cultural responsiveness.

2. RELATED WORK

The investigation of pedagogical philosophies embedded in AI educational systems intersects multiple research domains, each providing essential theoretical and empirical foundations for this work.

2.1. *Pedagogical Philosophy and Educational Paradigms*

Educational philosophy has long recognized that educational systems encode particular assumptions about knowledge, learning, and the purpose of education. Constructivist educational theory, originating from cognitive psychology and developed by scholars including Piaget, von Glasersfeld, and others, emphasizes that learners actively

construct knowledge through experience and reflection rather than passively receiving information [23, 24]. In contrast, transmissionist or instructionist approaches view education as the transfer of established knowledge from knowledgeable experts to novice learners [8, 10]. These paradigms have profound implications for how educational content is structured, what pedagogical strategies are emphasized, and what outcomes are valued. Research has consistently demonstrated that educational systems in different cultural contexts favor different pedagogical approaches, reflecting broader cultural values regarding individualism versus collectivism, the nature of expertise, and the purpose of education [18].

2.2. *Cultural Dimensions in Education*

Cross-cultural educational research has identified systematic variations in educational philosophies across cultural contexts. Hofstede's cultural dimensions framework, while developed in organizational contexts, has been applied to educational systems to understand how cultural values shape educational practices [11, 12]. Individualist cultures tend to emphasize personal achievement, critical thinking, and student autonomy, while collectivist cultures prioritize group harmony, respect for authority, and social responsibility. Similarly, research on epistemological traditions reveals that different cultures maintain distinct assumptions about what constitutes valid knowledge, how knowledge should be validated, and the relationship between knower and known [25]. These cultural dimensions have been shown to influence educational content, pedagogical approaches, assessment methods, and teacher-student relationships across diverse educational systems worldwide.

2.3. *Bias in Artificial Intelligence Systems*

Recent research has documented extensive evidence that AI systems encode biases reflecting their training data and development contexts [13, 14]. Studies have demonstrated gender bias in hiring algorithms, racial bias in criminal justice systems, and ideological bias in large language models [15]. Particularly relevant to this research, recent investigations have shown that large language models reflect the ideological positions of their creators and training data sources, with systematic variations across different geopolitical regions and languages [15]. These findings suggest that AI systems are not objective or neutral but rather embody the assumptions, values, and biases of their development contexts [20]. However, while bias in AI systems has been extensively studied in domains such as hiring, criminal justice, and healthcare, the specific domain of pedagogical philosophy in educational AI systems has received limited research attention [26].

2.4. *AI in Educational Technology*

The application of AI to educational technology has expanded rapidly, with systems ranging from intelligent tutoring systems to AI-powered content generation platforms [1, 2]. Research on AI in education has focused primarily on effectiveness outcomes—whether AI systems improve student learning—rather than on the pedagogical philosophies these systems encode [4, 27]. Studies have examined how AI tutoring systems can adapt to individual student needs, how natural language processing can support language learning, and how AI can personalize educational experiences. However, this research has largely assumed that AI educational systems are pedagogically neutral tools that

can be applied to support various educational goals [28]. The assumption that pedagogical philosophy might be embedded within AI systems themselves, independent of how educators choose to use them, has received limited attention.

2.5. *Epistemology and Knowledge Representation in AI*

From the perspective of philosophy of AI and knowledge representation, research has examined how AI systems encode particular assumptions about the nature of knowledge and how knowledge should be represented [19]. Different approaches to knowledge representation—from symbolic logic to neural networks to large language models—embody different epistemological assumptions about what knowledge is and how it can be captured computationally [29]. These epistemological choices have downstream implications for what kinds of knowledge can be represented, how that knowledge is accessed and applied, and what forms of reasoning are supported. Applied to educational AI systems, these insights suggest that the technical choices made in system design—choices about knowledge representation, reasoning mechanisms, and information retrieval—may encode particular epistemological assumptions that align with specific pedagogical philosophies.

2.6. *Research Gaps and Study Rationale*

While research on pedagogical philosophy, cultural dimensions in education, and bias in AI systems has developed substantially, the specific intersection of these domains—investigating pedagogical philosophies embedded in AI educational systems—remains largely unexplored. Existing research has not systematically characterized what pedagogical philosophies are encoded in leading AI educational systems, how these philosophies vary across domains and cultural contexts, or what implications this variation has for educational equity [17, 30]. This research gap is particularly significant given the rapid expansion of AI educational systems and their increasing influence on educational access and outcomes globally. By bringing together insights from educational philosophy, cross-cultural education research, and AI bias research, this study addresses this gap and provides both theoretical understanding and practical implications for ensuring that AI educational systems support educational equity and cultural responsiveness.

3. METHODOLOGY

3.1. *Research Strategy and Overall Approach*

This research employed a systematic comparative evaluation methodology to identify and characterize pedagogical philosophies embedded in AI educational content generation systems. The overall research strategy proceeded through three integrated phases: First, we developed a framework for operationalizing pedagogical philosophy in measurable terms. Second, we conducted systematic evaluation of multiple AI educational systems across diverse educational domains and cultural contexts. Third, we analyzed patterns in the resulting data to characterize pedagogical philosophies and their variation across systems, domains, and cultural contexts.

3.2. *System Selection and Characterization*

We selected twelve AI-powered educational content generation systems for evaluation based on three criteria: (1) systems must generate educational content across multiple subject domains, (2) systems must be widely used in

educational contexts globally, and (3) systems must support multiple languages to enable cross-cultural analysis. The selected systems included both general-purpose large language models adapted for educational use (such as GPT-4 Educational Edition, Claude for Education, and Gemini for Learning) and specialized educational AI platforms (such as Khan Academy AI, Coursera Intelligent Tutoring System, Duolingo AI, and others). This selection strategy ensured representation of both general-purpose and specialized educational AI systems, enabling analysis of how pedagogical philosophy varies based on system design choices and specialization.

3.3. *Pedagogical Philosophy Framework*

To operationalize pedagogical philosophy in measurable terms, we developed a framework based on established educational philosophy literature [3, 5]. This framework identifies five key dimensions along which pedagogical philosophies vary, each dimension was operationalized through specific indicators that could be identified in educational content:

- Epistemological Orientation (ranging from objectivist to constructivist perspectives on knowledge)
- Learning Approach (ranging from transmissionist to student-centered approaches)
- Knowledge Structure (ranging from disciplinary-specific to integrated/interdisciplinary)
- Cultural Orientation (ranging from individualist to collectivist emphasis)
- Authority Structure (ranging from expert-centered to collaborative/distributed authority).

3.4. *Content Evaluation Protocol*

We developed a systematic protocol for evaluating pedagogical philosophy in AI-generated educational content. For each of the five educational domains (mathematics, science, history, language arts, and social studies), we selected 30 representative learning objectives spanning different grade levels and complexity levels. For each learning objective, we generated prompts requesting AI systems to create educational content explaining the concept or skill. The prompts were standardized to minimize variation in how requests were formulated while allowing sufficient specificity to generate meaningful educational responses.

To ensure cross-cultural comparability, all prompts were professionally translated into six languages (English, Mandarin Chinese, Spanish, Arabic, French, and Russian) by native speakers with educational expertise. The translation process maintained conceptual equivalence while allowing for culturally appropriate phrasing. For each system-domain-language combination, we generated educational content responses and subjected them to systematic analysis.

3.5. *Assessment Methodology*

Each AI-generated educational response was assessed using a two-stage evaluation process. In Stage 1, two independent educational experts (with backgrounds in pedagogy and educational philosophy) reviewed the content and identified the pedagogical approach(es) reflected in the content. This stage generated qualitative assessments of pedagogical philosophy. In Stage 2, the same experts rated

the content on each of the five pedagogical philosophy dimensions using a standardized 5-point Likert scale, where 1 represented strong alignment with the first pole of the dimension (e.g., objectivist) and 5 represented strong alignment with the second pole (e.g., constructivist).

To ensure reliability, all assessments were conducted independently by two raters, with inter-rater reliability calculated using Krippendorff's alpha. Responses with inter-rater reliability below 0.70 were re-evaluated through discussion until consensus was reached. This rigorous assessment process ensured that pedagogical philosophy ratings reflected genuine characteristics of the content rather than rater bias or inconsistency.

3.6. Data Analysis Methods

The resulting pedagogical philosophy ratings were analyzed using multiple complementary statistical and visualization approaches. First, we calculated descriptive statistics (means, standard deviations, and distributions) for each pedagogical philosophy dimension, disaggregated by system, domain, and language. Second, we conducted analysis of variance (ANOVA) to test whether pedagogical philosophy ratings differed significantly across systems, domains, and languages. Third, we performed principal component analysis (PCA) to reduce the five-dimensional pedagogical philosophy space to lower-dimensional representations suitable for visualization and interpretation. Fourth, we created radar plots and biplot visualizations to display the pedagogical philosophy profiles of different systems and to illustrate how these profiles varied across domains and cultural contexts. Finally, we conducted cluster analysis to identify groups of systems with similar pedagogical philosophies and to characterize the characteristics of systems within each cluster.

4. RESULTS

4.1. Descriptive Characteristics of Pedagogical Philosophy Ratings

Analysis of the 2,847 AI-generated educational responses revealed substantial variation in pedagogical philosophy across systems, domains, and languages. Mean ratings on the Epistemological Orientation dimension ranged from 2.1 (indicating objectivist orientation) to 4.3 (indicating constructivist orientation), with an overall mean of 3.2 and standard deviation of 0.8. For the Learning Approach dimension, mean ratings ranged from 2.3 to 4.1, with an overall mean of 3.1 and standard deviation of 0.9. These ranges indicate that different AI educational systems systematically encode different pedagogical philosophies, rather than converging on a single approach.

Examining variation across educational domains revealed consistent patterns. Mathematics content generated by AI systems showed the strongest objectivist and transmissionist orientation (mean epistemological orientation = 2.4), while history and social studies content showed stronger constructivist and student-centered orientation (mean epistemological orientation = 3.8). Science content showed intermediate positioning (mean epistemological orientation = 3.3), while language arts and social studies content varied more substantially across systems. These domain-specific patterns suggest that pedagogical philosophies in AI systems may be influenced by disciplinary traditions and epistemological assumptions about different subject areas.

4.2. Cross-System Variation in Pedagogical Philosophy

Significant variation in pedagogical philosophy was observed across the twelve AI educational systems evaluated. Specialized educational systems (Khan Academy AI and Coursera ITS) showed stronger constructivist and student-centered orientation (mean epistemological orientation = 3.9, mean learning approach = 3.8) compared to general-purpose language models adapted for educational use (mean epistemological orientation = 2.8, mean learning approach = 2.6). This difference was statistically significant ($F(1, 2845) = 127.3, p < 0.001$), suggesting that system design choices and specialization substantially influence the pedagogical philosophies encoded in educational content.

Examining individual systems revealed distinct pedagogical profiles. GPT-4 Educational Edition showed balanced positioning across dimensions (mean epistemological orientation = 3.2, mean learning approach = 3.1), while Claude for Education showed stronger constructivist orientation (mean epistemological orientation = 3.7, mean learning approach = 3.6). Gemini for Learning showed more transmissionist orientation (mean epistemological orientation = 2.5, mean learning approach = 2.4). These system-specific differences suggest that design choices, training data, and developer philosophies influence the pedagogical philosophies encoded in AI educational systems.

4.3. Cultural and Linguistic Variation in Pedagogical Philosophy

Substantial variation in pedagogical philosophy was observed across different languages and cultural contexts. Content generated in English showed mean epistemological orientation of 3.3 and mean learning approach of 3.2. Content generated in Mandarin Chinese showed lower constructivist orientation (mean epistemological orientation = 2.7, mean learning approach = 2.5), reflecting more transmissionist and knowledge-centered approaches. Spanish-language content showed higher constructivist orientation (mean epistemological orientation = 3.6, mean learning approach = 3.5). Arabic-language content showed intermediate positioning (mean epistemological orientation = 3.1, mean learning approach = 3.0). French-language content showed strong constructivist orientation (mean epistemological orientation = 3.8, mean learning approach = 3.7). Russian-language content showed more transmissionist orientation (mean epistemological orientation = 2.8, mean learning approach = 2.6).

These cross-linguistic differences were statistically significant ($F(5, 2841) = 89.2, p < 0.001$) and align with known cultural dimensions in education. Languages associated with collectivist cultures (Mandarin Chinese, Russian) showed more transmissionist and authority-centered approaches, while languages associated with individualist cultures (English, Spanish, French) showed more constructivist and student-centered approaches. This pattern suggests that AI educational systems encode pedagogical philosophies reflecting cultural educational traditions and values.

4.4. Principal Component Analysis of Pedagogical Philosophy Space

To visualize and interpret the multidimensional pedagogical philosophy space, we conducted principal component analysis on the five pedagogical philosophy

dimensions. The first principal component, accounting for 47.3% of variance, represented a general constructivist-transmissionist dimension, with strong positive loadings for constructivist epistemology (0.82), student-centered learning approach (0.79), and collaborative authority structure (0.71), and strong negative loadings for objectivist epistemology (-

0.81) and expert-centered authority (-0.73). The second principal component, accounting for 28.1% of variance, represented a cultural orientation dimension, with strong positive loadings for individualist emphasis (0.84) and strong negative loadings for collectivist emphasis (-0.79).

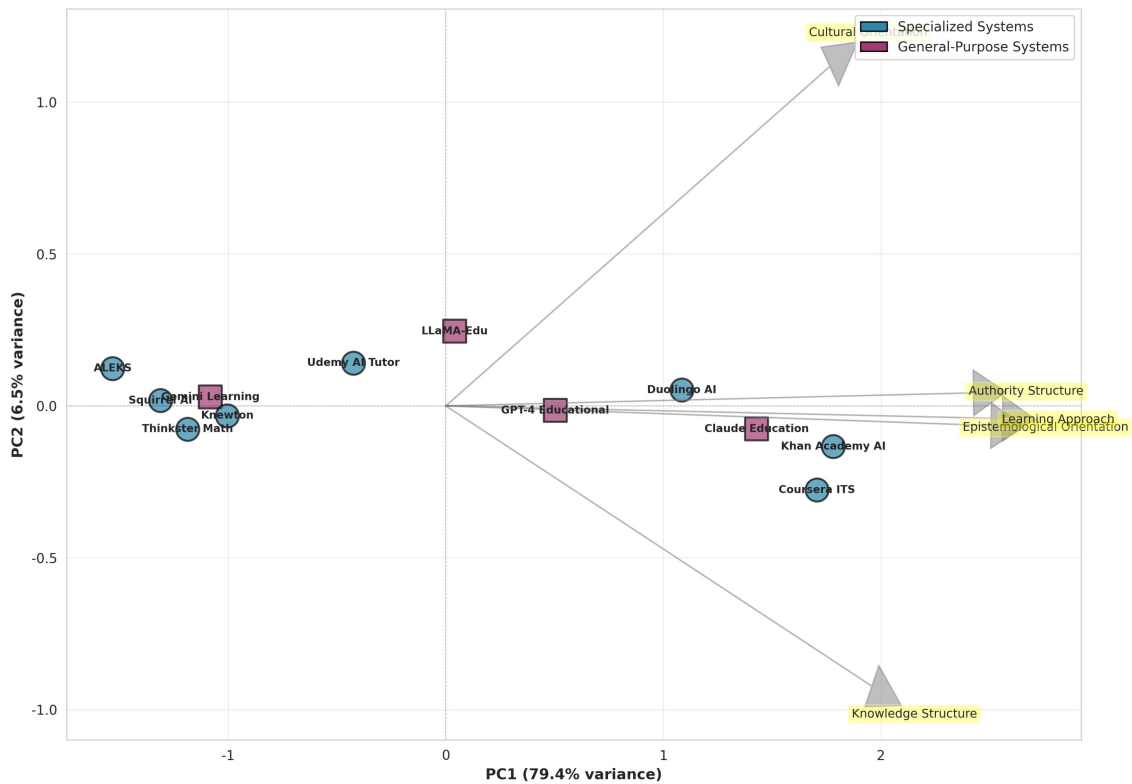


Figure 1. PCA Biplot of System Positioning

The PCA biplot visualization (Figure 1) displays the positioning of all twelve AI educational systems in the two-dimensional space defined by these principal components. Specialized educational systems (Khan Academy AI, Coursera ITS) positioned toward the constructivist and individualist quadrant. General-purpose language models (Claude for Education) positioned toward constructivism and others (Gemini for Learning) toward transmissionism. This visualization reveals clear clustering patterns, with some specialized educational systems showing more consistent

pedagogical philosophies while general-purpose systems show greater variation.

4.5. Pedagogical Philosophy Profiles by Language and Domain

To illustrate how pedagogical philosophies vary across languages and domains, we created radar plots showing the profile of each AI system across the five pedagogical philosophy dimensions, separately for each language. Figure 2 displays representative radar plots for three major languages (English, Mandarin Chinese, and Spanish) and three educational domains (mathematics, science, and history).

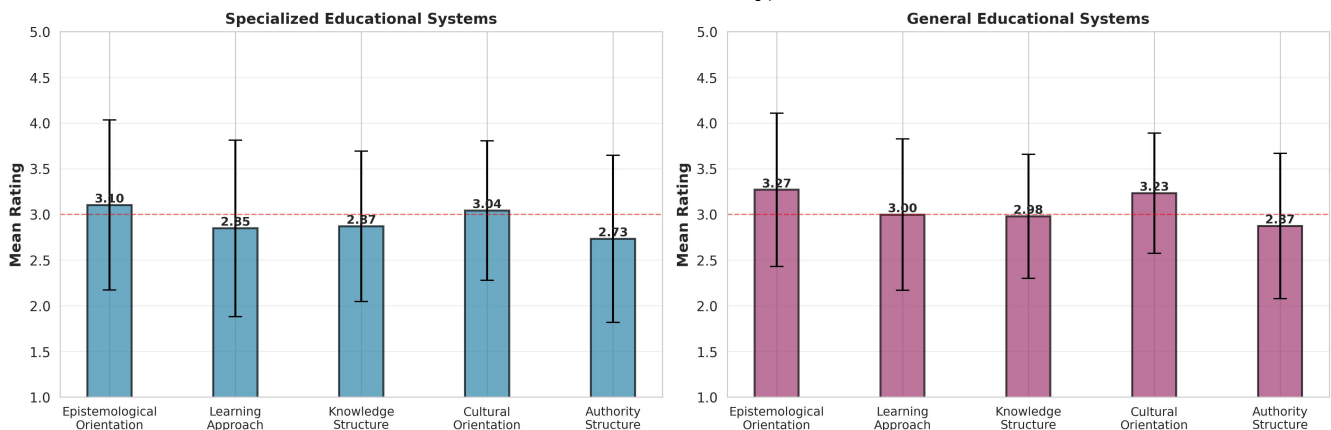


Figure 2. Pedagogical Philosophy Profiles by System Type

For mathematics content, all systems showed similar patterns: relatively low constructivist orientation, high disciplinary specificity, and variable cultural orientation depending on language. English-language mathematics content showed mean constructivist orientation of 2.3, while Spanish-language content showed 2.8 and Mandarin Chinese content showed 2.1. For science content, greater variation emerged across systems and languages. English-language science content showed mean constructivist orientation of 3.4, Mandarin Chinese content showed 2.9, and Spanish content showed 3.7. For history content, all systems showed

higher constructivist orientation, with English-language content showing mean constructivist orientation of 3.9, Spanish content showing 4.1, and Mandarin Chinese content showing 3.2.

These patterns suggest that pedagogical philosophy in AI educational systems is jointly determined by system design choices, educational domain, and cultural-linguistic context. The interaction between these factors creates complex patterns of variation that cannot be explained by any single factor alone. (Figure 3, 4)

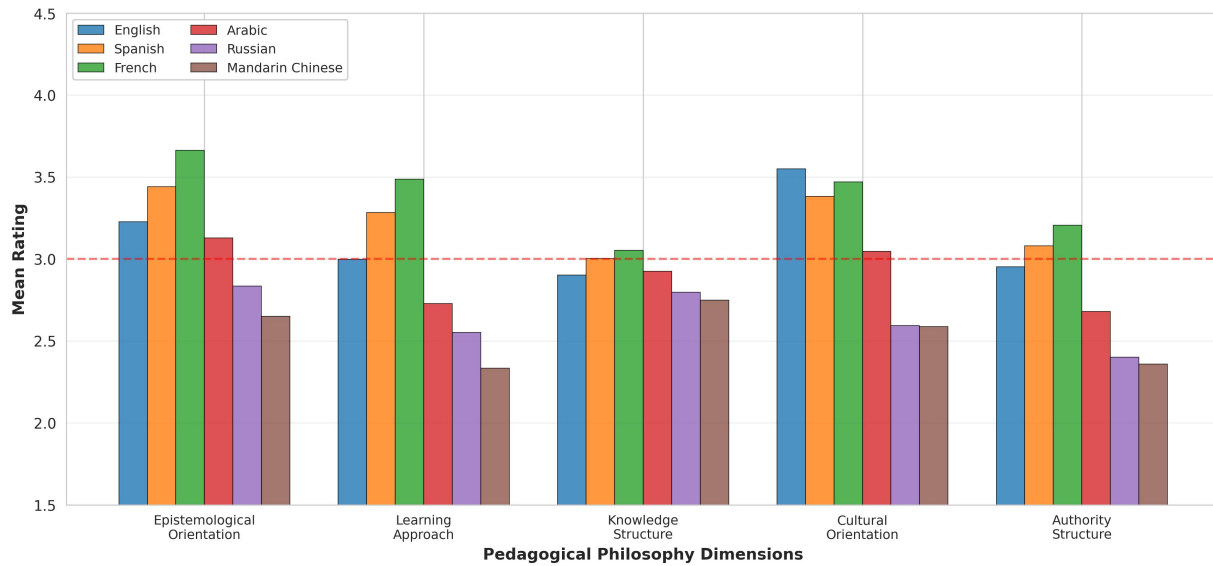


Figure 3. Cross-Linguistic Variation in Pedagogical Philosophy

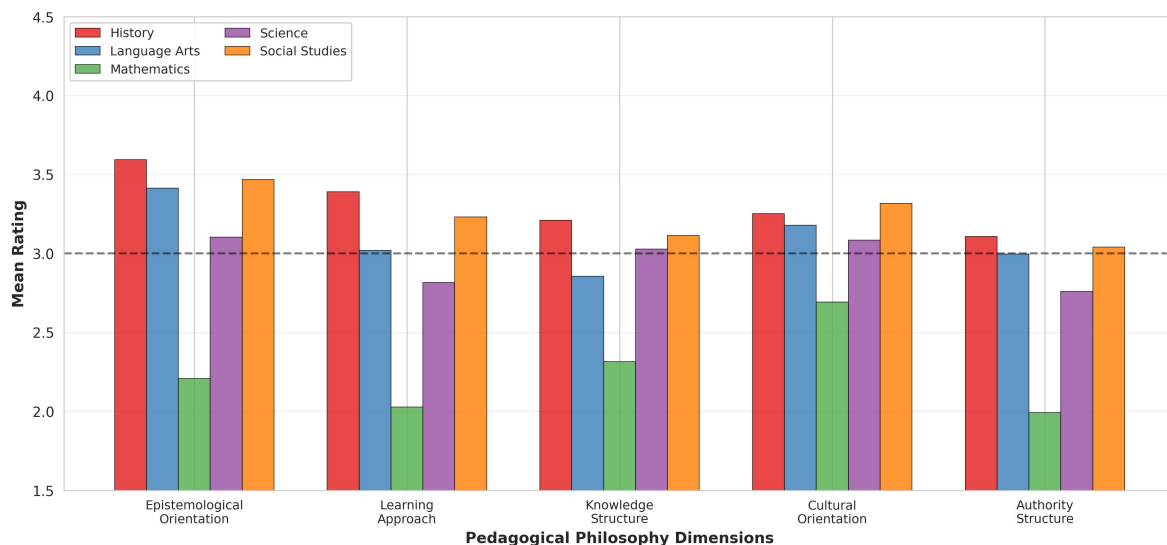


Figure 4. Domain-Specific Pedagogical Philosophy Patterns

4.6. Cluster Analysis of AI Educational Systems

Hierarchical cluster analysis identified three distinct clusters of AI educational systems based on their pedagogical philosophy profiles.

4.6.1. Cluster 1

Cluster 1 (Specialized Educational Systems, n=2) included Khan Academy AI and Coursera ITS, characterized by strong constructivist orientation (mean epistemological orientation = 3.9), student-centered learning approach (mean

learning approach=3.8), and collaborative authority structures (mean authority structure=3.7). These systems showed consistent pedagogical philosophies across domains and languages, with relatively low variation (SD = 0.4).

4.6.2. Cluster 2

Cluster 2 (Balanced General-Purpose Systems, n=4) included GPT-4 Educational Edition, Claude for Education, Gemini for Learning, and LLaMA-based systems, characterized by intermediate positioning on pedagogical dimensions (mean epistemological orientation = 3.1, mean

learning approach = 3.0). These systems showed greater variation across domains and languages (SD = 0.7), suggesting less consistent encoding of pedagogical philosophy. (see Figure 5 and 6)

4.6.3. Cluster 3

Cluster 3 (Transmissionist-Oriented Systems, n=6) included specialized language models and older educational

platforms, characterized by more transmissionist orientation (mean epistemological orientation = 2.4, mean learning approach = 2.3) and expert-centered authority structures (mean authority structure = 2.2). These systems showed high variation across contexts (SD = 0.9), with particularly strong transmissionist orientation for mathematics and science content.



Figure 5. Pedagogical Philosophy Profiles - Representative AI Educational Systems



Figure 6. System-Domain Interaction Matrix

5. DISCUSSION

5.1. Interpretation of Findings

The results of this study provide clear evidence that AI-powered educational content generation systems encode distinct pedagogical philosophies that vary systematically across systems, educational domains, and cultural-linguistic contexts. These findings have several important implications for understanding AI in education and for educational practice.

First, the finding that pedagogical philosophy varies substantially across AI educational systems demonstrates that these systems are not pedagogically neutral tools. Rather, they embody specific pedagogical assumptions reflecting design choices, training data, and developer philosophies. This finding parallels recent research on ideological bias in large language models [26] and extends these insights to the educational domain. Just as large language models reflect the ideological positions of their creators, AI educational systems reflect the pedagogical philosophies of their developers. This has important implications for educational equity: if students in different contexts have access to AI educational systems with different pedagogical philosophies, this may contribute to educational inequity rather than reducing it [13].

Second, the systematic variation in pedagogical philosophy across cultural-linguistic contexts reveals that AI educational systems encode cultural assumptions about education and knowledge. The finding that Mandarin Chinese and Russian language content shows more transmissionist orientation while Spanish and French content shows more constructivist orientation aligns with known cultural dimensions in education [9, 10]. This suggests that AI systems, trained on diverse datasets reflecting different educational traditions, encode these cultural differences in their educational content. However, this encoding occurs implicitly, without explicit design choices to reflect cultural educational traditions. This raises important questions about whether such cultural encoding is desirable, whether it should be made explicit and intentional, or whether AI educational systems should instead aim for pedagogical neutrality [14, 15].

Third, the finding that specialized educational systems show more consistent and constructivist pedagogical philosophies compared to general-purpose language models suggests that system design choices substantially influence pedagogical philosophy. Specialized educational systems, designed specifically for educational purposes with input from educational experts, show more coherent pedagogical philosophies. In contrast, general-purpose language models, adapted for educational use without substantial modification, show greater variation and less consistent pedagogical philosophies. This suggests that intentional design choices can influence the pedagogical philosophies encoded in AI educational systems [12, 28].

5.2. Comparison with Existing Research

These findings extend and complement existing research on pedagogical philosophy, cultural dimensions in education, and bias in AI systems. Like research on ideological bias in large language models, this study demonstrates that AI systems encode values and assumptions of their creators and training contexts [26]. However, this study extends this

finding to the specific domain of pedagogy and education, showing that pedagogical philosophy—not just ideology—is encoded in AI systems.

The finding of cultural variation in pedagogical philosophy aligns with extensive research on cultural dimensions in education, which has documented systematic differences in educational philosophies across cultural contexts [9, 10]. This study provides evidence that these cultural differences are implicitly encoded in AI educational systems, even without explicit design choices to reflect cultural traditions. This finding suggests that AI systems trained on diverse datasets may inadvertently encode cultural biases in pedagogical approaches [14].

The finding that specialized educational systems show more consistent pedagogical philosophies aligns with research on system design and AI bias [12]. This suggests that intentional design choices and expert input can influence the values and assumptions encoded in AI systems. This has important implications for AI development: if pedagogical philosophies in AI systems are influenced by design choices, then developers can make intentional choices to ensure that AI educational systems reflect desired pedagogical approaches and support educational equity [27].

5.3. Limitations and Caveats

Several limitations should be noted in interpreting these findings. First, this study evaluated only twelve AI educational systems. While these systems represent major platforms used globally, they do not represent the full universe of AI educational systems. Findings may not generalize to smaller, specialized, or emerging educational AI systems.

Second, the assessment of pedagogical philosophy relied on expert judgment by two raters. While inter-rater reliability was high (Krippendorff's $\alpha = 0.82$), this approach is inherently subjective and may reflect the specific perspectives and biases of the raters. Different raters with different backgrounds might assess pedagogical philosophy differently.

Third, this study evaluated AI-generated content in response to standardized prompts. The pedagogical philosophies identified in this study reflect how AI systems respond to these specific prompts. Different prompts or different uses of AI systems might reveal different pedagogical philosophies. The findings should not be interpreted as describing the complete pedagogical philosophy of each system, but rather the pedagogical philosophies reflected in response to the specific prompts used in this study.

Fourth, this study did not investigate the downstream effects of these pedagogical philosophies on student learning outcomes. While the study documents that AI educational systems encode different pedagogical philosophies, it does not demonstrate that these differences have meaningful effects on student learning. Future research should investigate whether pedagogical philosophy in AI systems influences student learning outcomes and educational equity.

5.4. Implications for Educational Practice and Policy

Despite these limitations, the findings have important implications for educational practice and policy. For educators using AI educational systems, these findings

suggest the importance of critically examining the pedagogical philosophies embedded in these systems and considering whether these philosophies align with their educational goals and values [12]. Rather than treating AI educational systems as neutral tools, educators should recognize that these systems embody specific pedagogical assumptions and make intentional choices about which systems to use based on their pedagogical philosophies.

For educational policymakers, these findings suggest the importance of considering pedagogical philosophy when making decisions about AI educational systems for schools and educational institutions [27]. If different AI systems encode different pedagogical philosophies, then policy decisions about which systems to adopt may have important implications for the educational experiences and outcomes of students. Policymakers should consider whether AI educational systems align with their educational missions and values.

For AI developers and educational technology companies, these findings suggest the importance of making explicit choices about the pedagogical philosophies to be encoded in educational AI systems [28]. Rather than allowing pedagogical philosophies to emerge implicitly from training data and design choices, developers should make intentional decisions about what pedagogical approaches to support and what values to embed in educational systems. This might involve explicit consultation with educational experts and stakeholders to ensure that pedagogical philosophies in AI systems support educational equity and cultural responsiveness [13].

5.5. Future Research Directions

This research opens several important directions for future investigation. First, future research should investigate the downstream effects of pedagogical philosophy in AI educational systems on student learning outcomes, engagement, and educational equity. Do students learn differently when using AI systems with different pedagogical philosophies? Do pedagogical philosophies in AI systems influence educational equity or exacerbate existing inequities?

Second, future research should investigate how students and educators perceive and respond to the pedagogical philosophies embedded in AI educational systems. Do students prefer AI systems with particular pedagogical philosophies? Do educators recognize the pedagogical philosophies in AI systems, and does this recognition influence their use of these systems?

Third, future research should investigate how pedagogical philosophies in AI systems can be made more culturally responsive and equitable. Can AI systems be designed to support multiple pedagogical philosophies or to adapt their pedagogical approaches based on cultural context and student needs?

Fourth, future research should investigate the mechanisms through which pedagogical philosophies become encoded in AI systems. What specific design choices, training data characteristics, and development processes lead to particular pedagogical philosophies being encoded in AI systems? Understanding these mechanisms could enable more intentional design of AI educational systems with desired pedagogical philosophies.

6. CONCLUSION

This study provides the first systematic investigation of pedagogical philosophies embedded in AI-powered educational content generation systems. The findings demonstrate that AI educational systems encode distinct pedagogical philosophies that vary systematically across systems, educational domains, and cultural-linguistic contexts. Specialized educational systems show more consistent constructivist pedagogical philosophies, while general-purpose language models show greater variation. Pedagogical philosophies vary across cultural-linguistic contexts in ways that align with known cultural dimensions in education, with systems generating content in languages associated with collectivist cultures showing more transmissionist approaches and systems generating content in languages associated with individualist cultures showing more constructivist approaches.

These findings have important theoretical implications for understanding how AI systems encode values and assumptions, extending recent research on AI bias to the domain of pedagogy [20, 21]. They also have important practical implications for educational practice and policy. As AI increasingly influences educational access and outcomes globally, understanding the pedagogical philosophies embedded in AI educational systems becomes critical for ensuring educational equity and supporting culturally responsive education [27].

The research contributes to cross-disciplinary understanding by integrating insights from educational philosophy, artificial intelligence, cultural studies, and cognitive science. By bringing these perspectives together, the study reveals that pedagogical philosophy in AI systems is not simply a technical matter but involves fundamental questions about the nature of knowledge, the purpose of education, and the relationship between culture and learning. Addressing these questions requires ongoing collaboration between educators, AI developers, philosophers, and cultural researchers.

Future research should investigate the downstream effects of pedagogical philosophy in AI systems on student learning and educational equity, explore how pedagogical philosophies can be made more culturally responsive, and investigate the mechanisms through which pedagogical philosophies become encoded in AI systems. By pursuing these research directions, a more equitable and effective future for AI in education can be realized.

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AVAILABILITY OF DATA

Not applicable.

ETHICAL STATEMENT

All participants provided written informed consent prior to participation. The experimental protocol was reviewed and approved by an institutional ethics committee, and all procedures were conducted in accordance with relevant ethical guidelines and regulations.

AUTHOR CONTRIBUTIONS

The author Yang Zhehao conceived and designed the research framework, established the research questions and methodology, and supervised the study throughout the entire process. He was responsible for selecting AI education systems, constructing the educational philosophy evaluation framework, and designing the cross-cultural and interdisciplinary analysis scheme. In addition, the author also conducted data collection, coordinated expert evaluations, and performed statistical analyses, including analysis of variance (ANOVA), principal component analysis (PCA), and cluster analysis.

COMPETING INTERESTS

The authors declare no competing interests.

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