Article

A Preliminary Study on Strategies for AI-Promoted Development and Implementation of Interdisciplinary School-Based Curriculum in Primary Schools

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Abstract: The Compulsory Education Curriculum Standards (2022 Edition) identifies interdisciplinary thematic learning as a pivotal initiative in contemporary curriculum advancement. Drawing upon the intersecting perspectives of curriculum and instructional theory alongside the philosophy of technology, this study argues that instructional content should be systematically organized around big ideas oriented towards the cultivation of core competencies. Furthermore, the integration of artificial intelligence technologies and project-based implementation strategies serves to promote reciprocal enhancement in both teaching and learning processes. Despite these policy directives, primary schools currently demonstrate insufficient intensity and effectiveness in developing interdisciplinary school-based curricula. Practical challenges are prevalent and include superficial knowledge integration across disciplines, overly formalized instructional implementation that lacks substantive depth, and homogenized evaluation systems that fail to capture the multifaceted outcomes of interdisciplinary learning. To address these pressing issues, this paper proposes a comprehensive and actionable solution for the development and implementation of interdisciplinary school-based curricula in primary schools through an integrated teaching-learning-evaluation framework. The proposed framework leverages artificial intelligence tools to facilitate dynamic curriculum design, supports teachers in constructing meaningful interdisciplinary learning experiences centered on big ideas, and establishes diversified assessment mechanisms aligned with competency-based educational objectives. This study provides both theoretical insights and practical guidance for educators and policymakers seeking to advance interdisciplinary curriculum innovation in primary education contexts.

Keywords: artificial intelligence; interdisciplinary learning; big ideas; school-based curriculum; primary education

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1. Introduction: The Value Attributes of Interdisciplinary School-Based Curricula in Primary Schools

The Compulsory Education Curriculum Plan (2022 Edition) explicitly requires that no less than 10% of instructional time in each discipline be allocated to interdisciplinary thematic learning. In November 2024, official guidance on strengthening artificial intelligence education in primary and secondary schools further emphasized the implementation of interdisciplinary learning, large-unit teaching, and other pedagogical approaches to support the deep integration of artificial intelligence with subject instruction. With the emergence of generative artificial intelligence technologies—such as those exemplified by widely used language models—possessing strong capabilities in knowledge synthesis, multimodal interaction, data analysis, and adaptive support, the development of interdisciplinary school-based curricula has entered a new phase of opportunity. A global review of government-endorsed AI curricula for K–12 education indicates that multiple countries have formally introduced AI education frameworks, with the majority adopting interdisciplinary integration as a core design principle.

Internationally, foundational concepts for AI education—including perception, representation and reasoning, machine learning, human–computer interaction, and societal implications—have been consolidated to inform curriculum design; some national systems adopt phased, developmentally appropriate approaches across primary, lower secondary, and upper secondary levels, consistently emphasizing human-centered educational values. Grounded in the realities of China's basic education context and informed by international practice, investigating feasible pathways for developing AI-enhanced interdisciplinary school-based curricula can effectively harness technological potential to address current implementation challenges [1]. This inquiry holds both theoretical relevance and practical utility in advancing the fundamental educational mission of cultivating well-rounded, innovative talents suited to the intelligent era.

As an extension and supplement to national and local curricula, school-based curricula are grounded in schools' distinctive educational features, regional resource advantages, and students' developmental needs, offering tailored and context-responsive implementation avenues for interdisciplinary education. The core value of interdisciplinary school-based curricula resides in the balanced alignment between national curriculum requirements and school-level implementation practices. Conventional subject teaching forms the foundation of the school curriculum system. Guided by established curriculum standards, it fulfills the essential function of delivering systematic knowledge and nurturing subject-specific thinking [2, 3]. As a school-level complement to national curricula, interdisciplinary school-based curricula broaden educational scope through integrated knowledge from multiple disciplines, underscoring adaptability to local contexts and learner diversity. At the same time, curriculum design and development at the school level operate within a structured framework, guided by shared educational goals and professional standards. Currently, the implementation of interdisciplinary school-based curricula in primary schools faces several persistent challenges, warranting further investigation and evidence-informed refinement.

2. Reflections from the Perspectives of Curriculum and Instructional Theory and Philosophy of Technology

Curriculum and Instruction Theory and Philosophy of Technology jointly constitute an interactive analytical framework, providing mutual support across two dimensions: educational foundations and value norms. This framework forms the theoretical basis for developing AI-enabled interdisciplinary school-based curricula. Curriculum and Instruction Theory offers Philosophy of Technology an application context within education, transforming abstract philosophical perspectives into actionable curriculum design principles [4]. Conversely, Philosophy of Technology provides Curriculum and Instruction Theory with theoretical grounding appropriate to the technological era, redefining relationships among teachers, students, and technology; challenging the notion of technological neutrality; and embedding value and ethics education into pedagogical practice.

2.1. Curriculum and Instructional Theory: The Theoretical Core of Interdisciplinary School-Based Curriculum Development

From the perspective of curriculum and instructional theory, the development of interdisciplinary school-based curricula must address two core propositions: first, how to break down disciplinary barriers and achieve deep, organic integration of multidisciplinary knowledge rather than simple aggregation; second, how to align with the developmental patterns of primary school students' cognition to ensure that interdisciplinary practical activities genuinely promote competency development rather than becoming mere formalities [5]. Systematic theoretical frameworks addressing content architecture and cognitive logic provide coherent answers to these propositions.

2.1.1. Big Ideas Integration: The Core Anchor for Organic Integration of Interdisciplinary Knowledge

Big ideas are concepts abstracted from foundational disciplinary facts, characterized by vitality, transferability, and depth, serving as concentrated carriers of disciplinary knowledge essence and internal logic. Their core function is to integrate scattered and fragmented disciplinary knowledge, break down barriers between knowledge domains, and construct a systematic, holistic, and structured cognitive framework [6, 7]. Occupying the apex of the disciplinary knowledge system, big ideas possess strong coherence and abstraction, supporting deep learning and providing essential guidance for curriculum design, knowledge transfer, and application. They also anchor unit-level competency objectives, shape summative assessment tasks, and inform the seamless integration of formative evaluation into instruction and learning, ensuring alignment among teaching, learning, and assessment toward deep competencies rather than isolated knowledge points. Academic frameworks classify big ideas into four tiers: lesson-level, unit-level, cross-unit within-discipline, and interdisciplinary. Interdisciplinary curricula do not represent mechanical aggregations of disciplinary content but instead entail purposeful reorganization of knowledge around big ideas exhibiting explanatory power, transferability, and generativity—moving beyond discrete facts to reveal disciplinary essence and connect meaningfully with real-world challenges. Artificial intelligence supports this process by assisting educators in identifying knowledge elements across disciplines that relate to a shared big idea, thereby facilitating the development of curriculum maps, question sequences, task sequences, and curated resource sets to advance interdisciplinary big idea formation and curriculum implementation.

2.1.2. Embodied Cognition: The Cognitive Basis for Designing Interdisciplinary Practical Curricula

Embodied cognition theory challenges the traditional mind-body dualist perspective by asserting that cognitive processes are fundamentally shaped by the physical characteristics of the body, that bodily experience constitutes a primary source of cognitive content, and that cognition, embodiment, and environment form an integrated, dynamic system. It holds that knowledge arises from sensory perception, motor engagement, and situated practice, emphasizing the role of bodily experience in enabling adaptive responses to environmental demands and effective problem solving [8, 9]. Building upon this theoretical foundation, embodied instruction represents a pedagogical approach that fully integrates mental and physical activity within teaching and learning, fostering cognitive development through purposeful bodily engagement. As artificial intelligence increasingly enhances tools and platforms for embodied learning, interdisciplinary school-based curricula at the primary level should prioritize authentic, context-embedded practical activities—systematically incorporating school facilities, community assets, natural settings, and everyday social experiences into the learning process.

2.2. Philosophy of Technology: The Logical Guidelines for AI-empowered Education

The philosophy of technology moves beyond a purely instrumental view of technology, examining its educational value and application boundaries from the perspective of human-technology symbiosis to ensure that technological advancement consistently supports the humanistic purpose of education [10].

2.2.1. Human-Machine Collaboration: The Dialectical Unity of Technical Rationality and Value Rationality

Human-machine collaboration is fundamentally a computational interactive process in which humans and machines jointly engage in information processing. Leveraging big data and logical rules, machines support knowledge generation. They excel at quantitative computation but have limited capacity to integrate non-rational cognitive dimensions such as emotion and intuition. Humans possess distinctive moral and ethical agency, and their cognitive capabilities—including computing power and memory—can be extended through machine augmentation. The complementary functions of both parties collectively constitute an integrated intelligent system. Moving beyond the traditional dualistic subject-object framework, machines—originally regarded as passive objects—acquire functional agency through intelligence endowment, giving rise to a relational configuration of dual subjects: human and machine [10]. Concurrently, dynamic interaction sustained by mutual feedback mechanisms ensures the stable operation of the collaborative system. This perspective emphasizes interrelations among humans, technology, and context, with attention directed toward synergistic mechanisms involving technological attributes, behavioral agents, collaborative structures, and contextual enablers. Synergy theory posits that system elements undergo cooperative effects through nonlinear interactions, enabling continuous self-organization and evolution toward increasing order. Order thus emerges as both an outcome and an enabler of synergy. With the integration of artificial intelligence into education, a central question arises: what role does technology assume? From the human-machine collaboration standpoint, artificial intelligence contributes by forming, together with teachers and students, a reconfigured learning support system that enhances curriculum development and learning activities, thereby fostering systematic synergy and orderly advancement in education and establishing a relational architecture of "teacher-led, student-centered, technology-supported."

2.2.2. Philosophy of Technology: The Ethical Examination of AI Curriculum Applications

The philosophy of technology, as a branch of phenomenological philosophy, examines how technology mediates the relationship between humans and the world, and explores its essence and role in human life. Technology functions not merely as a passive instrument but as an active mediating vehicle that shapes human engagement with reality. It is deeply embedded in human modes of existence, contributing to the formation of human-world relations and serving as an objective force that influences human practice and self-understanding. Key conceptual frameworks describe technology as both a process of revealing and a mode of ordering reality. Human-machine collaboration constitutes a computational interactive process wherein humans and machines jointly engage in information processing. Leveraging large-scale data and formal logical structures, machines support knowledge generation through quantitative computation, while human cognition contributes dimensions such as emotion, intuition, and ethical judgment. Humans retain distinct moral agency and reflective capacity; machines extend human capabilities in computation and memory. Their functional complementarity enables the emergence of integrated intelligent systems. Moving beyond traditional subject-object dichotomies, intelligent machines assume roles that transcend mere instrumental status, fostering relational configurations where both humans and machines participate as co-constitutive agents. Sustained dynamic interaction, reinforced through reciprocal feedback mechanisms, ensures system stability and adaptive functionality.

3. Realistic Challenges in AI-empowered Interdisciplinary School-Based Curriculum Development in Primary Schools

Traditional school-based curriculum development has predominantly relied on school traditions, local resources, and student developmental needs, implemented through curriculum selection, adaptation, integration, and other pathways, forming two mainstream models: teacher-driven bottom-up generation and school-led top-down direction. Artificial intelligence has introduced significant opportunities for this process, helping to address longstanding limitations such as deviation from learner-centered principles, imprecise needs assessment, insufficient personalization, and limited evaluation rigor [11]. However, while supporting the shift from experience-driven to data-informed, precision-oriented curriculum development, AI-empowered interdisciplinary education continues to encounter multiple interrelated practical challenges that constrain its effectiveness.

3.1. Curriculum Development: Superficial Knowledge Integration and Homogenized Technology Application

Interdisciplinary knowledge integration remains at the stage of "superficial splicing", failing to achieve in-depth integration of disciplinary logics. Influenced by the long-standing tradition of subject-based teaching, there is limited attention to extracting overarching interdisciplinary big ideas in school-based curriculum design. When curriculum themes remain confined to single disciplinary boundaries and lack internal logical connections and conceptual integration across disciplines, the result is a "disciplinary patchwork" characterized by shallow combination. Generative artificial intelligence offers technical advantages for integrating multidisciplinary knowledge; however, its algorithmic logic operates primarily at the statistical level and cannot substitute for teachers' professional judgment regarding the logical coherence among disciplines. Automatically generated knowledge integration outcomes often lack traceability and validation of the rationality underlying disciplinary connections, risking the emergence of "pseudo-interdisciplinarity"—a surface-level alignment driven by lexical co-occurrence rather than conceptual unity. When integration remains limited to content accumulation, it falls short of deep integration involving disciplinary thinking methods and authentic problem orientation, thereby hindering the development of structured interdisciplinary cognitive systems among students.

The application models of AI in curriculum development show strong convergence, diminishing the distinctive features expected in school-based curricula. In current practice, AI functionalities are largely restricted to basic operational tasks such as information retrieval, instructional design, and exercise generation, resulting in highly uniform application scenarios and usage patterns. Customized development aligned with school-specific characteristics, regional resource endowments, and students' cognitive developmental stages remains underutilized. This technology application, oriented toward instrumental rationality, tends to reinforce traditional curriculum development logic using new tools—a formalistic adaptation that preserves existing structures without substantive innovation. The full potential of AI's technical capabilities has yet to be realized. Consequently, interdisciplinary school-based curricula across institutions display considerable similarity in content structure, activity design, and resource formats, weakening the distinctive identity and regional relevance that such curricula are intended to reflect.

3.2. Instructional Implementation: Dual Deficiencies in Teachers' Interdisciplinary Competence and Digital Capabilities

Teachers face inherent limitations in interdisciplinary teaching literacy, which constrains the depth and coherence of curriculum integration. Effective interdisciplinary curriculum design depends significantly on teachers' breadth of knowledge and academic perspective. In the absence of systematic interdisciplinary training, curriculum development often reflects individual experience and subjective preferences rather than pedagogically grounded synthesis. Primary education teacher preparation and practice in China have historically followed a subject-specialized model. Although pre-service programs encourage multi-subject certification, candidates' knowledge structures tend to remain compartmentalized, and subject-centered thinking persists. This results in superficial juxtaposition of disciplinary content, limited capacity to establish meaningful conceptual linkages across disciplines around unifying themes, and ultimately a 'patchwork' implementation—formally interdisciplinary yet substantively fragmented, nominally integrated yet lacking conceptual depth. When AI tools are incorporated into curriculum development, teachers with insufficient interdisciplinary grounding find it difficult to assess the pedagogical suitability of AI-generated materials, support students in constructing and transferring deep conceptual understanding, and risk reducing interdisciplinary curricula to technologically enhanced single-subject instruction—diverging from the foundational goals of school-based curriculum design.

Deficiencies in digital intelligence application capabilities reflect structural constraints on effective human-machine collaboration in teaching. Current artificial intelligence systems operate primarily at levels of logical, probabilistic, and causal reasoning, falling short of human higher-order cognitive functions. Consequently, AI-supported interdisciplinary instruction requires more than tool adoption—it demands that teachers possess robust competencies in co-designing instruction with intelligent systems, guiding learning processes, and providing evaluative feedback. At the same time, critical analysis skills related to AI use remain underdeveloped among many educators. Most lack advanced proficiency in deploying artificial intelligence and may accept its outputs without sufficient scrutiny. As a result, their ability to interpret and meaningfully utilize multimodal data is limited, potentially weakening professional agency and pedagogical judgment.

3.3. Evaluation System: Absence of Formative Evaluation and Deviation from Educational Orientation

The collection of process-based evidence is fragmented, making it difficult to fully track the dynamic trajectory of competency development. From the perspective of embodied cognition, the formation of students' interdisciplinary competencies constitutes a dynamic construction process involving physical and mental engagement as well as contextual interaction. Its implicit and process-oriented developmental characteristics determine that educational evaluation must rely on continuous and diversified learning evidence for systematic assessment. Under the long-standing influence of objective-oriented curriculum models, China's curriculum evaluation tools have tended to emphasize selective and screening functions through absolute quantification. At present, interdisciplinary school-based curricula in primary schools predominantly adopt summative evaluation, with single evaluation tools that overemphasize final outputs. The absence of formative evaluation tends to conceal critical information such as thinking processes and collaborative performance, making it difficult to achieve precise evaluation of higher-order competencies. Some AI-assisted approaches have been implemented to statistically collect classroom behavioral frequency, attention levels, and other data. However, the various types of evidence lack logical connections and longitudinal accumulation, making it difficult to integrate them as a coherent supplementary component into the classroom teaching evaluation system, and failing to provide teachers with individualized guidance or accurate insight into the generative processes of students' higher-order competencies such as interdisciplinary integration ability and critical thinking.

The convergence of evaluation subjects and dimensions deviates from the competency-oriented educational value positioning. Evaluation issues in school-based curriculum development have largely remained at the level of assessing students' curriculum performance and schools' implementation fidelity, while neglecting the fundamental purpose of educational evaluation. AI-enhanced evaluation practices have yet to effectively support student self-assessment or enable qualitative judgment of higher-order competencies. First, it is necessary to move beyond equating self-assessment with numerical self-scoring, fully activating its reflective and self-guiding functions. What truly aligns with interdisciplinary learning is formative self-assessment oriented toward metacognitive awareness, embedded in the learning process, and aimed at supporting self-directed learning. Second, it is necessary to broaden the scope of evaluation dimensions, emphasizing students' holistic development under quality education. By leveraging the practical nature of interdisciplinarity and the personalized capabilities of artificial intelligence, multidimensional evaluation should be prioritized to enhance teaching and learning, highlighting the role of school-based curricula in fostering comprehensive individual development and reaffirming an education-centered approach [12, 13].

4. Practical Pathways for AI-empowered Interdisciplinary School-Based Curriculum Development in Primary Schools

To address the practical challenges outlined above, this paper proposes a practical framework grounded in big ideas and technology empowerment to advance multidisciplinary integration (Figure 1), thereby identifying feasible pathways for AI-empowered interdisciplinary school-based curriculum development in primary schools.

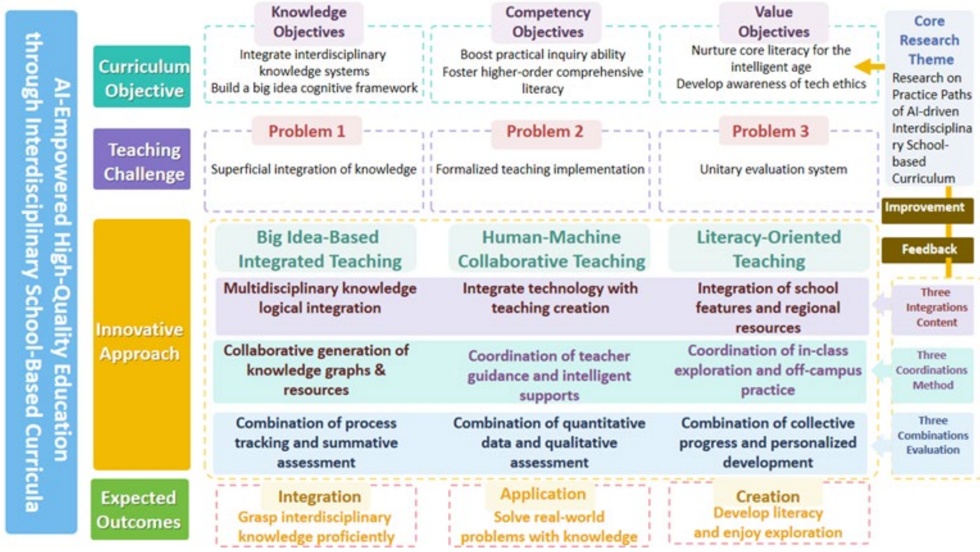

Figure 1. Flowchart of Ai-Empowered High-Quality Educational Framework for Interdisciplinary School-Based Curriculum

4.1. Curriculum Restructuring: Interdisciplinary Knowledge Integration and Deep Technology Integration Guided by Big Ideas

School-based curriculum development is an autonomous curriculum development activity undertaken by schools based on their own educational philosophies and guiding principles [3]. To address logical problems in the development process, it is first necessary to abandon the habitual thinking of blindly designing themes and mechanically adopting AI-generated solutions. Taking big ideas as the starting point, this study constructs a reconstruction path for interdisciplinary curriculum guided by educational objectives, featuring organic knowledge

integration, collaborative technological support, and authentic problem-driven learning [14, 15]. Interdisciplinary big ideas serve as anchors to construct a structured curriculum content framework. Designing interdisciplinary comprehensive curriculum units that promote deep learning can be largely achieved through a series of such big ideas. In the academic community, three mainstream approaches to extracting interdisciplinary big ideas have been identified: first, a progressive abstraction model that derives big ideas from specific small concepts and disciplinary core concepts; second, multidimensional extraction and identification, which draws upon observations of everyday life, disciplinary inquiry, and deep questioning, with comprehensive judgment grounded in factual evidence, intrinsic characteristics, and classical justifications; third, structured construction, which builds knowledge mind maps around big ideas, arranges concepts according to relational proximity, and integrates multidisciplinary knowledge frameworks. In this process, generative artificial intelligence can be employed to systematically organize core knowledge points and practical materials aligned with big ideas across disciplines, generating visual knowledge association maps and clarifying internal logical connections among disciplines. This supports curriculum content organization and enables rich, adaptive human-intelligent system interaction that balances the complementary strengths and limitations of humans and machines, thereby advancing the depth of knowledge integration in curriculum development. Human-machine collaborative co-creation serves as the pathway to develop distinctive school-based curriculum models. The key to tackling homogenization in technology application lies in establishing teachers' subject status in curriculum development and realizing in-depth integration between technology and school-based resources. On the one hand, relying on professional judgment and practical teaching expertise, teachers integrate student situation analysis, recognition of school-based culture, and exploration of regional resources throughout the entire curriculum development process. They conduct critical selection, localization adjustment, and pedagogical adaptation of AI-generated curricula to avoid the inherent limitations of universal and vague contents produced by technology. On the other hand, the construction of embodied cognitive learning environments incorporates various emerging technologies that enhance students' bodily participation. Full use is made of the multimodal generation capabilities of generative artificial intelligence to customize personalized learning resources and differentiated curriculum forms, thereby improving learning experiences and delivering personalized learning services.

4.2. Teacher Empowerment: Establishing a "human-Machine Collaboration, Research-Teaching Symbiosis" Teacher Development System

As the key subjective variable in interdisciplinary curriculum development, teachers face dual challenges: limited interdisciplinary literacy and insufficient digital-intelligent application capabilities. To address these, human-machine collaboration serves as the core implementation approach, research-teaching symbiosis functions as the sustainable operational mechanism, and scenario-based practice—enabled by technological scaffolding—acts as the practical carrier. Diversified digital literacy training programs and an integrated pre-service and in-service teacher development model should be implemented to ensure coordinated, systematic advancement. Interdisciplinary research-teaching communities serve as the primary vehicle for establishing enduring development mechanisms through collaborative inquiry and shared professional growth. Practical communities comprising teacher educators, classroom teachers, AI technology specialists, students, and other relevant stakeholders provide ongoing knowledge and skill support via structured exchange and peer learning. Within such communities, educators from diverse disciplinary backgrounds achieve complementary expertise, while artificial intelligence functions as a virtual teaching-research partner, delivering data-driven insights and resource support for pedagogical and scholarly activities. This human-machine symbiotic, multi-stakeholder model fosters reciprocal enhancement of teachers' interdisciplinary literacy and digital-intelligent competencies, thereby cultivating a virtuous cycle where teaching research informs instruction and instructional experience enriches teaching research. Intelligent tools act as cognitive scaffolds, augmenting teachers' capacity for interdisciplinary curriculum design through collaborative human-machine processes. Distributed cognition principles indicate that human and computational cognition possess complementary strengths, supporting more efficient distributed problem-solving [7, 16]. Leveraging educational agent systems, teachers can anchor school-based curriculum development around thematic foci, efficiently identify interdisciplinary big ideas, integrate curricular resources, and decompose complex design tasks across distributed agents. Educational agents continuously refine thematic learning plans based on teacher feedback and observed classroom outcomes, reducing cognitive load and time demands—thus enabling teachers to focus greater attention on interactive facilitation and personalized student support during implementation, ultimately elevating the quality of interdisciplinary thematic learning design. Throughout this process, teachers retain full agency in curriculum development, guiding iterative cycles of design, feedback, and revision. This collaborative model effectively mitigates constraints arising from individual disciplinary perspectives, affirms teachers' central role in curriculum innovation, and supports progressive, tiered development of digital competence.

4.3. Evaluation Innovation: Constructing a "process-Oriented, Multi-Stakeholder Collaborative" Educational Evaluation System

"AI + X" interdisciplinary integrated teaching emphasizes not only knowledge acquisition but also the development of students' innovative capacities and competencies; correspondingly, evaluation methods must evolve from traditional paper-and-pencil assessments toward diversified, evidence-informed, whole-process approaches. Guided by value criteria derived from overarching conceptual frameworks for holistic evaluation, supported by artificial intelligence technologies, and fundamentally aligned with the cultivation of core competencies, efforts should focus on restructuring the evaluation chain and optimizing evaluation mechanisms to establish an interdisciplinary school-based curriculum evaluation system characterized by process traceability, multi-stakeholder collaboration, and clear educational purpose. An evidence-informed, whole-process evaluation chain enables traceable and diagnostic tracking of core competency development. The Classroom Smart Evaluation System (CSMS), built upon a multi-model joint architecture, analyzes cognitive and interactive communication features essential to competency cultivation, thereby enabling evidence-oriented, whole-process teaching evaluation. Drawing upon principles of evidence-based practice—including best and corroborating evidence—the CSMS dynamically records and collects learning processes such as learner diagnosis and knowledge construction, automatically coding these using interdisciplinary conceptual frameworks as the primary coding dimension. This transforms heterogeneous data into traceable evaluative evidence, forming a coherent competency development evidence chain. Visual analytics techniques further support the generation of developmental profiles for interdisciplinary literacy, shifting evaluation toward process-oriented empowerment and delivering precise data to inform instructional refinement. A multi-stakeholder collaborative evaluation mechanism reinforces the competency-centered educational foundation. Artificial intelligence technologies enable technical implementation of such a collaborative system, supporting continuous classroom monitoring, revealing underlying instructional patterns, and enhancing evaluation precision. AI-powered platforms facilitate evidence aggregation and deliberation among diverse evaluators, establishing a system that integrates student self-assessment, peer assessment, teacher synthesis, and external stakeholder input. Structured self-assessment tools and peer rubrics guide learners toward self-regulated evaluation. Empowering students as evaluators fosters active engagement, affirms their agency, and strengthens intrinsic motivation for developing core competencies. Evaluation dimensions should be refined through performance assessment anchored in layered competency objectives derived from conceptual frameworks. Qualitative indicators—including affective dispositions, value orientation, and social responsibility—are incorporated alongside cognitive outcomes. Integrated with AI-driven affective analysis and behavioral inference capabilities, a three-dimensional portrait of students' comprehensive literacy becomes attainable. In this manner, evaluation genuinely supports holistic student development and reflects the learner-centered ethos of school-based curricula [11, 12].

5. Conclusion

Existing studies largely address either AI tool application or interdisciplinary curriculum design in isolation. This paper advances a deeper integration of both dimensions by distinguishing between "superficial technical application" and "in-depth human-machine symbiotic integration", thereby bridging the gap left by prior work that treats curriculum content, teaching practice, and evaluation as disconnected elements. The study introduces an evidence-based intelligent whole-process evaluation framework and an interdisciplinary teaching and research community model, responding to a persistent imbalance in the literature—where curriculum design receives disproportionate attention while teacher development and evaluation approaches remain underdeveloped.

This study has several limitations. Long-term school-based empirical tracking was not undertaken, and strategies for adapting the framework to schools with varying geographical contexts and operational conditions require further refinement. Future work may pursue multi-school action research to tailor AI implementation strategies for rural and urban primary schools, strengthen ethical guidelines for AI-supported curriculum practices, and support regional development of intelligent platforms for co-constructing and sharing school-based interdisciplinary curricula. Such efforts would further advance the digital and intelligent transformation of interdisciplinary education.

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