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Adapting the Artificial Intelligence Assessment Scale for K-12 Education: A Developmental Framework for Age-Appropriate AI Integration

Maureen Ruby

rubym@sacredheart.edu

Sared Heart University

Research Article

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Abstract

The emergence of generative artificial intelligence (GenAI) has disrupted educational assessment across all levels. While the AI Assessment Scale (AIAS) has succeeded in higher education contexts, K-12 environments present unique developmental, pedagogical, and contextual factors requiring significant adaptation. This theoretical framework paper examines AIAS evolution and proposes a K-12-specific adaptation accounting for cognitive development stages, regulatory constraints, and equity considerations. Through systematic literature analysis revealing only two published studies addressing K-12 AIAS implementation, we identified critical gaps necessitating this adaptation. Mapping AIAS levels against Piagetian cognitive stages, Vygotskian scaffolding principles, cognitive load theory, Kolberg's Moral Development Theory, and executive function development research, this paper proposes five adapted levels with progressive implementation structures. The proposed theoretical framework maintains AIAS core principles of transparency and pedagogical intentionality and provides developmentally appropriate pathways ensuring AI integration supports rather than supplants foundational skill development.

Introduction

The emergence of generative artificial intelligence (GenAI) tools in late 2022 disrupted traditional approaches to educational assessment and created pressing needs for frameworks supporting educators in navigating AI integration. Corbin et al. (2025a) characterized this situation as a "wicked problem," complex, contested, ever-evolving, and shaped by context with iteratively changing conditions and trade-offs (p.2). Responding to this challenge, Perkins, Roe, and Furze (2024a) developed the AI Assessment Scale (AIAS), a framework for incorporating GenAI into educational assessment practices in higher education.

Since its introduction, the AIAS has been used globally in over 300 educational institutions and translated into 30 languages (Furze, 2024; Perkins et al., 2025). The framework positions GenAI tools as valuable for enhancing learning opportunities, maintaining assessment validity, and scaffolding purposeful introduction of AI technologies in assessment design (Perkins et al., 2025). This premise aligns with social constructivist learning theory, wherein GenAI tools provide scaffolding to bridge the gaps between current and potential performance as described in Vygotsky's (1978) zone of proximal development.

While the AIAS has achieved remarkable success in higher education contexts (Furze et al., 2024), its application to K-12 environments requires careful consideration of unique developmental, pedagogical, and contextual factors characterizing primary and secondary education. Kılınç (2024) identified needs for developmentally appropriate adaptations for students in elementary, middle, and high school. However, limited AIAS implementation studies in K-12 result in gaps understanding how the framework might be modified to address specific needs, constraints, and opportunities in K-12 settings.

This theoretical framework paper addresses the identified gap by proposing a systematic K-12 adaptation of the AIAS grounded in developmental psychology, learning theory, and contextual analysis of primary and secondary educational environments. The adaptation maintains the AIAS's core commitment to transparency, pedagogical appropriateness, and equity. It also identifies developmentally appropriate pathways that support AI integration, honor foundational skill development, and prepare students for an AI-enabled future.

Background and Literature Review

Evolution of the AI Assessment Scale

As GenAI tools emerged, many educational institutions, particularly in higher education, viewed them as threats to academic integrity and imposed binary approaches to addressing GenAI use (Perkins et al., 2024a). In response, Perkins and colleagues developed the initial version of the AIAS, positioning GenAI tools strategically within assessment design rather than categorically prohibiting or permitting use.In 2025, Perkins et al. revised the AIAS framework, reflecting evolution in their thinking about how AIAS supports GenAI integration through pedagogical design. Grounded in social constructivist principles, the revision advances the framework's utility to support knowledge construction through social interaction rather than replacing human learning processes (Perkins et al., 2025). By prioritizing transparency, dialogue, and purposeful integration alongside constructivist principles, the AIAS distinguishes itself from approaches aimed at controlling, curtailing, or surveilling student AI use.

The revised AIAS framework is updated visually with a neutral circular design replacing the original red-amber-green traffic light colors. This change signals key philosophical evolution: the original colors implied some AI integration levels were "better" or "higher" than others. The new circular model emphasizes that no level is inherently superior (Perkins et al., 2025). Instead, the optimal level depends entirely on learning goals and the specific context, with educators designing each assessment intentionally for pedagogical appropriateness rather than technological limitation.

The Five AIAS Levels

The updated AIAS outlines five distinct GenAI integration levels, each addressing specific pedagogical needs and learning contexts. Level 1 (No AI) maintains traditional controlled assessment environments where GenAI is strictly prohibited through environmental and technical controls, not student honor systems. This level acknowledges certain essential foundational learning outcomes and professional competencies require demonstration of independent student capabilities (Perkins et al., 2025).

Levels 2-4 reflect how GenAI can support different learning process aspects. Level 2 (AI-Assisted Planning) permits GenAI use in brainstorming and ideation phases, with students demonstrating ability to develop, refine, and analyze AI-generated ideas. Level 3 (AI-Assisted Task Completion) acknowledges AI-assisted drafting and composition reality when emphasizing critical evaluation skills development and ensuring students maintain their own voice. Level 4 (Full AI) empowers students to strategically deploy

GenAI tools intentionally to achieve targeted learning outcomes, with evaluation considering both effective AI tool leveraging and demonstration of content mastery.

Level 5 (AI Exploration) engages students and educators in collaborative exploration searching out new GenAI applications beyond traditional templates and established content boundaries. Students are challenged to conceptualize and innovate applications extending business-as-usual use and capabilities (Perkins et al., 2025).

Critical AI Literacy Framework

The AIAS framework design aligns with Critical AI Literacy (CAIL), defined as the ability to critically analyze and engage with AI systems and understand the systems' technical foundations, societal implications, and embedded power structures (Roe et al., 2025). This emphasis on critical engagement highlights students' need to develop evaluative judgment that is necessary to assess AI contributions and also maintain their personal intellectual voice when engaging in AI-assisted work, going beyond acquiring fundamental technical skills.

Addressing Implementation Challenges

The AIAS addresses several challenges associated with GenAI tool ubiquity. The framework acknowledges AI detection tool unreliability and supports eliminating burdens on students to provide "proof" of original work through version histories (Perkins et al., 2024b; Weber-Wulff et al., 2023). The AIAS represents a pedagogical approach harnessing GenAI educational applications privileging transparency, honesty, relationship, and dialogue over restriction and surveillance.

Equity issues constitutes a central concern addressed in AIAS implementation guidance. Acknowledging differential access to advanced GenAI tools potentially creates or exacerbates educational inequalities, AIAS developers recommend students receive instruction in and provision of AI tools sanctioned for institutional use, though acknowledging this approach does not perfectly solve complex access issues (Perkins et al., 2025). Access issues become significant at higher AIAS levels where more advanced, costly AI tools with sophisticated capabilities may be necessary for successful task completion.

The revised AIAS framework provides practical, detailed guidance for assessment structural redesign. Simply labeling existing assignments with AIAS levels without substantive redesign creates an "enforcement illusion" students can easily ignore (Corbin et al., 2025b). The revised AIAS supports redesigning assessment mechanics, evaluation criteria, and evidence requirements aligning with framework AI integration levels.

The Gap: K-12 Adaptation Needs

The AIAS is designed as a flexible framework adaptable across educational contexts. However, as Perkins et al. (2025) acknowledged, K-12 contexts present unique considerations. Unscaffolded GenAI tool use at higher scale levels could be unreasonable, ineffective, and inappropriate. Educator judgment

about developmental readiness and contextual appropriateness is essential (Kılınç, 2024). Despite developmental variance across K-12 settings, some characteristics could advantage GenAI implementation, including smaller class sizes in elementary grades and more frequent face-to-face teacher-student interactions. K-12 settings offer varying opportunities for implementing controlled assessments and engaging in regular dialogue providing feedback about AI use.

However, K-12 educational environments and ways of functioning differ fundamentally from higher education which necessitates systematic adaptation. Students' developmental variance and their progression across kindergarten through grade 12 present fundamentally different considerations. Early learners are progressively developing foundational literacy, numeracy, beginning critical thinking, and executive function skills requisite for building CAIL. The progression from concrete to abstract thinking, characterizing cognitive development, requires adult scaffolding and suggests K-12 AIAS applications must be redesigned to align with age-appropriate developmental capabilities and desired learning outcomes.

Additionally, student agency and autonomy levels vary widely across K-12 grades. Early elementary students benefit from highly teacher-directed activities with gradual release of responsibility within instruction and across grade levels as students progress toward high school (Brandt, 2024) Concomitant considerations are needed with AI integration across the first thirteen years of schooling.Multiple structural differences between K-12 and higher education environments may impede or facilitate AI integration. According to Perkins et al. (2025), K-12 educators must navigate structural challenges like standardized testing and uneven technological infrastructure. Simultaneously, they are tasked with the strategic priority of balancing traditional academic success with social-emotional learning and digital citizenship in an AI-driven environment.

The regulatory and policy landscape for AI integration is more complex in K-12. Many higher education institutions have greater autonomy in assessment design aligned with "academic freedom." In contrast, K-12 schools must abide by federal and state educational standards, privacy regulations specific to minors, and community input and expectations regarding technology appropriateness and use.

Digital equity issues, though present in higher education, are perhaps more concerning in K-12 arenas. Many K-12 students lack technology access outside school environments. AIAS framework authors address the imperative of institutional AI tool provision as a basic access tenet. A K-12 framework adaptation must consider how schools can provide equitable AI access to effectively meet goals of teaching students to be critical consumers and ethical AI users.

Long and Magerko (2020) describe efforts of educators and researchers to develop guides for integrating artificial intelligence in curricula in K-12 spaces. They highlight the efforts of the joint working group of the Association for the Advancement of Artificial Intelligence (AAAI) and the Computer Science Teachers Association (CSTA) known as the "AI for K-12 Working Group." This group endeavored to create AI standards for K-12, with a focus on grade band competencies. Long and Magerko contrast a more historical definition of literacy, *the ability to express ourselves and communicate with written language*,

which they assert has “political and emancipatory consequences” with a new concept of literacy. They cite a broad set of disciplines that can afford people access to and communication of information and ideas. Examples provided include digital literacy, computational literacy, scientific literacy, and data literacy. They defined AI literacy as *a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace. Furthermore, they posit that AI literacy is related to, and dependent upon competence in some, but not all other literacies.*

Gu and Ericson (2025) assert that the concepts of both AI and literacy are complex concepts. In their view, AI literacy is viewed as an umbrella term encompassing specific knowledge and competencies that are distinct, yet interrelated, dependent upon context. Gu and Ericson reviewed trends in support for AI literacy in the educational space since the emergence of generative AI. In their integrative review of 124 studies on AI literacy definitions and trends on education since 2020, they found a pivotal shift in how AI literacy was studied in K-12 and higher education. Prior to the arrival of generative AI, researchers primarily studied AI literacy in the K-12 space, looking specifically at AI ethics and AI’s technical aspects. The introduction of and access to generative AI shifted the research focus to the higher education space and targeted AI tool application. Gu and Ericson also cite an emergence of recent studies in K-12 on AI tool use.

The need for contextually aligned AI assessment frameworks is driven by the complex relationships between disciplinary literacies and the competencies required for AI literacy (Gu & Ericson, 2025; Hutson et al., 2022; Long & Magerko, 2020). Additionally, frameworks must account for the developmental differences across the K-16 spectrum and the distinct pedagogical environments of K-12 and post-secondary spaces.

A comprehensive K-12-specific framework will support balancing K-12 education's fundamental responsibility to develop foundational skills, critical thinking capabilities, and ethical reasoning. The framework must be designed to meet education’s future-facing goal of preparing students for an AI-enabled future. Developing an adapted K-12 framework is a logical next step in the evolution of the AIAS work and an imperative to mitigate the distinctive challenges faced and maximize the opportunities present in K-12 educational contexts.

Methods

Framework Development Approach

The proposed theoretical framework development followed a systematic four-phase process designed to adapt the existing AIAS framework for K-12 contexts and maintain theoretical coherence and developmental appropriateness. As this work represents theoretical framework development rather than empirical research, we employed established approaches to systematic literature synthesis and theory integration.

Phase 1: Systematic Literature Review and Gap Analysis

Search Strategy. A comprehensive literature search was conducted across seven educational databases (EBSCO, Education Research Complete, Educator's Reference Complete, ERIC, ProQuest, PsychInfo, and Scopus) in September 2025. The search covered publications from January 2022 (ChatGPT's public release) through September 2025. We used the following search string: ("AIAS" OR "AI" OR "generative AI") AND ("AI assessment" OR "AI Assessment framework") AND ("K-12" OR "elementary" OR "secondary" OR "high school").

Inclusion and Exclusion Criteria. Studies were included if they: (a) addressed AI integration in K-12 assessment contexts, (b) discussed developmental considerations for AI use with school-aged children, (c) presented empirical data or theoretical frameworks, (d) appeared in peer-reviewed journals, and (e) were published in English. Studies were excluded if they focused exclusively on: (a) higher education contexts, (b) disciplines outside education (e.g., medicine, nursing, computer science), (c) AI detection technologies, (d) surveys of teacher or student AI knowledge without assessment implications, and (e) opinion pieces without theoretical grounding.

Selection Process. The initial search yielded 63 studies. After removing duplicates (n = 8), the remaining abstracts were screened against inclusion criteria, excluding 42 studies. Of the 13 full-text articles reviewed, only two studies directly addressed AIAS implementation or comparable frameworks in K-12 settings (Kılınç, 2024; Perkins et al., 2025). This limited yield revealed significant gaps in published research addressing AI assessment frameworks specifically designed for K-12 contexts, providing primary justification for the current theoretical development work.

Limitations of Search Strategy. There were several limitations in thesearch approach. First, rapid evolution of AI use in education means relevant work may exist in preprint servers, conference proceedings, or institutional reports not captured by our peer-reviewed journal focus. Second, the search terms may have missed studies using alternative terminology for similar concepts. Third, the 2022-2025 timeframe, which was appropriate for capturing GenAI-era literature, may have excluded relevant foundational work on educational technology integration frameworks. Future systematic reviews should expand to include grey literature and employ broader search terminology.

Phase 2: Developmental Theory Mapping

Theory Selection Rationale. Four primary theoretical frameworks were selected based on established relevance to cognitive development, learning scaffolding, and technology integration in educational contexts: (a) Piaget's cognitive development stages (Inhelder & Piaget, 1958; Piaget, 1977) for understanding age-related cognitive capacity, (b) Vygotsky's zone of proximal development (Vygotsky, 1978) for scaffolding principles, (c) Cognitive Load Theory (Sweller, 1988) for understanding working memory constraints, and (d) Kohlberg's moral development theory (Kohlberg, 1984) for ethical reasoning progression. These theories collectively address the cognitive, metacognitive, and ethical demands inherent in increasingly complex human-AI collaboration.

Mapping Procedure. Each of the five AIAS levels was systematically analyzed against developmental theory constructs using a structured analysis framework. For each AIAS level, the following was identified: (a) minimum cognitive capabilities required (mapped to Piagetian stages), (b) necessary executive function skills (based on Diamond, 2013), (c) cognitive load demands (categorized as low, moderate, or high), (d) scaffolding requirements (immediate, moderate, or minimal), and (e) ethical reasoning complexity (mapped to Kohlberg's stages).

This mapping revealed that AIAS Levels 4 and 5 require formal operational thinking, advanced executive functions, and postconventional moral reasoning—capacities typically not established until mid-to-late adolescence (Diamond, 2013; Inhelder & Piaget, 1958; Kohlberg, 1984). Early and middle elementary students, operating in preoperational and concrete operational stages, lack abstract reasoning and metacognitive capacities necessary for independent critical evaluation of AI outputs. This finding necessitated either significant modification or competency-based restriction of higher levels of the AIAS in K-12 contexts.

Phase 3: Contextual Adaptation Development

Contextual factors requiring framework modifications were identified through analysis of: (a) K-12 structural characteristics (e.g., class sizes, contact hours, assessment requirements), (b) regulatory constraints (e.g., FERPA, state standards, parental consent requirements), (c) developmental considerations across 13 grade levels (K-12), and (d) equity and access issues specific to school-aged populations.

For each AIAS level, we developed K-12-specific adaptations addressing: (a) age-appropriate implementation approaches, (b) necessary scaffolding structures, (c) prerequisite skill requirements, (d) teacher support needs, and (e) assessment validity considerations. These adaptations were iteratively refined through consideration of practical implementation constraints and alignment with established K-12 pedagogical practices.

Specific adaptations included: progressive implementation structures where elementary students receive teacher-mediated demonstrations before independent use, competency-based rather than strictly age-based advancement criteria for higher levels, explicit scaffolding specifications for each grade band (K-2, 3-5, 6-8, 9-12), and integration with existing K-12 assessment requirements such as state standards alignment.

Phase 4: Framework Coherence Evaluation

The adapted framework was evaluated for internal coherence using principles from learning progression research (Mosher & Heritage, 2017). Specifically, we verified that: (a) each level built logically upon previous levels, (b) cognitive demands increased systematically with developmental expectations, (c) scaffolding decreased appropriately across levels, (d) the progression aligned with established

developmental trajectories, and (e) the framework maintained consistency with original AIAS theoretical principles and addresses K-12-specific needs.

This evaluation process revealed areas requiring additional refinement, particularly regarding transition points between levels and specification of prerequisite competencies for Levels 4 and 5. We addressed these through developing explicit competency checklists and implementation timelines detailed in the framework presentation.

Limitations

This work represents theoretical framework development rather than empirical validation. The proposed adaptations require systematic empirical testing across diverse K-12 contexts to establish practical effectiveness and identify necessary refinements. Additionally, limited published research on K-12 AIAS implementation means our adaptations are informed primarily by developmental theory and higher education implementations rather than direct K-12 empirical evidence. The framework should be viewed as a theoretically-grounded starting point requiring iterative refinement through implementation research rather than a definitive solution. Future research should prioritize empirical validation across varied K-12 settings, student populations, subject areas, and socioeconomic contexts.

Theoretical Framework

K-12 Context Analysis

Adapting the AIAS for K-12 contexts requires clear delineation of the distinctive contextual factors in K-12 environments versus that of higher education settings. The three primary categories of differences necessitate adaptation are cognitive and developmental variations, institutional and structural differences, and digital literacy and access considerations.

Cognitive and Developmental Variations

K-12 students span a wide developmental spectrum, ranging from preoperational thought in early elementary grades to the establishment of formal operational capabilities in advanced high school students (Piaget, 1976, 1977). This complex developmental trajectory affects students' capacity forengaging in the metacognitive reflection skills required for using AI appropriately and ethically, evaluating source credibility, and managing human-AI collaborative dynamics.

Research in developmental psychology demonstrates that the executive function skills essential for effective AI collaboration, working memory, cognitive flexibility, and inhibitory control, develop well into adolescent years (Diamond, 2013). These developing cognitive skills directly influence students' capacity to critically evaluate AI outputs and simultaneously maintain focus on learning objectives. Student distraction by digital technologies, including cellular phones, is an ongoing concern in K-12 and higher education contexts (Lin, 2025; Martin et al., 2025). Additional distraction introduced by AI use may outweighany benefits afforded by AI with younger students. AI integration into K-12 assessment tools

and procedures requires educators' thoughtful consideration of students' cognitive development and planning for scaffolding and progressive introduction.

Institutional and Structural Differences

While higher education focuses on independent learning, K-12 systems are driven by standards-based accountability and measurable outcomes aligned with state and national mandates (National Governors Association Center for Best Practices, 2010). These requirements create tension between AI integration goals, including the potential for AI use to enhance students' academic performance in the short term only (Bastani et al., 2024). This tension highlights the need to demonstrate individual student mastery of specific learning standards in both the short term and in the long-term when AI use is integrated in learning. Student ability to independently transfer learning in novel contexts must be addressed through careful assessment design.

Additionally, K-12 environments feature more frequent teacher-student interaction, smaller class sizes in elementary grades, and greater teacher involvement in daily learning activities compared to higher education lecture-based models. These structural characteristics present opportunities for more intensive scaffolding and real-time feedback but also place greater demands on teacher AI literacy and pedagogical content knowledge for AI integration.

Digital Literacy and Technology Access

Digital literacy development follows a predictable progression beginning with basic computer skills in early grades and culminating in advanced critical evaluation and specialized courses in high school (Ribble, 2015). However, equity considerations are particularly crucial and often overlooked. Most K-12 students depend on school or district-provided technology. This dependence creates potential barriers to universal AI access that could exacerbate existing educational inequities. Unlike higher education students who may have personal devices and internet access, K-12 students' AI access depends entirely on institutional provision, making equitable implementation more challenging but also more controllable.

Developmental Theory Integration

Theoretical Foundation: Scaffolding Development for AI Integration

The proposed theoretical framework synthesizes key developmental inquiry lines addressing cognitive, metacognitive, and ethical demands inherent in increasingly complex human-AI collaboration. This synthesis establishes a coherent progression based on students' developmental capacities, primarily focusing on scaffolding cognitive and metacognitive demands to guide AI integration.

Scaffolding Cognitive and Metacognitive Demands

The framework's progression design aligns with students' developing capacity to process, manage, and reflect on information. Specifically, it considers progressing cognitive complexity and abstract reasoning,

managing cognitive load and working memory, and social and ethical scaffolding for CAIL.

Progressive Complexity and Abstract Reasoning

AI use progression in the proposed framework is informed by Piaget's cognitive development stages (Piaget, 1977), which describe students' ability to engage in abstract thinking. In the preoperational stage (K-2), learners cannot simultaneously execute perspective-taking and abstract reasoning. Therefore, teacher-mediated AI use demonstrations are necessary to support young students. In the proposed framework, AI is introduced in the adapted Level 1; however, students are observing teacher modeling and demonstrating thorough "think alouds." These teacher moves provide opportunities for students to observe AI application without experiencing the demands of independent use and critical evaluation.

At the concrete operational stage (Grades 3-5), students can engage in logical thinking about observations. In the framework's adapted Level 2, this capacity is tapped through applying AI to concrete, observable tasks (e.g., grammar checks) and avoiding abstract concepts like bias evaluation. When students approach the formal operational stage (late middle school and high school), they begin developing abstract and hypothetical thinking (Inhelder & Piaget, 1958). At this advanced stage, students are positioned to experiment with more sophisticated AI experiences and collaborations that are dependent upon critical evaluation and strategic tool selection. This progression coincides with executive function development research. Critical skills such as cognitive flexibility and inhibitory control, which are essential for navigating AI interaction nuances, continue emerging and developing throughout the adolescent period (Diamond, 2013).

Managing Cognitive Load and Working Memory

Cognitive Load Theory offers a foundational framework for optimizing pedagogical approaches to integrating AI tools in K-12 education (Sweller, 1988). AI integration is managed to prevent tools from creating extraneous cognitive load that can overwhelm students' available working memory. Elementary implementations focus on single AI functions to maintain low load. As students mature and cognitive capacity increases, AI implementations can accommodate higher cognitive demands. However, students continue benefiting from structured metacognitive scaffolding to help them monitor resources and strategically select AI tools. Through educators' intentional integration of supports for navigating complexities of AI use, AI can enhance students' achievement of content learning objectives.

Social and Ethical Scaffolding for Critical AI Literacy (CAIL)

The proposed theoretical framework views CAIL as socially constructed skillsets developed through structured guided practice within ethical educational environments. The framework envisions this environment as an activity system that is iteratively evolving in response to student development, culture, and technology.

AI Tools as Culturally Mediating Artifacts

Moore and Tillberg-Webb (2022) reframe educational media as culturally mediating artifacts (CMAs) within a Cultural-Historical Activity Theory (CHAT) framework, rooted in Vygotsky's sociocultural theory. CHAT conceptualizes human activity as mediated by artifacts (tools and signs) and extends Vygotsky's work to considering activity systems. In K-12 environments, this system includes teachers and students, their goals, tools, the community, and community rules. CHAT provides a lens for examining how historical and cultural factors influence human thinking within system complexities (Hite et al., 2024; Miles, 2020).

Following Moore and Tillberg-Webb's (2022) reframing, the proposed theoretical framework identifies AI tools as CMAs. AI tool use influences how student users engage in goal-directed activities such as achieving grade-appropriate learning outcomes. In K-12 environments, aligned with Vygotsky's zone of proximal development (Vygotsky, 1978), AI tools require social scaffolding. In the zone of proximal development, learners' successful task completion depends on guidance from a more" knowledgeable other." For K-12 students, the teacher is the primary "more knowledgeable other,"and socially guides students in learning to use AI tools. This is accomplished through teacher modeling of appropriate AI questioning and critical evaluation, deigned to scaffold student advancement through the gradual release of responsibility model. This social interaction-based approach to learning how to use AI tools ensures CAIL develops through guided practice and collaborative reflection ,thus promoting student agency. Students incrementally move toward skill mastery in ways designed to prevent reliance on or misuse of technology.

Graduated Ethical Reflection

Kohlberg's moral development theory also informs the proposed theoretical framework, identifying necessary AI ethics instruction (Kohlberg, 1984). Elementary students, operating at preconventional moral reasoning levels, must be introduced to basic, authority-driven "AI use rules." Middle school students operate in conventional moral reasoning stages and learn social expectations and academic integrity for AI use. High school students, developing postconventional moral reasoning, grapple with complex issues of bias, personal and data privacy, confidentiality, and long-term societal and environmental impacts of AI.

Proposed K-12 AIAS Framework

The proposed theoretical framework presents five levels specifically modified for K-12 implementation. Each level considers developmental appropriateness and maintains core theoretical principles of the original AIAS. Table 1 summarizes the adapted framework with theoretical justifications

Table 1 *Proposed K-12 AIAS Framework*

*K-12 AIAS Framework*Level	K-12 Focus & Adaptation	Justification/Theoretical Alignment
Level 1	**Foundational Skills Development (All Grades).** Extended focus on content foundational skills **before** introducing AI assistance. Maintains traditional controls to prevent technological dependence.	Cognitive Load Theory (Sweller, 1988); Foundational Skill Acquisition.
Level 2	**Guided AI Introduction (Elementary-Secondary Progression).** AI should be introduced gradually with substantial support. This is achieved through teacher-mediated demonstrations (K-2), which are then faded to structured, supervised AI engagement (Grades 3-5), before providing increasing independence (Grades 6-12).	Scaffolded learning theory (Wood et al., 1976; Wood & Wood, 1996); Zone of Proximal Development (Vygotsky, 1978).
Level 3	**Collaborative AI Use (Middle-High School).** Intentional focus on developing critical evaluation skills, accomplished through scaffolding for source evaluation, bias recognition, and age-appropriate documentation. Requires sufficient cognitive development to manage complex collaborations.	Social Constructivist Theory (Vygotsky, 1978); Emerging Formal Operational Thinking.
Level 4	**Advanced AI Integration (High School based on Competency).** Requires **demonstrated mastery of prerequisite CAIL skills and advanced executive function**. Focuses on professional-level skill development, authentic application of complex problem solving, and preparing students for post-secondary and professional AI collaboration.	Formal Operational Thinking (Piaget, 1976; Lourenço, 2016); Executive Function Development (Diamond, 2013).
Level 5	**AI Innovation and Experimentation (Advanced High School based on Competency).** Requires **demonstration of substantial prerequisite skills** and close mentorship/supervision. Students pursue experimental and creative AI applications, extending business-as-usual use and capabilities.	Convergence of Advanced Cognitive Development; Postconventional Moral Reasoning (Kohlberg, 1984).

Level 1: Foundational Skills Development (All Grades)

The theoretical framework, rooted in cognitive load theory and skill acquisition research (Sweller, 1988), requires that students develop foundational capabilities before introducing AI assistance. This perspective considers the multiple definitions and types of literacy previously discussed and honors the contribution and interrelationships of the skills and knowledge of all literacies to student learning. This sequential approach is vital to prevent technological dependence from interfering with students' fundamental skill development. Consequently, K-12 adaptations must include extended focus on broad, interdisciplinary content foundational skills and concepts, as well as instruction, support, and modeling, to cultivate intrinsic motivation, self-efficacy, and metacognitive awareness of thinking processes.

Level 1 maintains traditional controlled assessment environments where GenAI is strictly prohibited through environmental and technical controls. However, unlike pure prohibition approaches, Level 1 includes preparation for future AI use through teacher modeling and demonstration. In early elementary grades (K-2), teachers demonstrate AI capabilities through whole-class think-aloud sessions, introducing concepts of AI assistance without requiring students to independently evaluate outputs. This approach builds conceptual understanding and protects against cognitive overload and premature AI dependence.

Level 2: Guided AI Introduction (Elementary-Secondary Progression)

Drawing from scaffolded learning theory (Wood et al., 1976; Wood & Wood, 1996), complex tools, including AI, should be introduced gradually with substantial support. Developmental considerations require different approaches across grade levels. For K-2 students, Level 2 involves teacher-mediated demonstrations building upon students' exposure in Level 1. Teachers continue modeling AI use, and they begin to invite student observations and simple reflections about AI capabilities and limitations. Students do not yet independently use AI tools; however, they develop foundational concepts necessary for future critical engagement.

Older elementary students (Grades 3-5) benefit from transitioning to structured, supervised AI engagement and use. Teachers provide explicit protocols for AI use in specific, constrained tasks such as grammar checking or vocabulary exploration. Scaffolding remains strong with teachers providing oversight of all AI interactions, structured reflection prompts to guide students to evaluate AI suggestions, and clear boundaries regarding appropriate AI use contexts.

Middle school and high school students (Grades 6-12) are provided with opportunities to increase their independence, while still being scaffolded by clear guidelines. Teachers gradually release responsibility to students, yet they maintain structured support through provision of explicit rubrics delineating acceptable AI use, required documentation of AI-assisted processes, and regular metacognitive reflection activities. This progressive approach respects students' cognitive developmental limitations as it supports building conceptual understanding of AI as an educational tool.

Level 3: Collaborative AI Use (Middle-High School)

Grounded in Vygotsky's social constructivist theory (1978), learning is viewed as a process mediated by social interaction and tools and is dependent on sufficient cognitive development for managing complex collaborations. In K-12 settings, this principle requires intentional focus on developing critical evaluation skills and is accomplished through providing scaffolding for source evaluation, bias recognition, and age-appropriate documentation.

Level 3 acknowledges AI-assisted drafting and composition as a cultural reality. This level emphasizes developing critical evaluation skills and ensuring students maintain their own voice. Meaningful AI collaboration requires developing and solidifying formal operational thinking. These cognitive capabilities typically emerge in middle school years and continue developing into adulthood.

At Level 3, students collaborate with AI for task completion and are responsible for: (a) critically evaluating AI-generated content, (b) making final decisions about incorporating AI suggestions in their work, (c) maintaining their voice and perspective, (d) documenting AI use transparently, and (e) demonstrating understanding of core concepts without AI assistance.

Implementation at Level 3 requires explicit instruction in recognizing the characteristics of AI-generated content, evaluating source credibility and bias, synthesizing multiple sources including AI-generated content, and citing AI use appropriately. Teachers provide structure and scaffolding through guided practice activities, peer review opportunities that focus on maintaining student voice, and formative assessments verifying students' growing understanding.

Level 4: Advanced AI Integration (High School Based on Student Competency)

At this stage, formal operational thinking and advanced executive functioning enable students to grapple with sophisticated academic material and AI tool management while engaging in strategic thinking (Diamond, 2013; Lourenço, 2016; Piaget, 1977). Level 4 is dependent on demonstrated mastery of prerequisite CAIL, executive function skills, and developmental readiness rather than strictly age-based limitations.

Key educator considerations for Level 4 include a focus on professional-level skill development, application of complex problem solving, and preparing students for the types of AI collaboration that may be expected in post-secondary and professional contexts. Students operating at Level 4 use GenAI tools intentionally to achieve specific learning outcomes. They learn to evaluate their effective application of AI tools and to demonstrate content mastery across disciplines.

Students' access to Level 4 requires that they demonstrate multiple competencies including (a) consistent ability to critically evaluate AI outputs across contexts, (b) ability to maintain their voice when collaborating with AI, (c) advanced understanding of AI limitations and biases, (d) ethical reasoning regarding appropriate AI use in a variety of contexts, and (e) metacognitive awareness of their personal learning with and without AI assistance.

Assessment at Level 4 emphasizes students' strategic decision-making about when and how to employ AI tools, critical evaluation of AI contributions to their work products, ethical analysis of their AI use, verification of their personal intellectual contribution when collaborating with AI, and ability to provide evideance that AI assistance enhanced rather than supplanted their learning.

Level 5: AI Innovation and Experimentation (Advanced High School Based on Student Competency)

The convergence of students' advanced cognitive development and their developing specialized interest areas creates a "sweet spot" for students to experiment and create AI applications. Level 5 requires students' documented mastery of prerequisite skills and depends on having close mentorship and supervision with highly knowledgeable and experienced collaborators. Academically advanced students will require sophisticated oversight and ethical guidance.

Students at Level 5 explore with AI knowledgeable mentors, challenging the defined boundaries of content and standard applications, to discover and uncover new GenAI applications. By experimenting with AI tools in non-routine ways, students have opportunities to innovate applications and create the future (Perkins et al., 2025).

Level 5 implementation requires that schools have policies for clear digital citizenship requirements, data privacy, intellectual property, and ethical AI use. Students must have mastered established prerequisite skills demonstrated by documented performance evidence such as a portfolio assessment of prior AI-integrated work. The school must provided students with sophisticated mentorship through educators or partners with demonstrated advanced AI literacy. Additional policies on research, including documentation of experimental processes and the impact of AI impact on the school community, broader society, and the environment must be established.

Level 5 is only appropriate for advanced high school students who wish to pursue independent research projects, capstone experiences, or specialized coursework focused on innovation and experimentation as their learning targets. Participation must align with the student's demonstrated competency and the school's ability to provide the aforementioned recommendations, not grade level alone.

Illustrative Applications and Pedagogical Analysis

Three examples are provided to demonstrate practical framework application across different grade levels and subject areas. Each example incorporates systematic pedagogical analysis grounded in learning theory and developmental research.

Example 1: High School Marketing Campaign (Level 4 Implementation)

Learning Context and Objectives. In an 11th-grade business course, students develop authentic marketing campaigns for local nonprofit organizations. Learning objectives include (a) applying marketing principles in authentic contexts, (b) demonstrating ethical reasoning in business contexts, (c) demonstrating adaptability and creative problem-solving, and (d) developing professional-level AI collaboration skills.

AI Integration Approach. Students use AI tools for content generation as they remain responsible for (a) strategic decision-making about campaign direction and messaging, (b) ethical analysis of persuasive techniques and target audience appropriateness, (c) scenario adaptation responding to simulated market feedback, (d) creative direction ensuring campaign authenticity and organizational mission alignment, and (e) critical evaluation of all AI-generated content for accuracy, appropriateness, and effectiveness.

Assessment Structure. The assessment employs a multi-component structure (a) campaign proposal requiring strategic rationale for AI tool selection and integration plans, (b) iterative development portfolio documenting AI interactions, decision-making processes, and rationale for accepting or rejecting AI suggestions, (c) final campaign presentation including reflection on AI's role in development process, (d)

ethical analysis paper examining persuasive techniques and audience considerations, and (e) peer and community partner feedback integration.

Pedagogical Analysis. This application provides an authentic example of sophisticated integration of authentic assessment principles with AI collaboration skills, addressing multiple Common Core State Standards including research skills and argumentative reasoning. The assignment facilitates transfer of learning to professional contexts (National Governors Association Center for Best Practices, 2010; Wiggins & McTighe, 2005). The emphasis on strategic decision-making and ethical analysis ensures that students' uniquely human capabilities remain central to assessment, concurrent with building of valuable professional practices. The iterative portfolio structure provides formative feedback opportunities that supportmetacognitive development as well as assessment validity through a focus on strategic thinking and ethical reasoning, neither of which can be delegated to AI.

Example 2: Middle School Science Experiment (Progressive Level Implementation)

Learning Context and Objectives. In a 7th-grade life science class, students design and conduct experiments testing fertilizer effects on plant growth. Learning objectives include (a) applying scientific method systematically, (b) collecting and analyzing quantitative data, (c) communicating scientific findings effectively, and (d) developing appropriate technology use in scientific contexts.

AI Integration Approach: Two-Phase Design. Phase 1 (Level 1): Students design experiments, collect data, and complete initial analysis without AI assistance. This phase ensures students demonstrate foundational scientific method application including hypothesis formation, experimental design with controlled variables, systematic data collection, and basic statistical analysis. Students complete laboratory notebooks documenting observations and preliminary conclusions.

Phase 2 (Level 3): After demonstrating foundational competencies, students access AI assistance for report writing and data visualization. Students are responsible for (a) scientific reasoning and interpretation of results, (b) experimental design justification, (c) critical evaluation of AI-generated visualizations for accuracy and appropriateness, (d) authentic voice in discussion and conclusion sections, and (e) connection of findings to broader biological concepts.

Assessment Structure. The assessment employs differentiated evaluation across phases: (a) Phase 1 laboratory notebook and preliminary analysis assessed for scientific method application without AI, (b) Phase 2 formal report assessed for effective AI integration, scientific reasoning quality, and communication effectiveness, (c) reflection component requiring students to analyze how AI assistance enhanced communication and identify limitations, and (d) peer review protocol where students evaluate each other's data visualizations and report clarity.

Pedagogical Analysis. This progressive implementation of AI respects the research process by showing students need foundational skill mastery before technological tools become educationally productive (Reddy et al., 2023). The approach addresses Next Generation Science Standards (NGSS Lead States,

2013). It also maintains fidelity to inquiry-based learning principles by preserving student ownership of scientific questions and data interpretation and using AI to enhance communication effectiveness. The two-phase structure explicitly separates foundational skill demonstration from AI-enhanced communication, preventing AI dependence while building appropriate technology integration skills.

Example 3: Elementary Opinion Writing (Scaffolded Introduction)

Learning Context and Objectives. In a 2nd-grade classroom, students write opinion letters to their principal about their desired qualities in a teacher. Learning objectives include (a) expressing opinions with supporting reasons, (b) using appropriate letter format, (c) developing personal voice in writing, and (d) beginning awareness of revision processes.

AI Integration Approach: Teacher-Mediated Demonstration. Phase 1 (Level 1): Students independently complete opinion letter writing activity, demonstrating foundational skills including stating clear opinions, providing two to three supporting reasons, using basic letter format, and expressing authentic personal perspectives. The teacher provides traditional feedback through writing conferences and written comments.

Phase 2 (Level 2): Using anonymous student work samples (with permission), the teacher demonstrates AI assistance for grammar review and revision suggestions through modeling. The teacher uses a think-aloud protocol showing (a) how to request specific feedback from an AI chatbot (e.g., "You are an expert in grammar, Please check this letter for punctuation errors.”), (b) how to evaluate AI suggestions critically ("Does this suggestion make sense and help communicate my intended message?"), (c) when to accept or reject AI recommendations, and (d) importance of maintaining your own voice.

Students observe demonstrations; however, they do not independently engage in using AI. Rather, they are building the conceptual foundations necessary for future AI literacy. The teacher emphasizes that writing improvement comes from learning, practice, and teacher/peer feedback, not from AI tool dependence.

Assessment Structure

Assessment focuses exclusively on Phase 1 independent writing, evaluating: (a) clarity of opinion statement, (b) relevance and development of supporting reasons, (c) appropriate letter format use, and (d) authentic personal voice and emotional expression. Phase 2 demonstrations are not assessed but serve as foundation-building for future AI integration.

Pedagogical Analysis

This approach aligns with research on writing development showing second-grade students are still developing basic compositional skills (Graham & Harris, 2013). Teacher-mediated demonstration prevents cognitive overload as they introduce AI concepts through modeling developmentally appropriate learning processes in a social setting. This instructional approach builds conceptual

foundations for future AI literacy and maintains student focus on personal voice and authenticity essential in developing opinion writing pieces. By keeping AI at the observation level, rather than for independent use, the instructional design simultaneously respects cognitive limitations of early elementary students and prepares them for eventual scaffolded AI integration.

Discussion

Assessment Validity Framework and Implementation Considerations

Maintaining assessment validity when integrating AI tools in classroom practices requires systematic attention to a variety of validity dimensions. This section examines content, construct, consequential, and face validity considerations essential for effective K-12 AIAS implementation.

Content Validity Preservation

Content validity addresses whether assessments measure what we intend them to measure. Strategic AI integration must ensure measurement of identified learning objectives when incorporating AI (Kane, 2013). The proposed framework addresses content validity through (a) clearly identifying the learning objectives that must be demonstrated by students independently versus those where AI collaboration is appropriate, (b) explicit communication to students about which parts of the assignment require human-generated work products, (c) assessment design that ensures AI cannot circumvent students' independent demonstration of core competencies and skills, and (d) intentionally designed progressions that identify and require foundational skill demonstration before intoroducing and permitting AI access and implementation.

For example, in the middle school science experiment example, core scientific method application is assessed without AI (Phase 1). By design, this ensures content validity for science process skills. Next, AI use for improving communication (Phase 2) is assessed separately. This intentional separation of skill assessment ensures content validity for both scientific reasoning and appropriate technology integration.

Construct Validity Considerations

Construct validity addresses whether assessments measure intended psychological constructs (Cronbach & Meehl, 1955). When students use AI assistance, critical questions arise about measured abilities. Is the assessment measuring students' writing ability, their ability to collaborate with AI, or some combination? The proposed framework maintains construct validity by (a) specifying what must remain primarily human-generated, (b) explicit measurement of AI collaboration skills as educational constructs, (c) assessments requiring evidence of conceptual understanding separate from that generated by AI, and (d) transparent documentation of student versus AI contributions to the work product(s).

At higher framework levels (4 and 5), both content mastery and AI collaboration skills are measured constructs that are accounted for in assessment rubrics. Educators must evaluate students' strategic AI tool use and their content mastery independent of each other.

Consequential Validity

Consequential validity examines intended and unintended effects of assessment practices on teaching and learning (Messick, 1989). The proposed framework prioritizes positive consequential validity by ensuring AI integration does not supplant student learning. By design, this is accomplished by (a) progressions to prevent premature AI dependence, (b) requirements to demonstrating independent skills prior to employing or accessing AI assistance, (c) explicit teaching of metacognitive strategies for effective AI collaboration, and (d) assessment designs that prioritize and promote independent student learning over AI output.

Educators must maintain awareness of potential negative consequences of AI use including students developing AI dependence at the expense of skill development, teachers over-relying on AI-restricted assessments to avoid integration challenges, equity gaps resulting from AI access issues, and students' emotionality and potential anxiety about AI use. The possibility of these unintended outcomes require not only awareness but monitoring for evidence.

Face Validity and Stakeholder Acceptance

Face validity concerns whether assessments appear to measure what they claim to measure, impacting stakeholder acceptance (Allen et al., 2023; Holden, 2010). K-12 contexts require particular attention to face validity because a variety of stakeholders, students, parents, teachers, administrators, and community members, must understand the ways in which AI-integrated assessments are being used and why this practice is educationally sound, beneficial to students, and an appropriate practice.

The proposed framework supports face validity through (a) transparent communication about the "why" for AI integration and the specificity of students learning objectives, (b) clear documentation making student versus AI contributions visible, (c) progressive implementation that demonstrate use and benefits of AI before advancing to higher levels, and (d) alignment of AI integration with established educational frameworks, standards, and outcomes. Providing education to all stakeholders, transparently, about framework implementation is essential for building trust and acceptance and the ultimate success.

Implementation Guidelines and Professional Development Framework

Successful implementation requires systematic assessment of institutional readiness a comprehensive professional development plan to support educators in effective framework application.

Assessing Institutional Readiness

Schools and districts must evaluate readiness across three primary dimensions before implementation: student readiness, teacher readiness, and institutional support capacity.

Student Readiness Assessment. Evaluate current student skills and capabilities including (a) digital literacy prerequisites for AI tool use, (b) grade-level cognitive development indicators suggesting appropriate starting levels, (c) metacognitive skills and capacity for reflection, and (d) prior technology integration experiences.

Teacher Readiness Evaluation. Assess educator preparedness including (a) AI literacy competencies and comfort with AI tools, (b) pedagogical content knowledge for integrating AI into content instruction, (c) assessment design literacy, and (d) capacity to provide individualized support to all learners.

Institutional Support Assessment. Evaluate organizational capacity including (a) technology infrastructure capacity to support AI access for all students, (b) current and needed policy frameworks for AI use, data privacy, and academic integrity, (c) administrative support for progressive implementation and openness to teacher learning curve, and (d) resources for professional development and ongoing support and coaching.

Progressive Implementation Timeline

A three-year implementation timeline allowing for systematic professional development, iterative refinement, and stakeholder engagement is recommended

Year 1: Foundation Building. Focus on (a) comprehensive professional development for all K-12 educators on proposed AIAS principles and framework adaptation, (b) community engagement including parent information sessions and collecting and addressing stakeholder feedback, (c) policy development for AI use guidelines, data privacy, and academic integrity, (d) pilot implementation at Levels 1-2 in selected grade bands and collecting and analyzing formative data, and (e) development of assessment resources, facilitation guides, and rubrics for expanded implementation.

Year 2: Structured Implementation. Expand through: (a) full implementation of Levels 1-2 across all grade levels, (b) pilot implementation of Level 3 in middle and high schools with aligned teacher preparation, (c) iterative policy review and refinement based on Year 1 experiences, (d) intentional, ongoing professional development, based on teacher feedback and observation, focusing on assessment design and validity, and (e) systematic data collection on implementation successes and challenges, including student voice.

Year 3: Full Integration and Evaluation. Achieve comprehensive implementation through: (a) full framework implementation across appropriate grade levels, (b) introduction of Levels 4-5 for competency-qualified high school students, (c) comprehensive evaluation of student learning outcomes, teacher experiences, and equity impacts, (d) sustainability planning for ongoing professional development and framework updates, (e) iterative policy review and refinement based on Year 2

experiences, and (f) documentation of effective practices and lessons learned for continuous improvement.

Professional Development Framework

Effective implementation requires sustained, job-embedded professional development and coaching rather than “one-and-done” training. We recommend multi-tiered professional development addressing foundational AI literacy, pedagogical integration skills, and content specific integration.

Foundational AI Literacy. All educators need (a) understanding of AI capabilities, limitations, and biases, (b) hands-on experience with AI tools used in instruction and assessment, (c) awareness of ethical considerations and data privacy issues, and (d) knowledge of age-appropriate AI integration principles.

Pedagogical Integration Skills. Teachers require (a) assessment design expertise for creating valid AI-integrated evaluations, (b) scaffolding strategies for progressive AI introduction aligned with student development, (c) facilitation skills for classroom dialogue about AI use and academic integrity, and (d) differentiation techniques supporting diverse learners in AI-integrated contexts.

Content-Specific Applications. Content area teachers benefit from (a) discipline-specific examples of effective AI integration, (b) understanding of how AI is used in their subject area professionally in the workplace, (c) strategies for maintaining content integrity when integrating AI, (d) collaborative planning opportunities with colleagues teaching similar content, and (e) ongoing coaching from a technology integration coach.

Common Implementation Challenges and Mitigation Strategies

Based on higher education AIAS implementation experiences and developmental considerations unique to K-12, we anticipate several implementation challenges requiring proactive mitigation strategies.

Challenge 1: Over-Reliance on AI Tools. Students may develop dependence on AI assistance, using tools for work that would be most educationally productive completed independently.To mitigate over-reliance on AI, strategies include strategies include (a) progressions that require students to demonstrate foundational skill mastery before accessing AI tools (as exemplified in the science experiment example), (b) regular assessments of independent capabilities ensuring skill maintenance as best practice indicates, (c) explicit teaching about appropriate AI use and discussion of the “why,” and (d) metacognitive reflection activities that scaffold student self-monitoring of their independent skills and competencies.

Challenge 2: Equity and Access Issues. AI access disparities could exacerbate current educational inequities. To mitigate equity and access concerns, strategies include (a) school provision of AI tools to ensureall students have equivalent access, (b) educator professional development on recognizing and addressing access barriers, (c) assessment designs that only include AI tools available to all students,

(d) alternative pathways for demonstrating competencies that are independent of AI access, and (e) iterative review and revision of AI policies and associated regulations (minimum annually).

Challenge 3: Assessment Validity Concerns. To ensure stakeholders questions about what and how AI-integrated assessments measure intended learning outcomes, strategies to mitigate potential doubt include (a) clearly and transparently communicating of learning objectives and AI's role in achievement, (b) documentation making student versus AI contributions transparent, and (c) regular stakeholder feedback informing ongoing refinement.

Challenge 4: Academic Integrity Challenges. Students may struggle determining appropriate versus inappropriate AI use of AI in their performance tasks. To mitigate this challenge, strategies include (a) explicit instruction on academic integrity regarding AI use beginning in elementary grades, (b) clear communication of expectations for each individual assessment, (c) intentional communication with students emphasizing transparency and student learning over surveillance, and (d) formative feedback to support internalization of appropriate AI use.

Theoretical Contributions and Research Implications

This framework advances educational technology integration theory and establishes foundation for systematic empirical research on K-12 AI assessment integration.

Theoretical Contributions

This work contributes to educational technology theory in the following ways:

Methodology for Cross-Context Framework Adaptation. The systematic four-phase process for adapting the AIAS framework to K-12 education provides a model for future technology integration framework development. The explicit integration of developmental theory, contextual analysis, and coherence evaluation provides a replicable methodology for future adaptation efforts.

Identification of Critical Adaptation Factors. The framework identifies specific factors affecting AI assessment integration in K-12 settings. The factors include cognitive development stages, executive functioning development, institutional structures, government and regulatory constraints, and equity considerations. These factors provide structure for researchers and practitioners when adapting other educational technology frameworks for use in K-12 contexts.

Theoretical Justification for Developmental Progressions. The synthesis of Piagetian cognitive stages, Vygotskian scaffolding principles, cognitive load theory, and moral development theory provides theoretically-grounded rationale for progressive AI integration. This multi-theoretical approach demonstrates how multiple established learning theories can inform technology integration decisions and maintain pedagogical soundness.

Conceptualization of AI as Culturally Mediating Artifacts. The application of Cultural-Historical Activity Theory to AI tool integration provides a novel lens for understanding how AI mediates learning within the highly complex and variable K-12 educational systems. This conceptualization establishes pathways for future research examining systemic factors that influence AI integration success.

Research Implications and Priority Areas

The framework establishes foundation for systematic empirical research agenda addressing:

Longitudinal Learning Outcome Analysis. Future research should examine long-term effects of progressive AI integration on (a) foundational skill development across content areas, (b) metacognitive awareness and self-regulated learning capacities, (c) critical thinking and evaluative judgment skills, (d) transfer of AI collaboration skills to new contexts, and (e) preparation for post-secondary educational and work environments.

Comparative Implementation Research. Studies should compare implementation across diverse K-12 contexts to study and ascertain (a) effectiveness across different grade bands and subject areas, (b) impact of various professional development approaches on implementation quality, (c) outcomes across different socioeconomic contexts and school types, and (d) cultural and linguistic factors affecting implementation.

Validity Studies. Research should systematically examine assessment validity through (a) alignment between intended and measured constructs in AI-integrated assessments, (b) reliability of scoring AI-integrated performance tasks, (c) consequential validity examining intended and unintended effects on teaching and learning, and (d) stakeholder perceptions of assessment fairness and appropriateness and impact on school climate and culture.

Equity and Access Research. Researchers should investigate (a) effectiveness for ensuring equitable AI access, (b) impact on achievement gaps and educational equity, and (c) scalability of equitable implementation in resource-constrained environments.

Teacher Professional Development Effectiveness. Researchers should examine (a) effective professional development models for building AI literacy and integration expertise, (b) factors supporting sustainability in classrooms and schools, (c) the relationship between teacher AI literacy competencies and fluency with tool use and student learning outcomes, and (d) strategies for supporting teachers' implementation challenges.

Subject-Specific Framework Development. Future work should explore detailed content-specific adaptation needs addressing: (a) unique issues of AI integration in different content areas (Disciplinary AI Literacy), (b) alignment with subject-specific standards and learning progressions, and (c) professional practice preparation for college and career readiness in specific fields.

Limitations

This theoretical framework has several important limitations requiring acknowledgment.

Lack of Empirical Validation. The proposed adaptations represent theoretically-grounded recommendations requiring empirical testing.A claim of effectiveness is moot without systematic implementation research across diverse K-12 contexts. The framework should be viewed as hypothesis-generating, not practice validating.

Limited Literature Base. The systematic literature review revealed only two published studies directly addressing K-12 AIAS implementation, limiting the ability to ground the prpopsed adaptations in empirical K-12 evidence. Adaptations rely heavily on developmental theory and higher education implementation experiences rather than direct K-12 data. Notably, the field of AI study is rapidly changing with the possibility of new studies emerging daily.

Potential Theory-Practice Gaps. Theoretical frameworks developed without concurrent implementation cannot fully account for practical constraints, unintended consequences, or contextual factors affecting real-world application. Implementation will likely reveal necessary refinements not apparent in theoretical development.

Generalizability Questions. The framework was developed primarily considering U.S. K-12 contexts. Different educational systems, cultural contexts, and regulatory environments may require further adaptation. Generalizability to international contexts requires empirical investigation.

Rapid Technological Change. AI capabilities are evolving rapidly, potentially outpacing framework development. The framework, like AI policies, will likely require iterative updates as new AI tools and applications are developed and released.

Resource Requirements. The framework assumes resource availability for professional development, technology infrastructure, and implementation support that may not exist in all contexts. Implementation feasibility in resource-constrained environments requires investigation. Additionally, as environment consequences of AI emerge, the risk-benefit relationship of AI use will need to be considered in educational contexts.

Conclusions

The integration of generative artificial intelligence into K-12 educational assessment represents both unprecedented opportunity and significant challenge. Though the AIAS has demonstrated success in higher education, the unique developmental, institutional, and contextual characteristics of K-12 education dictate systematic adaptation. This theoretical framework provides such adaptation, grounded in established developmental theory and informed by careful analysis of K-12 contextual factors.

The proposed framework maintains the AIAS's core principles, transparency, pedagogical intentionality, assessment validity, and equity, and concurrently provides a developmentally appropriate progression

aligned with cognitive development, executive function maturation, and moral reasoning advancement. Through progressive implementation structures, explicit scaffolding specifications, and competency-based advancement criteria, the framework ensures AI integration supports, rather than supplants, the fundamental learning objectives of primary and secondary education.

The framework advances beyond simple prohibition or unscaffolded permission, whereby students receive little or no instruction in AI use, by providing specific guidance for how AI can be appropriately integrated at different developmental stages and for different educational purposes. Early elementary students benefit from teacher-mediated demonstrations that build conceptual foundations without cognitive overload. Upper elementary students engage in structured, supervised AI use developing critical evaluation skills. Middle and high school students progress toward collaborative AI use and, for those demonstrating prerequisite competencies, advanced integration and innovation.

Successful implementation requires sustained institutional commitment including comprehensive professional development, progressive implementation timelines, ongoing validity monitoring, and attention to equity considerations. The framework provides specific guidance for assessing institutional readiness, structuring professional development, and addressing anticipated implementation challenges.

This work establishes foundation for systematic research agenda examining long-term learning outcomes, comparative implementation effectiveness, validity evidence, equity impacts, and subject-specific applications. Such research is essential for empirically validating theoretical recommendations and identifying necessary refinements supporting effective practice.

As AI becomes increasingly ubiquitous in educational and professional contexts, K-12 education faces responsibility to prepare students beyond just the use of AI tools. Educators must design instructional opportunities that engage students in learning about and using AI critically, ethically, and strategically. The proposed framework provides a theoretically-grounded starting point for meeting this responsibility and provides for the developmental needs and fundamental learning objectives inherent in primary and secondary education systems. Through careful implementation, ongoing refinement, and systematic research, educators can capitalize on AI's educational potential and simultaneously remain committed to essential foundational skill development, critical thinking, and ethical reasoning requisite for students' lifelong success.

Declarations

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Author Contribution

The author, Maureen Ruby, is the sole author of this manuscript.

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