ACADEMIA International Journal for Social Sciences
Volume 5, Issue 3(s5), 2026 ISSN-L (Online): 3006-6638

Integrating AI Literacy into Secondary Education Curricula: Impact on Critical Thinking and Problem-Solving Skills

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Received: 02-02-2026 **Revised:** 16-02-2026 **Accepted:** 04-03-2026 **Published:** 19-03-2026

ABSTRACT

AI now permeates search, translation, social media, writing support, tutoring systems, and even workplace decision-making. Secondary education can no longer afford to treat AI as a minor technological subject of a small subset of computing students. The current paper establishes an evidence-based curriculum integration model of AI literacy in secondary education and discusses how it is likely to affect the critical thinking and problem-solving skills of students in secondary education. The paper presents arguments based on the literature of AI literacy teaching as an interdisciplinary skills development, versus the teaching of particular tools. The offered framework will make AI literacy organized into four curricular strands: conceptual understanding of AI, practical and responsible use, critical evaluation of AI results, ethical-social reasoning. The analysis defines three mechanisms by which AI literacy can enhance higher-order thinking: the evidence-based evaluation of machine outputs, metacognitive control of tool use, and genuine problem-based inquiry across subjects. Meanwhile, the paper cautions that improperly implemented AI integration can compromise independent reasoning by prominently supporting shortcut behaviour, shallow prompting and blind belief in what they are generating output. The paper adds a spiral curriculum model, assessment cycle and implementation tables to schools that strive to achieve a measured improvement in critical thinking and problem solving without compromising human judgment with the automated systems.

Keywords: *AI literacy; secondary education; curriculum integration; critical thinking; problem-solving; generative AI; K-12 education; educational technology*

INTRODUCTION

Artificial intelligence no longer exists in the periphery of computer science wholly but has been implemented in the toddler stage learning classroom. Students are now experiencing recommending

engines, automatic translation, generated images, adaptive practice, plagiarism detecting, conversational agents, and search dummies even prior to them having a full and fully mature grasp of how each system operates. This educational problem therefore stops being a question of whether students will be using AI but whether it is wise, morally, and critically that minds in schools can put students to good use of AI. Secondary education is an urgent step in this line of work since learners are mature enough to think about evidence, prejudice, withholding, social ramifications, and punishment and yet, they are also old enough to design a curriculum that can provide a long-lasting habit of mind.

This paper will assert that AI literacy needs to become a formal part of high school curricula since it can enhance the abilities and skills of critical thinking and problem-solving when structured around inquiry and assessment and the human condition. AI literacy refers not to informal knowledge of chatbots or functions of software. In order to define AI literacy, Long and Magerko (2020) propose that it is a collection of skills that enable an individual to be able to critique AI technologies, converse and collaborate with AI, and utilize AI as an instrument in their daily life. Ng et al. (2021) add another conceptualization of AI literacy, namely knowing and understanding AI, using and applying AI, evaluating and creating with AI, as well as addressing ethical issues. These definitions are important to the schools as they shift the emphasis of operation of the tool and move it to the area of judgment. A student who is able to command a chatbot to give them an answer is not AI literate; a student who can criticize an answer, see evidence gaps, do comparisons, and discuss the drawbacks of models, and practice a solution is moving toward AI literacy.

The urgency of curriculum integration may be justified by the fact that AI is gaining traction at a fast pace in both the public and the private life. The guidance UNESCO offers on using generative AI is anthropocentric, age-related, ethically sound, and pedagogical (Miao and Holmes, 2023). As well, the European Commission (2022) wraps AI and data-driven teaching as an ethical and a professional concern that asks an educator to be aware of opportunities and risks. Wang and Lester (2023) suggest that a solid evidence-based framework of K-12 AI literacy, such as learning and teaching, curriculum integration, teacher professional development, and assessment, should exist. All these writings taken together point to a situation where AI literacy is not only a factor of employability in the future but it is also a factor of civic, cognitive and educational quality.

This problem is based on critical thinking and problem solving. Purposeful and reflective judgment which includes interpretation, analysis, evaluation, inference, explanation and self-regulation have been long described as critical thinking (Facione, 1990). Reasoned and reflective thinking, with a focus on deciding what one should believe or do, as stressed by Ennis, (1985), is vital to life. The problem solving process should entail the learner stating the problem, finding information that is pertinent, and formulating and experimenting strategies, tracking progress and changing strategies where early strategies are unsuccessful. The processes can be facilitated via AI supporting the process examples, feedbacks, simulations, data trends, and alternative explanations. Unfortunately, however, the very weapons can be brought against them, in case they will leave to a machine the strenuous labor of thinking. The implications of AI literacy on cognition are conditional (they are contingent on the curriculum, pedagogy, assessment, teacher capacity and norms of use).

This paper adds the conceptual synthesis to the research on AI literacy into a conceptual model as a secondary curriculum model with cognitive results of measurement. His paper sets a special framework due to the aid of the existing literature and policy, rather than creating its artificial data of experiments. It talks about three questions: What do you think ought to be covered on the secondary curriculum on AI literacy? And what could AI literacy define in terms of critical thinking and problem solving? What should schools do to consider the impact without endangering the staff with overdependence on AI? The paper has formulated the paper in the form of literature review of the literature available, proposed conceptual

framework, methods to integrate curriculum, anticipated cognitive impact, a research design, research and practice implementation risks and implications

LITERATURE REVIEW

AI literacy can be seen as an antidote to the widening social divide between the social contribution of AI and the social consciousness of AI systems. Digital literacy was initially defined as access, the ability to search information, and technical functionality; AI literacy includes the ability to reason about data, algorithms, predict,sense ambiguity, explainability, bias, automation, and consider ethics. The competency model by Long and Magerko (2020) remains dominant in that it does not differentiate AI literacy as either a technical or social competency. Students are postulated to be knowledgeable of what AI can and cannot do, how AIs think and articulate reality, how AI systems learn and respond to data, how individuals interact with AI, and how social suppositions might be incorporated in automated decision-making. It can be used with the AI4K12 initiative which designs K-12 AI education around five big ideas, including perception, representation and reasoning, learning, natural interaction, and societal impact (Touretzky et al., 2019). This model has an advantage since it is easy to access it. It gives the students the ability to speak about AI without having to learn advanced programming but still has conceptual richness.

Research regarding AI literacy classes has found that structured training could benefit in raising the level of conceptual and confidence in students, including those without a programming background. A trial by Kong et al. (2021) was done on university students on a seven-hour program on AI literacy, which showed that students reported improvements in their AI concepts and self-perceived AI literacy and empowerment. Although the participants were not high school students, the outcome is important as it is a refutation of the ideas of starting AI education complex coding. The authors have been categorical on the fact that even senior secondary students could be able to implement such courses. Similar arguments are made by Wang and Lester (2023); who encourage comprehensive K-12 AI literacy (but also warn that many new curricula are not, yet, sufficiently based on educational research). This is more than just an admoniture to secondary schools, which have limited time in curriculum and can be seduced into trivial use with a technological fad.

The second line of the research is the relationship between higher order thinking and technology rich instruction. The AI will be able to provide individualized explanations, adaptive feedback and a chance of participating in the process of exploratory learning but determining the cognitive advantage will require the manner in which the students will be required to reason. The solution to this dilemma is problem-based learning which comes as a good compromise. Hmelo-Silver (2004) agrees that PBL places the students in complex scenarios with no single answer, and therefore compels students to find out the learning requirements, do a self-directed investigation, discuss, practice, and reflect the strategies. Such are the identical circumstances in which AI literacy could turn into cognitively useful. In reply to the question of enquiry, experimentation with a scientific hypothesis, or critique of an account of history, or the prototype of a community solution, AI becomes a partner in inquiry. In the cases where students participate in the usage of AI to only receive final answers it constitutes a bypass on thinking.

Critical thinking literature makes the issue of evaluation as the centre of AI literacy clear. Facione (1990) has identified the primary dimensions of critical thinking as interpretation, analysis, evaluation, inference, explanation and self-regulation. According to Ennis (1985), critical thinking has to do with choice of what to believe or do as a result of reasoning. The best way to practice these skills is by the AI generated text as in most instances machine generated text appears fluent despite the fact that it might have errors, omissions, unwarranted claims or prejudiced framing. Students must study hence to ask: What makes this output worth it? What are the assumptions that are concealed? What are other options that we did not take? Is it getting the job done to the task, to the context and to the audience? What was the information that might have

informed the response? This questioning allows AI literacy to be a promising learning direction to pedagogy of critical thinking rather than an additional issue to the curriculum.

Predominantly also is computational thinking but like Lisp literacy, should not be confused with AI literacy. Wing (2006) views computational thinking as problem solving, system design and understanding of human behaviour in the light of basic computer science concepts. Shute et al. (2017) determine that decomposition, abstraction, algorithms, debugging, iteration, and generalization are all problem-solving processes involved in computational thinking. AI literacy is also intersected with these concepts, in particular model building and data reasoning, although it adds its own unique concerns: probabilistic results, training data, automation bias, human-machine interface, explainability, privacy, and accountability in AI applications. The secondary curricula are intended to balance AI literacy against computational thinking but maintain a balanced scorecard to the particular judgment skills that must not be lost in AI-mediated environments.

AI in education is a potential governance and equity issue, which is being denoted in policy literature. UNESCO proposes the review of the human-centred, ethical, safe, equitable, and meaningful generative AI use in education (Miao and Holmes, 2023). The policy advice on AI and children offered by UNICEF highlights the importance of child rights, transparency, child safety, inclusion, and accountability (UNICEF, 2021). European Commission (2022) advises teachers to positively, critically, and ethically engage with AI and Data and be aware of risks. These policy papers are not blueprints of the curriculum but also require guide rails. The learning data of the secondary students should be considered, their level of development; language in which they were brought up and their social vulnerability. In turn, AI literacy should not only address the issue of learning how to use AI, but also the issue of considering not to use AI, of protecting privacy, and even of understanding manipulation and the ability to retain human agency.

The reviewed literature has only a single obvious conclusion that AI literacy can be implemented to facilitate critical thinking and problem solving only under a single condition: it has to be offered as one of the reflective practices in the curriculum. The field, however, can be described as having strong conceptual definition and having encouraging initial course assessments, the field is yet to be more elaborated on with additional class room-based demonstrations, especially in the secondary circles and other educational systems that may not predominantly aim at the West. An exaggerated claim of a good responsible paper on this issue should not exist. It is possible to believe that AI literacy can reach a great potential in improving critical thinking and problem-solving skills when thoughtfully planned tasks are considered, yet one cannot believe that it can positively affect all aspects, without considering pedagogy, assessment, equity, and teacher preparation.

Conceptual Framework

The suggested framework is able to correlate the integration of AI literacy in the curriculum with the result of critical thinking and problem-solving by using three mediating processes; critical inquiry, metacognitive control and authentic problem-based learning. This relationship is shown by figure 1. Thought of as a series of learning experiences, rather than as a subject, the curriculum of AI literacy can be envisioned as a set of experiences. The experiences include training in concepts through AI systems, guided practices of AI tools use, performance analysis of machine output and moral-social thinking. More than a better AIs knowledge it is a better quality of evaluation, better transparency of reasoning, better strategy selection, better collaboration and interdisciplinary transfer of reasoning, strategies, and resources, that one can look forward to.

The initial mediator is a critical inquiry. By continuously analyzing the output of AI as a claim and not an answer, students develop skills of critical thinking. Taking the case of science, one can request the AI tool to tell the greenhouse effect, and observe that the descriptions would match the evidence found in textbooks

and reveal what information is missing. They can pursue discussions on its position based on urban surveillance, group the assertions by the quality of evidence, portfolio perspective and risk of ethics. The language classes need to be organized on the principles of communication between the life of human beings and computers during classes when the problems of coherence, bias, originality, and computer usage are discussed and tested. This type of analysis, assessment, inference and explanation in the form of direct play.

Metacognitive control is the second mediator. AI will offer information more easily and in less time, but it is the responsibility of the students to be able to control AI use in terms of when, why and how. Metacognition is the ability to formulate plans on how to support the task, what AI support is necessary, and what was understood without the aid of the AI. Without metacognitive control there is a risk of AI promoting dependency. It may become a way of thinking, a reflection of metacognitive control. Students will be in a position to juxtapose the solution steps that they have and those which AI continues to propose and how either of these can be superior to the other and modify their project. This is particularly crucial in problem solving since people who find the solutions most starting track the progress and change strategies should evidence alter.

Authentic problem based learning is the third mediator. AI literacy is meaningful when students use AI to solve complex problems, where copying of a generated paragraph is not sufficient and students are expected to solve these problems. Examples of open-ended problems which have been set up in the curriculum include coming up with a campaign to conserve water, testing misinformation on health, modeling local traffic jams or designing an inclusive school policy to utilize AI. These activities challenge the students to specify constraints, information sources, trade-offs, rationalize decisions and explain solutions. Students and teachers can facilitate but not substitute the brainstorming, simulation, explanation, translation, coding or critique based on AI. The key idea of the framework is that AI is applicable to support the learning process, but it should not be applicable to solve the reasoning part of the assignment.

Figure 1

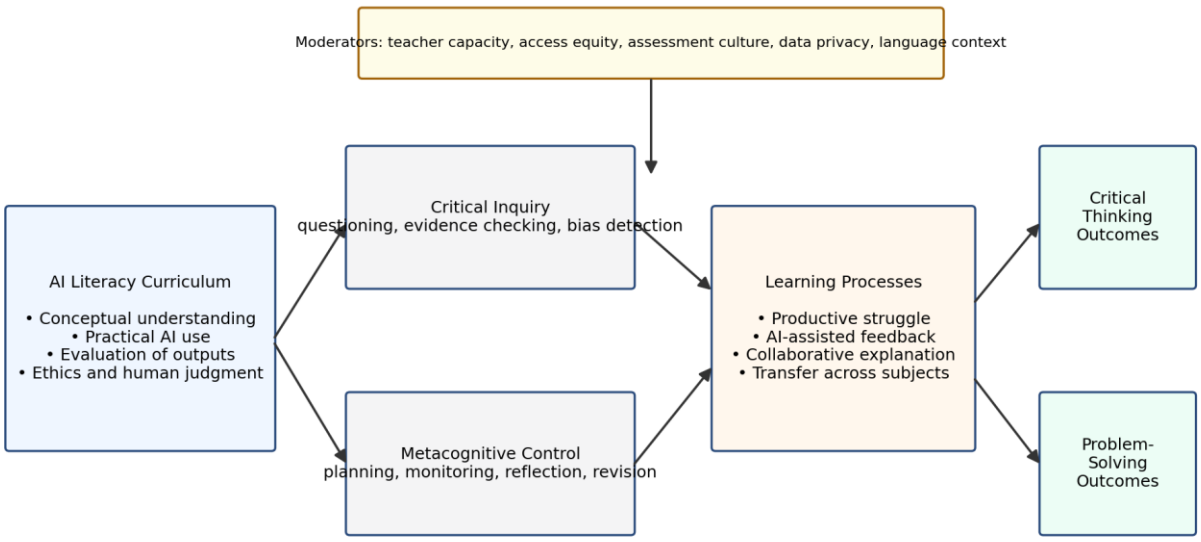

Figure 1. Proposed mechanism linking AI literacy curriculum integration with critical thinking and problem-solving outcomes.

Curriculum Integration Model for Secondary Education

The introduction of AI literacy in secondary education can be in the form of a spiral model, and not in the form of a standalone technology course. The development of the concept of recognition and explanation to the development of evaluation and responsible design is shown in figure 2. Grade 9 students can be taught to identify AI systems in practice and distinguish between AI and non-AI software, the footprint of information, and implement some of the simplest examples of prediction and recommendation. Activities of age level will allow students to share their thoughts on training data, model error, bias, classification, and pattern recognition. In Grade 11, students will be able to evaluate AI output in such disciplinary tasks as the verification of the sources, the analysis of the arguments, the limitations of the models, and ethical issues. Students in Grade 12 have the opportunity to create responsible solutions to problems based on AI assistance, create portfolios, and justify their choices either orally or in writing.

There are two benefits of this spiral approach. First, it can be used to ease cognitive burdens since it couples the concepts and the developmental preparedness. Even basic mathematics is unnecessary to make the students realize that AI systems learn the patterns in the data and might make mistakes when the latter are incomplete, biased, or not well aligned to the problem. Second, transfer takes place among the spiral model spouses. Concepts on AI are returned to science, mathematics, language, social studies, ICT, arts and entrepreneurship, progressively at a level of increased complexity. The reiteration between subjects will lead the students to understand that AI is not just something taught in the computer classroom but is a way of interrelating with information, systems, and choices.

Table 1 can be used to provide a viable curriculum map. The map is deliberately interdisciplinary since in most cases secondary schools are unable to add a complete new subject without distorting the existing material. Short modules, project weeks, cross-curricular work, assessment rubrics are all examples of AI literacy that can be taught. As an example, a mathematics teacher can teach correlation, outliers and misleading visualization using the help of AI-generated datasets. A teacher of science can use the explanations as objects of verification to compare with other objects in order to ensure explanations are substantiated by experimental evidence. To inform students about the quality of their argument, the teacher of the language can make a comparison of student drafts, AI drafts and peer reviews. Facial recognition, algorithmic discrimination, automation of employment and misinformation are the social issues that a social studies educator may study. Model training, timely design, confidentiality, and fundamental algorithmic thinking are some of the concepts that the ICT teacher can introduce.

The substantial principle of curriculum design means that the usage of AI must be linked to the way of thinking. The lesson should not convey, with the help of the AI, that the task can be performed. It must say, use AI to find out the possibilities, then validate the evidence, detect bias, compare options, update your rationale, and justify your final decision. This mere change safeguards learning. It transforms AI to become an incentive to inferring and not a substitute for inferring. It is also subject to the same ethical requirements as that of the policy advice, as meaningful and safe AI usage is based on critical engagement and not passive use.

The professional development of teachers is necessary. There are a number of teachers who are ready to communicate about AI but are not sure about technical aspects, rules of the policy, and tracked methods. Demonstrations of the tools alone should not be the purpose of professional development. It should include fundamental notions of AI, classroom, prompt-literacy, privacy and safeguarding, academic integrity, rubric design and oral questioning approaches. Examples of their own subjects in the same way should be prepared in front of the teachers as well. The training of a teacher of history is not shared with one of ICT; they need some shared ethical framework and subject-related applications. Schools are encouraged to form

teacher teams, which can collaborate in designing AI literacy activities and to agree on shared expectations with regard to student disclosure of their use of AI.

Table 1

AI literacy curriculum strands and links to cognitive skills

Curricular strand	Student learning focus	Example classroom task	Targeted cognitive skill
Conceptual understanding	AI systems, data, models, prediction, error, and uncertainty	Classify daily technologies as AI/non-AI and explain the basis for each decision	Concept formation, classification, explanation
Practical responsible use	Prompting, tool selection, disclosure, and human oversight	Use AI to generate three study questions, then improve them using textbook criteria	Planning, monitoring, revision
Critical evaluation	Accuracy, evidence, bias, missing context, and source triangulation	Annotate an AI-generated paragraph for unsupported claims and missing evidence	Analysis, evaluation, inference
Ethical-social reasoning	Privacy, fairness, accountability, safety, and social impact	Debate whether an AI attendance system should be adopted in school	Perspective taking, ethical judgment, decision-making
Creative problem solving	AI-assisted brainstorming, prototyping, testing, and reflection	Design an AI-supported public awareness campaign and defend design choices	Problem framing, strategy selection, transfer

Figure 2

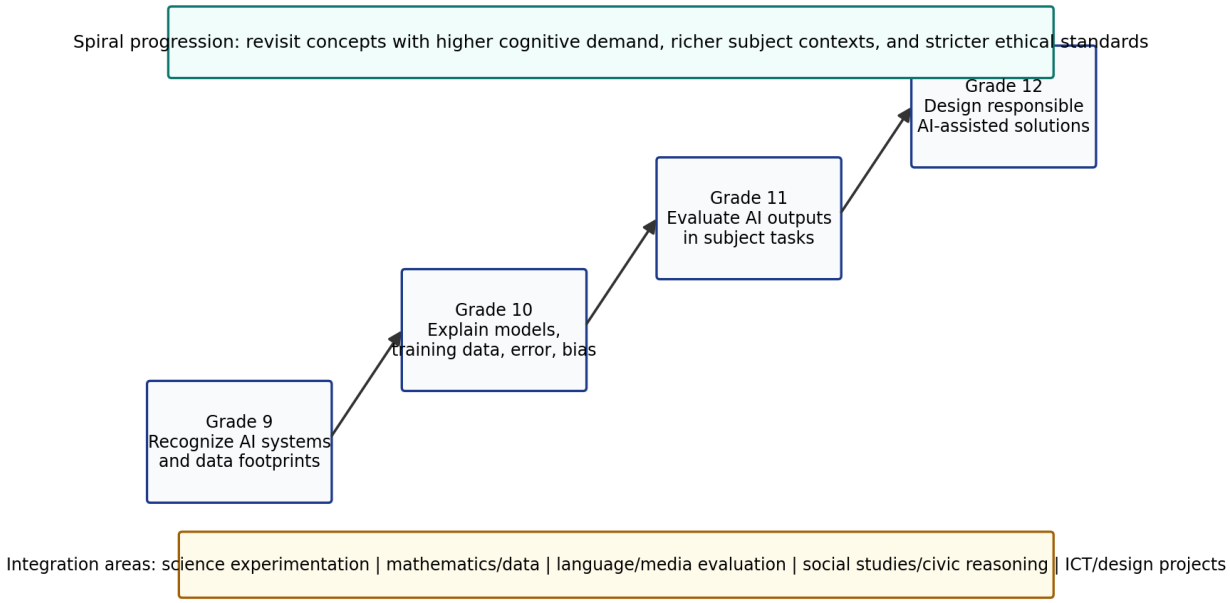

Figure 2. Spiral curriculum model for secondary AI literacy integration.

Expected Impact on Critical Thinking

The effects of AI literacy on critical thinking should be interpreted in terms of four pathways of skills. The first pathway is the review of the sources and evidence. Outputs created by AI have a tendency to condense data with no outside source. Students who come to see these products as temporary claims gain a greater sense of the evidence quality. They are taught to check facts, triangulate with credible sources, inquire whether evidence is up-to-date, and differentiate explanation and proof. This profoundly aids evaluation and inference component to critical thinking that Facione and Facione, (1990) defined. It also develops intellectual humility since students perceive the knowledge of fluent language to not be equal with the truth.

The second pathway is by detection of bias. Biases in training information, design decisions, prompts, and interpretation by the user can be reflected by AI systems. It is teachable to high school students by simple illustrations: image search stereotyping, translation fuzz, automatic scoring or predictive policing or recommendation, strengthening the short-sighted targets of concern. By tearing these examples apart, learners are practicing the skills of uncovering assumptions, considering other missing viewpoints, and judging on the social consequences. It is civic thinking in a critical manner. It also prepares students to not only work with AI but to also question institutions and platforms that are working with automated decisions.

Analysis of arguments is the third way. Arguments can be written in a short period of time with the help of the AI tools, and they can be generic, imbalanced or unproven. The teachers can get students to mark AI generated essays to help teach them claim, evidence, reasoning, counter argument and conclusion. The students would then be able to add knowledge of the subject in improving the argument. This assignment educates that the process of writing is more than the expression but the discipline of thought. AI can also be used to aid multilingual translation and vocabulary, though students still need to examine the meaning,

tone and precision. The learning advantage is in critique and revision and not in taking on the first draft written.

Self-regulation is the fourth pathway. By critically thinking, thinking becomes self-monitored. This could be visualized through teaching AI literacy: students will be asked to provide an AI-use-log: what prompt was selected, what response they got, what was accepted or rejected, what evidence was verified, how the final response varied. Such logs discourage not a lot of hidden outsourcing, and it encourages reflexive decision-making. They also assist teachers evaluate the process and not just the product. When students know that they have to justify their usage of AI and how they confirmed their usage, they are more likely to carefully consider their actions.

What is anticipated though is not necessarily a good effect. By making the assessment rewarding the refined final product rather than the reasoning process itself, students can use AI to skip the stages of reading, writing, calculating and rewriting. When the teachers are in doubt, inconsistency in rules applied in the classroom could occur. AI implementation can exacerbate inequality in case the students fail to connect to the devices that they can rely on or utilize the tools that do not meet the language. In this way, the alleged hit should be attenuated. Given the evaluation of AI literacy through evidence verification, bias screening, argument and reasoning evaluation and critique, critical thinking may be improved. It can undermine critical thinking by watering down critical thinking to the mediocre level of bone throwing tricks and turn out answers.

Expected Impact on Problem-Solving Skills

Problem solving is an activity which is practiced through perceiving the situation and defining the problem, brainstorming strategies, choosing tools, testing solutions and staying updated with feedback. AI literacy is potentially appropriate to help these processes due to the capability of AI tools to generate examples, simulate alternative examples, summarize constraints, and provide feedback. But these aids can be of only help in such cases as in which they are combined with the notion that students are to be responsible in formulating the problem and making up their minds on the solution. Authentic, inter-disciplinary and constrained by real-life considerations such as cost, fairness, sustainability, safety and the needs of the audience are the strongest problem-solving activities in secondary school.

One of the avenues of influence is problem representation. Problem solving is one of the problems that a student fails to solve since the student does not know what the problem is asking. AI literacy can condition the students to ask more problem-framing questions: What is known? What is unknown? What are the assumptions that are made? What is the data needed? What do you think would be a good solution? Students are able to compare their problem statement with the problem statement generated by AI then criticize both. This enhances decomposition and abstraction and does not alleviate human judgment.

The second channel is the generation of strategy. AI is capable of offering several solutions to a problem, but the students will have to be educated on how to compare the approaches. Mathematically, an AI tool might give clues on algebraic, graphical and numerical solutions. In science, it could imply experimental variables. It can refer to marketing techniques in business or entrepreneurship. These strategies can be ranked by students in terms of the feasibility, evidence, ethical risk and anticipated impact. The task that develops flexibility in thinking is comparison. It also eradicates one of the weaknesses of a naive problem solver; selecting the first plausible system without necessarily considering the options.

The 3rd pathway is the iterative testing. The revision time can be reduced with the assistance of learning on AI. Students can be enabled to test prompts, models, explanations or designs, and provide feedback and revise their work. An example of this can be a group of people who are already formulating a recycling

program in schools can request an AI tool to analyze them on how clear their message would convey to younger students and compare it with crowdsourcing. Air pollution analysis local groups can also make use of AI to organize the potential causes, and subsequently compare the potential causes to the actual environmental information. In either case problem solving is also improved as students go through a cyclic hypothesis, evidence, feedback and revision process.

The fourth line is the collaboration of explanation. The group discussion can be personalized by using AI to aid students in putting together background knowledge prior to the discussion to allow them to reason on a personal level. Roles that students can be assigned include evidence checker, prompt designer, ethics reviewer and solution defender. These roles are social and responsible to resolve problems. They also agree with the perspective by Hmelo-Silver (2004) about PBL being collaborative inquiry with support provided by reflection. The goal of the teacher is to make sure that the utilization of the AI assistance will not reduce the requirement of reasoning, but, in fact, enhance it.

Assessment Design and Evidence of Impact

A serious curriculum proposal should have the aspect of assessment. Figure 3 includes an assessment cycle starting with baseline measures, progresses through learning tasks, performance evidence, feedback, reflection and instructional adjustment. None of the student satisfaction or teacher impressions should be used solely by the schools. Critical thinking and problem solving impact should be measured using multiple sources that are: pre and post task analysis, rubrics, portfolios,reflective logs, oral defence and subject based analysis.

In Table 2 there are proposed indicators and instruments. The evaluation work on evidence, the analysis of bias, the critical work on arguments and the quality of justification has proven to be influential in the evaluation of critical thinking. The problem solving process can also be assessed through problem framing, strategy diversity, testing, revising and transfer of problem solving strategy to different situations. The idea of conceptual questions, disclosure of tool usage, ethical reasoning, and limitation explainability can be measured even by AI literacy. The potent assessment program should differentiate between AI-assisted performance and independent performance. One such case would be to give students a problem to solve independently and then to give them the opportunity to seek assistance using AI and then afterwards, submit some reflection about what was changed and why. This design will show whether such use of AI, besides substituting knowledge, enhances comprehension.

Oral defence could be helpful dedicatedly during secondary school. Learners presenting polished AI-assisted work have to be able to explain their reasoning, facts, decisions, and limitations. Verbal inquiry discourages harmful outsourcing, and reveals whether or not students have internalised the concepts. Portfolios help to store evidence as well; those processes include: prompts, drafts, feedback, verification notes, revisions and final justification. A portfolio approach can give the coverage of an AI literacy that a single written test can provide, though there may still be a role in vocabulary and conceptual understanding.

Ethical assessment practices must be there as well. We ought to inform students of what they can do with AI use, what must be revealed and what is misuse. The schools need to come up with age related policies which can assist in establishing the distinction between learning support and academic dishonesty. As a case in point, brainstorming questions with AI assistance may be fine, whereas submitting the AI-generated analysis as one of one's own may not be. It is not going to ban AI without reason but rather to provide education. Assessment should be of clarity of process, strict judgment, and good accountability.

Table 2

Assessment indicators for AI literacy, critical thinking, and problem solving

Outcome area	Observable indicator	Suggested instrument	Evidence of positive impact
AI literacy	Explains AI concepts and limitations in age-appropriate language	Concept quiz and explanation task	More accurate explanations; fewer misconceptions
Critical thinking	Checks evidence before accepting generated claims	Source-verification task and rubric	Improved relevance, reliability, and justification scores
Critical thinking	Identifies bias, assumptions, and missing perspectives	AI-output critique task	More precise bias detection and stronger counterarguments
Problem solving	Defines constraints and compares alternative strategies	Performance-based project rubric	More explicit problem framing and strategy comparison
Metacognition	Documents AI use and reflects on independent learning	AI-use log and reflection journal	Clearer explanation of what was accepted, rejected, and revised
Transfer	Applies AI evaluation routines in new subjects	Cross-disciplinary portfolio	Evidence of reasoning transfer beyond ICT lessons

Figure 3

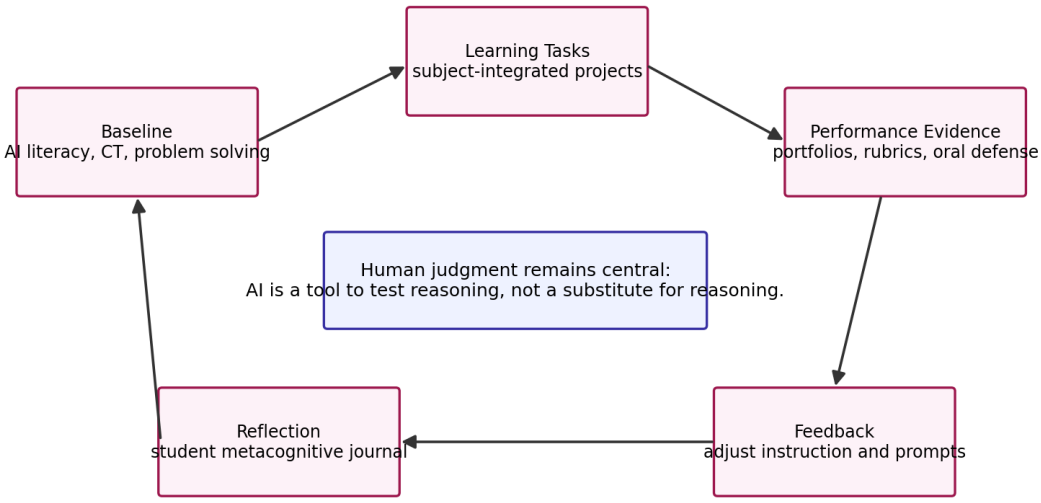

Figure 3. Assessment cycle for measuring cognitive impact while reducing overreliance on AI tools.

Risks, Equity, and Implementation Conditions

Implementation of AI literacy is not risk-free. Table 3 provides an overview of important risks and mitigation strategies. The first risk is the overreliance. Students can get used to consulting AI prior to making independent decisions. It can be responded to by schools by means of staged tasks: think, discuss, use AI, verify, reflect. This sort of a sequence maintains productive conflict, which is required to viable learning.

Misinformation and hallucination is the second risk. AI systems also may create incorrect or fake content when answers demanded by the prompts are definitely accurate. The teachers should not hide this weakness but instead learn to take this as a learning experience. The students should be taught to accept the AI output with the condition that they should verify it and doubt is permissible and power is grounded not on eloquence, but on facts. This is one of the reasons why AI literacy receives an opportunity to improve the critical thinking process: by making the process of evaluating claims a routine classroom activity, AI literacy would have a more significant effect on the critique of claims.

Inequity is the third risk. Devices, internet, language support, and parental guidance is uneven among students. In a scenario whereby schools give homework that is supported by AI without making it accessible, then the advantaged students will be able to gain more as a result. Equity assumes that there should be no barriers in the way of giving the most effective assistance to those who cannot get personal tools because of provision of access to school, off-line solutions, supervising the use, multiple languages, and defined rules. AI literacy must be part of public education since lack of it at schools will continue to widen the inequity.

Privacy and protection risk is the fourth risk. Data of users is collected by many AI tools and secondary students are underage. The schools should not coerce those students to put in their personal details within the systems that they do not own themselves. They are to use their more acceptable tools in a way that does not deny the policy holder his or her right to free speech. Instead of making privacy and safety the key components of AI implementation negotiable as suggested by both UNESCO and UNICEF, child-and-human centred approaches to AI make them the unquestionable conditions of AI application.

Teacher overload is the fifth risk. Failure in the execution of curriculum reformation takes place when the teachers are not given the new expectations with time, training, resources, and assessment. The pilot modules, collaborative planning, and shared rubrics should be the beginning elements to implement. The schools can form an AI literacy commission comprised of teachers in the field of ICT, science, mathematics, language, social studies, administration, and student representatives. Some of the tools that the committee should look into are tools, policies, lesson plans, and evidences of learning. Artificial intelligence literacy is too prized to be limited by a single educator, or one market.

Table 3

Implementation risks and mitigation strategies

Implementation risk	**Why it matters**	**Mitigation strategy**
Overreliance on AI	Students may skip productive struggle and weaken independent reasoning	Use think-first tasks, oral defence, process logs, and independent-plus-AI assessment phases
Misinformation and hallucination	Fluent outputs may contain errors or fabricated details	Teach verification routines, source comparison, uncertainty language, and evidence rubrics
Equity gaps	Unequal access may widen learning advantages	Provide school-supervised access, offline alternatives, and multilingual scaffolds
Privacy and safeguarding	Minors may expose personal data to external systems	Use approved tools, anonymized prompts, data minimization, and parental/school policy alignment
Teacher overload	Curriculum adoption fails without confidence and resources	Start with pilot modules, shared rubrics, professional development, and cross-subject planning teams
Assessment confusion	Unclear rules may encourage misuse or unfair punishment	Define acceptable AI use, disclosure expectations, and grading criteria for process and reasoning

DISCUSSION

The key postulation of the paper is that AI literacy can prove a promising direction towards critical thinking and problem solving as soon as it can be scrutinized as an education of disciplined judgement in AI-mediated contexts. This argument is an alternative to two typical extremes. The first one is optimism in technology: the belief that introducing AI resources to students will improve the process of learning. The second extreme is the technological rejection: the notion that AI should be out of schools in order to maintain classical learning. Neither of the two jobs is complete. Already students live with the AI and failure to take it into consideration puts students in unreadiness. But the AI is not applied wisely, and consequently it may be stimulating the superficiality of thought. guided integration is the stance (in which the responsibility is attributable).

The given model can provide some information to curriculum developers, according to which AI literacy should be interdisciplinary, spiral, and assessment-driven. The interdisciplinary mixture will ensure the applicability of the subject by subject. It is the spiral development that gives the right depth in consideration of age. The design based on assessment will include the measurement of reasoning in the schools instead of measuring the use of tools separately. This framework also puts the ethics at the core of the cognition, instead of the party that is cosmetic. Ethical thinking requires the students to consider the outcomes and stakeholders, fairness, privacy and accountability. These are problem solving that are of a more advanced nature since real world problems are hardly ever just technical.

The article offers a reality test to educators: AI can enhance the quality of questions that the student asks; just extending the rate at which a student answers is not a sufficient response. A lesson with an excellent instructional purpose is an AI literacy lesson where the student is asked to compare, verify, explain, revise, defend and reflect. A weak lesson will involve a request in which a student is required to formulate a solution and submit it. It is not the tool that makes the difference but the pedagogy. What is then needed by teachers is to help them develop an activity where the AI outputs can be used to create raw material on which reasoning can occur.

In the opinion of the researchers, it is correct that the paper outlines the need to carry out empirical studies in secondary schools. The suggested method to use in the future study to apply the proposed framework includes the quasi-experimental or design-based approach. Those who conduct research would be capable of comparing between classes conducted through conventional teaching digital literacy and classes conducted through AI literacy tasks with core attention on evidence evaluation and inquiry-based issues. There should be quality measures that will entail the general critical thinking exercises, discipline specific problem solving questions, portfolio analysis and interviews. Studies are also underway to investigate the variation in the effects due to gender, socioeconomic, language, past achievement, and teacher preparedness. In the absence of such evidence, AI literacy policy can increase quicker than the research base.

To the policy makers, it would mean that AI literacy needs to be among the curriculum standards, educating teachers, and the policy of assessment. Nonetheless, policy must not be preoccupied with the use of tools. The rapid tempo of commercial AI applications aims to change itself; critical thought, problematizing, assessment of evidence, awareness of privacy, responsibility are all permanent elements in educational goals. The future lesson plan should not be centered around the new interfaces but the eternal principles and practices. The policies should also cover procurement, protection, data control, teacher workload and also fair access.

CONCLUSION

As more use of AI-intermediate communication, decision-making, and learning becomes widespread, AI literacy is becoming a prerequisite of a high school education. This paper has speculated that AI literacy may play a beneficial role in critical thinking and problem solving skills taught through an interdisciplinary, spiral and ethically based curriculum of teaching AI literacy. The framework suggests critical inquiry, metacognitive control, and authentic problem-based learning as the incorporating processes among the AI literacy and cognitive development. This argument is translated into the curriculum strands, assessment indicators, and implementation safeguards in the paper in terms of tables and figures.

The best warning of the paper is that there is no assurance of better thinking provided that AI is integrated. Unstructured use can undermine hard work and the originality and encourage students to accept produced material that lacks evidence. The learning quality of AI literacy hinges on teacher instruction, clear evaluation, rewriting and justification of arguments. The reason why AI literacy in high schools cannot be seen as a trendy fad in an automated world is that this is a methodical way of ensuring that students are prepared to be intelligent agents in the human agency of an automated world.

REFERENCES

AI4K12 Initiative. (2024). K-12 AI guidelines: Five big ideas in AI. Association for the Advancement of Artificial Intelligence and Computer Science Teachers Association.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). How people learn: Brain, mind, experience, and school (Expanded ed.). National Academy Press.

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. Educational Leadership, 43(2), 44-48.

European Commission, Directorate-General for Education, Youth, Sport and Culture. (2022). Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators. Publications Office of the European Union.

Facione, P. A. (1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction: The Delphi report. California Academic Press.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16, 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educational Psychologist, 41(2), 75-86. https://doi.org/10.1207/s15326985ep4102_1

Kong, S.-C., Cheung, W. M.-Y., & Zhang, G. (2021). Evaluation of an artificial intelligence literacy course for university students with diverse study backgrounds. Computers and Education: Artificial Intelligence, 2, Article 100026. https://doi.org/10.1016/j.caeai.2021.100026

Long, D., & Magerko, B. (2020). What is AI literacy? Competencies and design considerations. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1-16. https://doi.org/10.1145/3313831.3376727

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. Pearson.

Miao, F., & Holmes, W. (2023). Guidance for generative AI in education and research. UNESCO.

Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. Computers and Education: Artificial Intelligence, 2, Article 100041. https://doi.org/10.1016/j.caeai.2021.100041

OECD. (2019). OECD learning compass 2030: A series of concept notes. OECD Publishing.

Selwyn, N. (2019). Should robots replace teachers? AI and the future of education. Polity Press.

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. Educational Research Review, 22, 142-158. https://doi.org/10.1016/j.edurev.2017.09.003

Southworth, J., Migliaccio, K., Glover, J., Glover, J. N., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI across the curriculum: Transforming the higher education landscape via innovation in AI literacy. Computers and Education: Artificial Intelligence, 4, Article 100127. https://doi.org/10.1016/j.caeai.2023.100127

Touretzky, D., Gardner-McCune, C., Breazeal, C., Martin, F., & Seehorn, D. (2019). A year in K-12 AI education. AI Magazine, 40(4), 88-90. https://doi.org/10.1609/aimag.v40i4.5289

Touretzky, D., Gardner-McCune, C., Martin, F., & Seehorn, D. (2019). Envisioning AI for K-12: What should every child know about AI? Proceedings of the AAAI Conference on Artificial Intelligence, 33(01), 9795-9799. https://doi.org/10.1609/aaai.v33i01.33019795

UNICEF. (2021). Policy guidance on AI for children 2.0. United Nations Children's Fund.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Wang, N., & Lester, J. (2023). K-12 education in the age of AI: A call to action for K-12 AI literacy. International Journal of Artificial Intelligence in Education, 33, 228-232. https://doi.org/10.1007/s40593-023-00358-x

Williamson, B., & Eynon, R. (2020). Historical threads, missing links, and future directions in AI in education. Learning, Media and Technology, 45(3), 223-235. https://doi.org/10.1080/17439884.2020.1798995

Wing, J. M. (2006). Computational thinking. Communications of the ACM, 49(3), 33-35. https://doi.org/10.1145/1118178.1118215

World Economic Forum. (2025). The future of jobs report 2025. World Economic Forum.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education: Where are the educators? International Journal of Educational Technology in Higher Education, 16, Article 39. https://doi.org/10.1186/s41239-019-0171-0