'A good question is half the answer:' a learning-oriented K-12 prompt literacy competency cultivation framework

Jing Zhou, Li Si, and Xianrui Liu

Abstract

Introduction. As an emerging key competence, prompt literacy is gradually becoming an essential component of artificial intelligence literacy and is increasingly emphasised in K–12 education. This study aims to construct a learning-oriented K-12 prompt literacy competency cultivation framework.

Method. The framework was theoretically informed by Bloom's taxonomy, Zimmerman's self-regulated learning theory, and existing AI literacy frameworks for K–12 students. The framework was then refined through the deductive content analysis based on the semi-structured interview data that were conducted with teachers and students.

Results. The framework comprises three dimensions. (1) Four core competencies: prompt cognition, prompt skills, prompt thinking, and prompt values; (2) three learning objectives: understand, apply, and evaluate; (3) four cultivation stages: observation, emulation, self-control, and self-regulation. The indicators of competencies, specific descriptions of objectives, and corresponding cultivation approaches were also proposed. Ultimately, a stage-based, progressive, and highly actionable guideline for cultivating prompt literacy was developed, which clearly specifies the competencies to be nurtured and the learning objectives to be achieved at each stage.

Conclusion(s). This study contributes to AI literacy education by establishing the first comprehensive framework for prompt literacy cultivation in K–12 students.

Introduction

Recently, several countries have incorporated AI in K-12 education into national strategies. For example, the U.S. K-12 AI Education Initiative (The White House, 2025) and Singapore's AI Student Outreach Programme (AI Singapore, 2025). In China, the launch of Guangdong's 'AI *Education 211*' framework (Department of Education of Guangdong Province, 2025) and the Ministry of Education's Guidelines for AI Education in Primary and Secondary Schools (Xinhua News Agency, 2025) signalled the initial establishment of an AI literacy education system. The quality of Generative AI (GenAI) outputs relies heavily on the clarity and precision of prompts. This makes prompt literacy a key component of AI literacy. The prompt literacy of K-12 students is their ability to design effective prompts, interpret outputs, and iteratively refine prompts. Strengthening prompt literacy can stimulate students' creativity in inquiry-based learning and foster human–AI collaborative learning. Hence, this study proposes a learning-oriented prompt literacy competency cultivation framework for K-12 students, aiming to provide a practical and theoretically grounded reference for integrating prompt literacy into AI literacy education.

Related works

Prompt literacy

Existing studies have explored the strategies of cultivating prompt literacy (Zhang & Jia, 2024), the prompt literacy theoretical framework (Li et al., 2025), and curriculum systems (Huang, 2024) in libraries. Research has also examined the role of prompt literacy, showing that prompt literacy levels influence users' willingness and frequency in writing prompts (Bozkurt et al., 2023; Knoth et al., 2024), as well as learning experiences. Improving prompt literacy can also foster critical thinking and problem-solving skills (Walter, 2024; Chang et al., 2023). Currently, studies on prompt literacy among K-12 primarily focus on its application to language learning (Hwang et al., 2023) and academic writing (Kim et al., 2025).

AI literacy frameworks for K-12 students

Most existing AI literacy frameworks adopt either a one-dimensional or two-dimensional structure. For example, as for one-dimensional frameworks, Guangdong's 'AI *Education 211*' framework outlines four components: human–AI concepts, technical implementation, intelligent thinking, and ethical responsibility (Department of Education of Guangdong Province, 2025). The Guidelines for AI Education in Primary and Secondary Schools define cultivation objectives as cognition, skills, thinking, and values across different grade levels (Xinhua News Agency, 2025). Two-dimensional frameworks include UNESCO's AI Competency Framework for Students, which includes Aspects (Human-centred mindset, Ethics of AI, AI techniques and applications, AI system design) and Progression (Understand, Apply, Create) (UNESCO, 2024). Similarly, the Framework for AI Technology and Engineering Literacy in Primary and Secondary Schools in China incorporates both content and requirements. The content includes AI and humanity, AI and society, AI technologies, and AI system design, with corresponding first- and second-level indicators. The requirements specify what students '*should know*' and '*should be able to do*' at different grade levels (China National Center for Educational Technology, 2021). The AI4K12 project has also proposed five key AI concepts: perception, representation and reasoning, learning, natural interaction, and societal impact, along with '*should know*' and '*should be able to do*' requirements for each grade level (AAAI & CSTA, 2019).

In summary, existing studies and practices mainly focus on the conceptualisation and role of prompt literacy. Research on prompt literacy among K-12 students remains at an early stage, ignoring both teachers' and students' perspectives. As for AI literacy frameworks, while one-dimensional frameworks provide core AI literacy components and clear secondary indicators, they do not specify the developmental goals or requirements for each grade level. Two-dimensional frameworks balance content with requirements or objectives, but often fail to specify

corresponding cultivation strategies or measures. Therefore, it is necessary to construct a multidimensional competency framework for prompt literacy for K-12 students according to their cognitive development levels.

Research design

This study adopted a mixed-methods design to construct the framework for cultivating prompt literacy among K-12 students. Firstly, primary dimensions are conceptualised, informed by existing AI literacy frameworks and education science theories. To refine two of the dimensions, which are core competency and learning objectives, semi-structured interviews were conducted with both teachers and students. The resulting data were analysed through deductive content analysis, which enabled the development of secondary indicators and a coding matrix. The third dimension, which is the cultivation stage, was proposed by synthesising teachers' suggestions with education science theories.

Identification of primary dimensions

This study draws upon existing AI literacy frameworks for K-12 students and research on prompt literacy, as well as theories in education science that have been proven effective in AI literacy. Based on these, we conceptualise the K-12 prompt literacy competency cultivation framework as a three-dimensional(3D) structure consisting of core competencies, learning objectives, and cultivation stages (see Figure 1). The 3D structure is used to represent the combinatorial and relational structure among different dimensions of the framework.
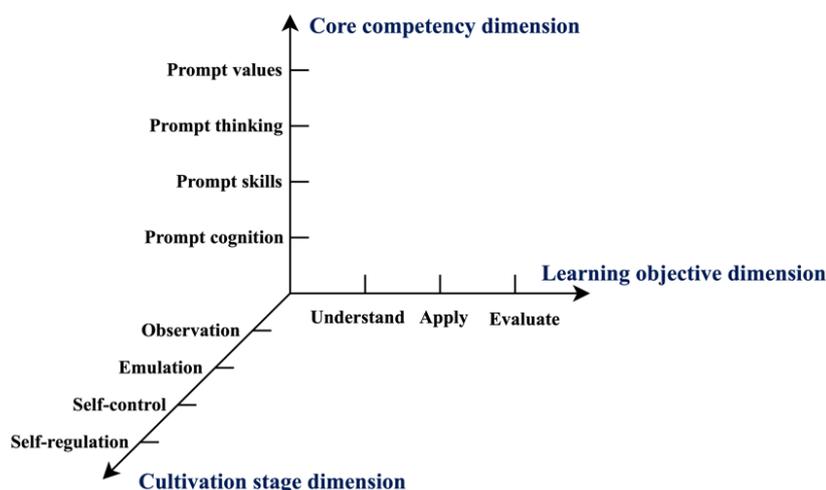

Figure 1. Primary dimensions of the K-12 prompt literacy competency cultivation framework.

Core competency dimension

Unlike prompt engineering, which focuses solely on designing prompts and improving their effectiveness, prompt literacy also encompasses critical thinking, as well as ethical awareness during the prompting process (Zhao et al., 2025; Zhang & Jia, 2024). Drawing on the Guidelines for AI Education in Primary and Secondary Schools (Xinhua News Agency, 2025), this study divides the core competencies of prompt literacy into four categories: prompt cognition, prompt skills, prompt thinking, and prompt values. Taking solving mathematics problems with AI assistance as an example, prompt cognition concerns basic understanding of AI and large language models, such as recognising that the model generates answers based on patterns rather than true mathematical reasoning and may produce plausible but incorrect results. Prompt skills emphasise the technical ability to formulate effective prompts, for example by clearly specifying known conditions, unknown variables, and requesting step-by-step solutions. Prompt thinking reflects a strategic and problem-structuring mindset in human−AI interaction, exemplified by decomposing a complex

problem into sub-steps (e.g., identifying variables, selecting formulas, and checking results). Prompt values address ethical and normative considerations, such as using AI outputs as learning support rather than directly copying answers and maintaining academic integrity.

Learning objective dimension

This study adopts Bloom's taxonomy of educational objectives, first proposed in 1956 and later revised by Anderson and Krathwohl in 2001, which remains widely applied in educational theory (Anderson & Krathwohl, 2001). Bloom's taxonomy covers cognitive processes ranging from lower-order skills (remember and understand) to higher-order skills (evaluate and create) (Wilson, 2016), and emphasises the dynamic nature of learning, such as *'know and understand AI'*, *'use and apply AI'*, and *'evaluate and create AI'* (Ng et al., 2021). The essence of prompt literacy, which is formulating precise prompts, analysing AI-generated outputs, and iteratively refining prompts to achieve intended outcomes, also aligns with educational objectives in Bloom's taxonomy (Rowland, 2023). Considering the cognitive level of K-12 students, this study defines the learning objectives dimension as *'understand'*, *'apply'*, and *'evaluate'*.

Cultivation stage dimension

Zimmerman's multi-level self-regulated learning (SRL) framework emphasises learners' ability to actively engage in, control, and regulate their learning processes (Zimmerman, 2000). This framework has been shown to be applicable to scenarios where students learn with the support of GenAI (Chang et al., 2023). Under this framework, prompts can be categorised into three types: cognitive prompts, metacognitive prompts, and reverse prompts. Cognitive prompts focus on students' knowledge acquisition, corresponding to the observation and emulation stages; metacognitive prompts guide learners' monitoring and control of their learning, aligning with the self-control stage; and reverse prompts, generated through reciprocal questioning with AI, correspond to the self-regulation stage. This highlights the bidirectional interaction between students and GenAI in prompt literacy cultivation. Accordingly, this study defines the cultivation stages as observation, emulation, self-control, and self-regulation.

Specification of secondary indicators

Interview design

In order to refine the secondary indicators of the framework, semi-structured interviews were conducted with a total of 22 participants, including 16 teachers from primary and secondary schools and 6 students from junior secondary schools. Teachers were selected from different subject areas (e.g., information technology, language, and math) to ensure disciplinary diversity, while students were selected from the 7th to 9th grade levels. The interviews were carried out face-to-face or via online video conferencing, each lasting approximately 15–20 minutes. All participants were informed of the purpose of the study, and informed consent was obtained prior to data collection. The interview questions are designed separately for teachers and students (Appendix A).

Data coding and analysis

All interviews were audio-recorded with participants' consent and transcribed verbatim. A deductive content analysis was conducted, following a theory-driven approach (Appendix B). First, the main categories were defined according to the primary dimensions. Second, participants' statements were coded deductively into these categories and assigned specific labels (e.g., the statement *'a good prompt should include context information'* was coded under *'prompt cognition'* and labelled as *'prompt elements'*). Third, sub-categories were refined and expanded based on the labels to build a coding matrix (e.g., the sub-category *'concepts of prompts'* included the label *'prompt elements'*). To ensure reliability, two researchers independently coded the transcripts, and intercoder agreement was reached through discussion and reconciliation of differences. For instance, after discussion, the relatively abstract concept of *'principles of writing prompts'* was replaced with the more practical indicator of *'rules of writing prompts.'*

Results

We have established indicators of core competencies of prompt literacy for K-12 students, together with the corresponding learning objectives and cultivation stages. As shown in Table 1, the core competencies and their learning objectives are denoted using letters and numbers: A, B, C, and D represent the four core competencies, while the numbers specify the concrete indicators under each competency. For instance, 'A1' refers to the first indicator of *'Prompt cognition* (A)', namely *'Principles of GenAI.'* G1, G2, and G3 denote the three levels of learning objectives. Thus, 'A1-G1' indicates that the *'Understand'* objective (G1) of A1 is *'Understand the terminology and generation process of GenAI.'* The framework is aligned with the cognitive developmental characteristics of K-12 students. It follows the principle of *'gradual progression from the simple to the complex,'* ensuring that students can progressively develop prompt literacy across learning objectives. It is also closely integrated with authentic educational contexts, focusing primarily on curriculum-based learning tasks such as creative writing, reading comprehension, and mathematical problem-solving.

Core competency dimension		Learning objective dimension		
Core competency	Indicators	Understand (G1)	Apply (G2)	Evaluate (G3)
Prompt cognition (A)	Principles of GenAI (A1)	Understand the terminology and generation processes of GenAI	Apply different functions of GenAI to support learning tasks	Evaluate the performance of GenAI in supporting learning tasks
	Concepts of prompts (A2)	Understand the definition, types, and functions of prompts	Select the most appropriate prompts to accomplish learning tasks	Evaluate the effectiveness of different prompts in accomplishing learning tasks
Prompt skills (B)	Prompt-writing rules (B1)	Understand the components and structure of prompts	Write complete prompts to accomplish learning tasks	Evaluate the applicability and limitations of different rules in specific learning tasks
	Prompt design frameworks (B2)	Understand existing prompt design frameworks (e.g., CAST, CLEAR, TRUST)	Use standardised processes to write prompts to accomplish learning tasks	Evaluate the applicability and limitations of different frameworks in specific learning tasks
	Prompt-writing methods (B3)	Understand existing prompt-writing methods (e.g., Chain of Thought, Self-Prompting, Tree of Thoughts)	Write logically clear and concretely operable prompts to accomplish learning tasks	Evaluate the applicability and limitations of different methods in specific learning tasks
Prompt thinking (C)	Critical thinking (C1)	Understand common errors in GenAI outputs	Revise prompts to gain responses from multiple perspectives and standpoints	Evaluate the accuracy, validity, reliability, and bias of GenAI outputs
	Systematic thinking (C2)	Understand interconnections of different GenAI outputs	Integrate and synthesise different outputs	Evaluate whether different outputs demonstrate coherence and interconnectivity
	Engineering thinking (C3)	Understand the structure of prompts and outputs	Break down complex prompts into sub-prompts	Evaluate the effectiveness of sub-prompts under different decomposition standards
Prompt values (D)	Privacy awareness (D1)	Understand the scope of privacy information	Write prompts that avoid privacy disclosure	Judge whether prompts adequately protect personal privacy
	Awareness of equity, diversity, and inclusion (EDI) (D2)	Understand principles of EDI	Write prompts that express EDI	Judge whether prompts reflect EDI
	Autonomy and subjectivity awareness (D3)	Understand the role of humans in prompting	Integrate GenAI outputs with one's own knowledge	Judge whether GenAI outputs conflict with one's own knowledge

Table 1. Indicators of core competencies and learning objectives of prompt literacy.

According to Zimmerman's multi-level SRL framework, the four cultivation stages together with their corresponding cultivation approaches are illustrated in Figure 2. In addition, the specific competencies to be developed at each stage and their corresponding learning objectives are also presented.
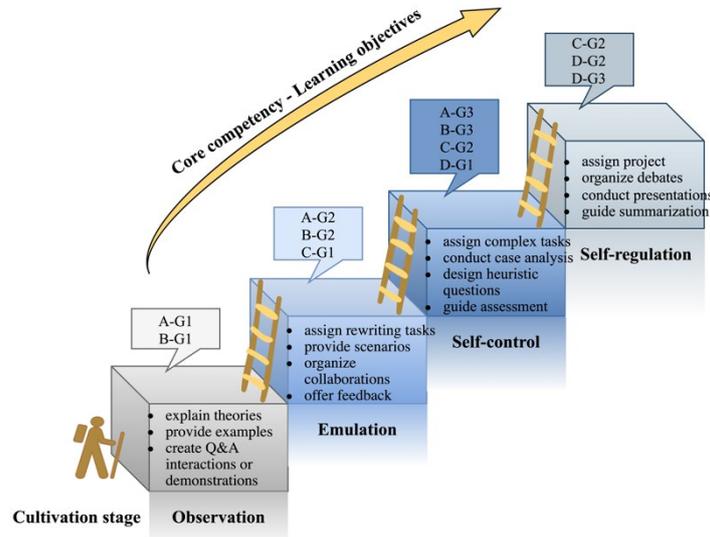

Figure 2. Four cultivation stages of prompt literacy.

(1) Observation stage. Students firstly observe teachers as they master a skill and are able to generalise its main steps (Chang et al., 2023). Teachers should explain the theories of AI and prompting, provide diverse examples of prompts, demonstrate the differences between effective and ineffective prompts, and create Q&A interactions or demonstrations using AI tools. At this stage, the primary task for students is to achieve the *'understand'* objectives of prompt cognition and prompt skills.

(2) Emulation stage. Students then attempt to imitate others' behaviors, but still rely on external feedback and have not yet fully developed autonomous learning ability (Chang et al., 2023). Teachers need to provide operational methods for prompt design, assign rewriting prompt tasks, provide contextualised task scenarios, organise group collaborations, and offer targeted feedback and evaluation. This enables students' prompt outputs to gradually approach standardised expressions, helps them gain an initial understanding of prompt thinking, and fosters the gradual development of their application abilities in prompt cognition and skills.

(3) Self-control stage. Thirdly, students begin to generate and refine prompts independently, without relying on teachers or examples (Ericsson & Lehmann, 1996). Teachers should assign more complex tasks, encourage students to try and compare multiple prompt strategies according to different contexts and goals in cases. At the same time, teachers can pose heuristic questions to stimulate students' awareness of prompt values, while encouraging them to use self-assessment and peer-assessment to evaluate prompt strategies and AI outputs. This promotes the development of students' evaluation ability in prompt cognition and skills, enables them to achieve the *'apply'* objectives of prompt thinking, and facilitates their initial understanding of prompt values.

(4) Self-regulation stage. Finally, students can adjust their use of prompt strategies based on evaluation results, and no longer rely on teachers. This stage emphasises their autonomy in human–AI interaction (Zhang & Chen, 2025). Teachers' tasks shift toward guiding students in prompt thinking and values, such as assigning project-based learning, organising situational debates, conducting group presentations, and guiding reflective summarisation. The focus is on

cultivating students' evaluation abilities in prompt thinking and their application and evaluation abilities in prompt values, representing the advanced stage of prompt literacy cultivation.

Discussion and conclusion

As GenAI is increasingly integrated into educational practice, prompt literacy is gradually becoming one of the core competencies that should be emphasised and cultivated in basic education. Drawing on Bloom's taxonomy and Zimmerman's multi-level SRL model, as well as research on prompt literacy and AI literacy frameworks for K-12 students, this study proposes a three-dimensional prompt literacy competency cultivation framework for K-12 students. The framework defines four core competencies: prompt cognition, prompt skills, prompt thinking, and prompt values; and three learning objectives: understand, apply, and evaluate. It further outlines four staged cultivation stages: observation, emulation, self-control, and self-regulation. Through semi-structured interviews with teachers and students and subsequent deductive content analysis, the framework is substantiated by concrete indicators.

The resulting three-dimensional framework is not only theoretically grounded but also practically feasible. The study integrates insights from AI literacy frameworks and education science theories into a unified model of prompt literacy cultivation. It is also explicitly learning-oriented, which grants it broad applicability across different educational settings. Hence, it can both serve as an evaluative standard for assessing students' prompt literacy and as a reference for structuring the cultivation process in school or extracurricular learning. Besides, by incorporating the perspectives of both teachers and students through semi-structured interviews, this study ensured a more comprehensive understanding of prompt literacy. Teachers offered insights into pedagogical feasibility and developmental progression, while students provided opinions on actual learning practices and challenges. This dual-perspective approach enabled the framework to bridge theoretical constructs with learners' authentic needs. More importantly, the primary dimensions of the framework are designed to be cross-culturally adaptable. However, the specific indicators and cultivation practices are derived from interviews with Chinese teachers and students and are therefore contextually grounded in the Chinese K–12 educational setting. Applying the framework in other cultural or educational contexts would require localised empirical investigation and adaptation of the indicators.

Despite these contributions, certain limitations should be acknowledged. The relatively small sample size restricts the generalisability of the findings. Moreover, the framework has not yet been empirically tested in experimental or longitudinal classroom settings. Future research will therefore focus on conducting field-based trials and assessments, using the proposed framework as the basis for intervention design and evaluation.

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About the authors

Jing Zhou is a Lecturer in the School of Law, Humanities and Sociology, Wuhan University of Technology, China. Her research interests are digital humanities and human-AI collaboration. She can be contacted at lsiwhu@163.com

Li Si is a Professor in the School of Information Management, Wuhan University. Her research interest focuses on digital literacy, knowledge organisation. She can be contacted at darui552@whu.edu.cn

Xianrui Liu is a doctoral candidate in the School of Information Management, Wuhan University. Her research interest focuses on data governance, human-AI interaction. She can be contacted at darui552@whu.edu.cn

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Appendix A: Interview questions for both teachers and students.

Indicators	Teacher interview questions	Student interview questions
Prompt cognition	How do you think students currently understand the concepts of GenAI and prompts?	What do you know about GenAI and prompts?
		What do you think you should know when using GenAI and prompts?
		Can you explain what a prompt is in your own words?
Prompt skills	In your teaching, what kinds of skills do students need most when writing or revising prompts?	Can you give an example of how you used prompts in your study (e.g., writing, math, reading)?
		What factors do you consider when writing prompts?
Prompt thinking	In what ways do you see students showing critical or creative thinking when they design or refine prompts?	What methods do you use to make GenAI give more creative or more task-oriented answers?
		What criteria do you use to judge which answer is better?
		What do you do if the AI answer is not good?
Prompt values	What ethical or responsible behaviors should students demonstrate when using GenAI prompts in learning?	What do you think you should be careful about when using GenAI (e.g., plagiarism, fairness, bias)?

Appendix B: Examples of interview data coding results.

Main categories	Sub-categories	Labels	Initial statements
Prompt cognition	Principles of GenAI	The benefits and risks of GenAI	Students should understand both the benefits and risks of GenAI before using it in learning.
	Concepts of prompts	Prompt elements	A good prompt should include context information.
Prompt skills	Prompt-writing rules	Precise wording of prompt	The wording of the prompt must be precise, otherwise the AI will misunderstand.
	Prompt design frameworks	CLEAR	I sometimes follow a template like CLEAR to make sure I cover all aspects.
	Prompt-writing methods	Chain-of-thought	When I want detailed reasoning, I add 'think step by step' in the prompt.
Prompt thinking	Critical thinking	Questioning from different angles	Sometimes I deliberately ask from another angle to test the reliability.
	Systematic thinking	Integrating answers	I combine AI outputs from different prompts to get a more complete picture
	Engineering thinking	Modular prompts	I hope students can break a big task into several smaller prompts and then combine the results.
Prompt values	Privacy awareness	Protecting sensitive information	Students should never include their personal ID or phone number when writing prompts.
	Awareness of equity, diversity, and inclusion	Equity awareness	When I asked AI to output images of a person from Shanghai and a person from Henan, I think the AI's output showed regional discrimination.
	Autonomy and subjectivity awareness	Human-AI balance	Even though I use AI frequently, I don't want to be replaced by AI